POWER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

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VOLUME XLVII

January 1 to June 30, 1918

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POWER

INDEX TO VOLUME XLVII

January 1 to June 30, 1918

EXPLANATORY NOTE

Illustrated articles are marked with an asterisk (*), book notices with a dagger (†), inquiries with a double dagger (‡). The cross-references condense the material and assist the reader, but are not to be regarded as complete or conclusive. So, if there were a reference from "Boiler" to "Power plant," and if the searcher failed to find the required article under the latter word, he should look through the "Boiler" entries, or others that the topic might suggest, as he would have done had there been no cross-reference. Letters are indexed under title or subject, general articles under writer's name as well. Not all articles relating to a given topic necessarily appear under the same entries.

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POWER

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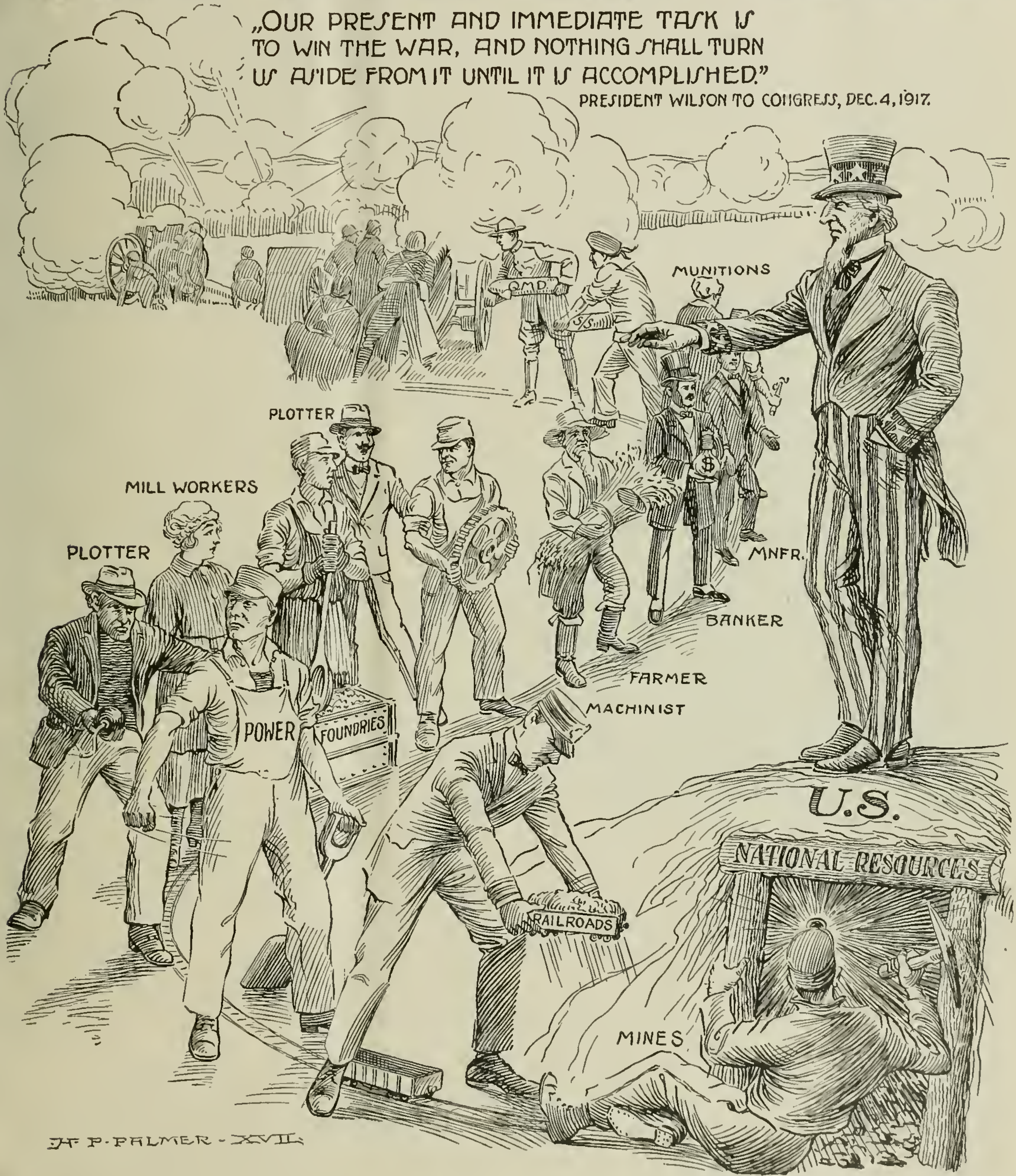
THE VICTORY LINE

„OUR PRESENT AND IMMEDIATE TASK IS TO WIN THE WAR, AND NOTHING SHALL TURN US ASIDE FROM IT UNTIL IT IS ACCOMPLISHED."

PRESIDENT WILSON TO CONGRESS, DEC. 4, 1917.



The Year's Progress in The Power Field

DURING the last year war has been the one great factor influencing the power field. In certain branches it has brought forth intensive development (the "Liberty" motor, for example), but for the most part progress has been delayed. In the face of readjustment of labor due to the call of the army, shortage of coal and raw materials and inadequate transportation facilities, maximum production has absorbed largely the energy of the mechanical industry. There have been enormous demands for boilers, prime movers and auxiliary equipment for the numerous boats now building. To keep pace with the great output from the shops, power-plant capacity has been increased with a decided tendency toward the use of larger units. Comparatively small plants that not long ago considered machines of 5000-kw. capacity large, are now installing 10,000-kw. turbo-generators with the idea of larger machines on the next order. This has led to the use of larger boilers, stokers and condensers. Over a period of years there has been steady progress in this direction and a trend toward higher pressures accompanied by superheat of increasing degree. Back of this has been the demand for higher efficiencies, due to the rising price of fuel. For the same reason the economizer is no longer a doubtful investment, and impetus has been given toward improving the economy of all auxiliaries.

The Trend Toward Higher Pressures

With proper selection of available equipment and close attention to air leakage it is now possible to maintain a vacuum 97 per cent. perfect, leaving little to gain. At the upper end of the thermal cycle the opportunity for improvement is greater. With present materials and designs a maximum initial temperature of 700 deg. is considered the practical limit. Made up in the proper proportions by pressure and superheat, there is a possible 10 to 12 per cent. gain in economy over present results. Increase of friction with the density of the steam, the greater expansion and contraction and other practical difficulties detract from the previous theoretical estimate, but even a portion of the gain mentioned is worth striving for. Turbine builders see no insurmountable difficulties in perfecting their machines for the higher pressures. However, radical changes in boiler and valve design will be necessary. The pressure limit for the standard boiler has been placed at 350 lb., whereas 500 to 600 lb. is anticipated. Experimental work to develop boilers for these pressures is now in process. At the present time pressures up to 250 lb. are common, and during the last year a number of installations were made or planned in which the pressures will be higher.

Notable Steam Plants

At Joliet, the Public Service Company of Northern Illinois has cross-drum boilers designed for 350 lb. pressure and 225 deg. of superheat. This is the highest pressure used in a central-station plant in this country, and it is generally conceded that it is about the limit for boilers of the present standard design. In the same plant an innovation is the use of a horizontal all-steel individual economizer placed above and integral with the boiler, the whole being inclosed by a steel casing Although careful tests have not been made as yet, the boilers have been in operation long enough to indicate that they will develop exceptionally high capacities and that the efficiency may exceed 80 per cent.

To withstand the high pressure the plates of the boiler drum are 1$\frac{5}{16}$ in. thick and the longitudinal seam is a quadruple-riveted butt joint with double cover straps. The boiler tubes are of lower gage than in boilers designed for 250 lb. pressure, and the metal in the economizer tubes is one-quarter inch thick. Valves that had been previously designed for the pressure were available, the piping is extra heavy and the joints are of the bolted type having a welded seal commonly employed by Sargent & Lundy for high pressures. With smooth metal-to-metal joints, the difficulties that gaskets would cause are eliminated. At normal load a steam velocity of 7200 ft. per min. in the turbine leads is employed. This permits piping of comparatively small diameters, so that the initial cost is very little more than for pressures of 250 pounds.

Extensions to many plants have been made, and a number of new stations have been placed in operation during the year. Perhaps the most notable is the new steam station of the Buffalo General Electric Co. designed for 275 lb. pressure and 275 deg. of superheat, giving a total steam temperature of 689 deg. The station was planned for a capacity of 200,000 kw., but the initial installation was 60,000 kw. in three units. The boilers are of the cross-drum type having 11,400 sq.ft. of steam-making surface each. They are fired at both ends by two 15-retort underfeed stokers. This duplex stoker setting, measuring at the grate level nearly 24 ft. wide by 17½ ft. deep, is the largest ever built, and the ratio of grate area to heating surface, 1 to 27.3, is probably the most liberal employed in power-plant practice. At normal rating a trifle less than two tons of coal per hour is fed to each boiler. The stokers are capable of supplying 15 tons per boiler per hour, and when feeding 10½ tons per hour per boiler, which is well within easy operation, the rate of combustion is about 50 lb. per sq.ft. of grate and the evaporation per square foot of heating surface is 14.4 lb. When this is compared to three pounds, which is considered a fair figure for normal operation, it is evident the plant has been designed to carry overloads that would have been considered impossible a few years ago. To avoid difficulties with scale the makeup water is distilled. Valves in the high-pressure lines are of steel and of the gate type. In line with modern tendencies, duplex exciter units, with a motor on one end and a turbine on the other, are employed. An innovation tending to collect some of the stray heat units is the circulation of condensate for cooling the main turbine bearings.

Steam-Turbine Development

In the review last year was given a list of large turbines on order. Some of these were the 50,000-kv.-a. turbo-generator for Connors Creek, the 60,000-kw. three-cylinder unit for the Interborough, a 45,000-kw. turbine for the Narragansett Electric Lighting Co., of

Providence, and five 30,000- and 35,000-kw. machines for the Commonwealth-Edison Co. One of the 35,000-kw. units is shown in Fig. 1. The turbine is of the two-cylinder tandem-compound type, with the high-pressure element single-flow and the low-pressure element double-flow. To this list may be added a 45,000-kw. two-cylinder compound unit and a 70,000-kw. three-cylinder machine, the largest ever made, for the Duquesne Light Co., of Pittsburgh. Some of these machines have been installed and the others are still in the making. A close observance of their operation should go a long way in determining the status of the large turbine. Data will be collected that should decide the features of the various designs to be retained or modified, the best arrangement of the unit and the economical limitations.

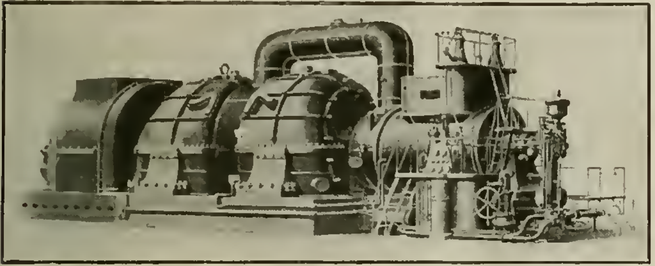


FIG. 1. WESTINGHOUSE 35,000-KW. TURBO-GENERATOR

Opinion has been expressed that the mammoth unit is perhaps after all a mistake. At least development should first come in designs for high pressure and intermediate heating of the steam to raise the average temperature. The various makers of turbines are working along different lines. Some are perfecting the impulse turbine and leaning toward a single-cylinder machine even in the largest sizes. Opposed to this is the reaction turbine with two and, in the largest machines, three cylinders. The present year should be significant in turbine development, as many great machines of either type will be placed in operation and there should be abundant data to point the way.

In the impulse turbine there is a noticeable tendency toward symmetrical cone-shaped construction, the elimination of angles and the production of a straight path for the steam. The early stages are becoming smaller in diameter and fewer to minimize the friction and leakage, which increase with the density and pressure of the steam, and better metals are being employed so that a high velocity of the blading may be maintained. The numerous control valves regulating the quantity of steam to the turbine have been replaced by a single throttle valve that for loads below normal lowers the pressure. This reduces the density of the steam and lessens the aforementioned losses without diminishing the heat content per pound. At the low end the stages are increasing in diameter to reduce the leaving loss to a minimum. In many of the late machines the length from the first to the last stage is less than the short diameter of the exhaust opening.

In the smaller units it may be stated that the turbine is rapidly replacing the reciprocating engine, even invading the small office-building plant. This is particularly true in the West. It requires comparatively small space and little attendance. There is no oil in the exhaust steam and reduction gearing permits economical speeds in different classes of work for both the prime mover and the driven machine. The turbine is even proposed for locomotive drive where with its high speed more power can be concentrated in the limited space available. The small turbine for auxiliary drive has been perfected and its economy improved. To make a combined pump or blower unit with less cost, weight and dimensions, a one-bearing turbine has been brought forth. It is incomplete in itself, but becomes an integral part of the over-all equipment.

Reciprocating Engines

Developments in the reciprocating engine have remained practically unchanged. However, the demand for marine engines has tended to accelerate the construction of this type. What is probably the most powerful rolling-mill reversing engine in existence was put in service during the year. Its cylinder sizes are 36 in. and 70 in., with a 60-in. stroke. The engine is geared and when running at its maximum speed is capable of developing more than 30,000 hp. if maximum torque occurs at the same time. However, they do not occur at the same time and it is doubtful whether the engine will ever be called on to develop more than 11,000 hp. The approximate weight is 1,350,000 pounds.

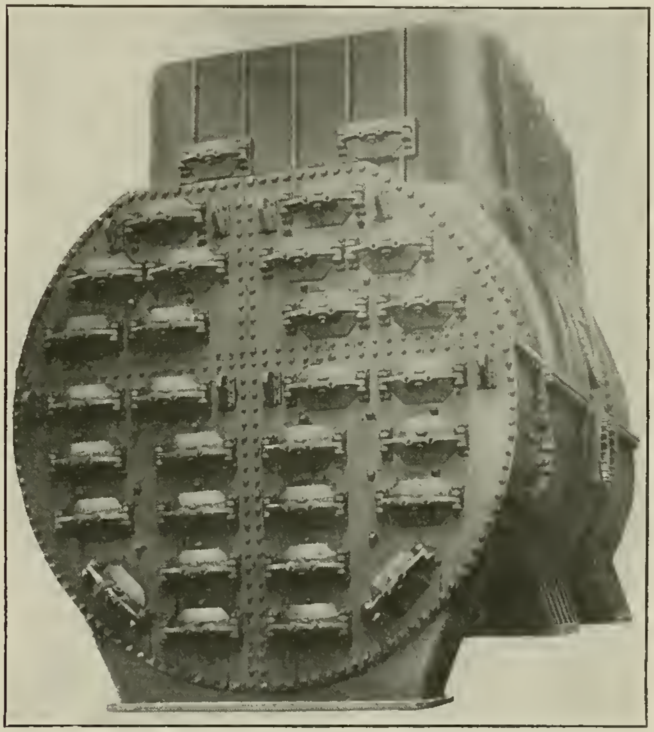


FIG. 2. WORTHINGTON SURFACE CONDENSER, 70,000 SQ.FT. OF ACTIVE TUBE SURFACE

Auxiliary Equipment

To take advantage of the low steam rates of the large turbines, the trend toward electric-driven auxiliaries has continued, steam drives, principally turbines, being maintained in lesser number to insure continuity of service and to maintain a proper heat balance. In some few cases this movement has been carried to the point of bleeding the main turbine to supplement the supply of exhaust steam to the heater. The lack of exhaust steam for feed-water heating due to the above practice has brought about almost universal adoption of the economizer in new plants.

Manufacturers report orders for geared units as opposed to the direct-connected turbine in the ratio of three to one. In operation the gears are standing up well and have been perfected to such a point that they make little noise. An interesting development is the use of large geared units for excitation, these machines being built in capacities up to 1000 kw. In these designs the turbine may operate at its most economical speed and the generator at the low speed necessary to insure perfect commutation.

Surface condensers are naturally following the turbine and getting larger each year. Up to date 70,000 sq.ft. of active tube surface in a single shell is the largest (Fig. 2), but there appears to be no good reason why this enormous capacity could not be increased. Condensing equipments for the 60,000- to 70,000-kw. turbines for the Interborough and the Duquesne Light Co. plants are to contain 100,000 sq.ft. of surface, but it is to be disposed in four shells. Among large jet condensers the installation at Providence serving a 45,000-kw. turbine still holds the record. The outstanding feature of the year in all condensing equipment has been the unprecedented volume of business. In surface condensers there has been a tendency to increase the water pumped per pound of steam. It is also becoming apparent that, although the highest vacuum obtainable is to be desired, it should not be produced with an accompanying drop in the temperature of the condensate below that called for by the vacuum.

Some interesting developments in air pumps have been made. Maurice Leblanc, inventor of the hydraulic air pump quite universally used for turbines, has improved upon this centrifugal type by bringing forth the *multijector*. No revolving parts are employed, vacuum being produced by steam passed through a number of nozzles to give injector effect. As expected, this type takes up much less room than the well-known Leblanc air pump for like capacities. An interesting description of the *multijector*, together with recent air-pump-design progress, will appear in an early issue of *Power*.

LARGER STEAM BOILERS

War demands have so overloaded the boiler manufacturers as to hinder and for the time being practically stop development. For the last few years there has been a gradual increase in unit size, but the growth has not kept pace with that of the turbine. In the last year, however, a boiler unit commensurate in size with the larger turbines has been developed. It is known as the Stevens-Pratt boiler, and is made up in four sections, each being a complete Babcock & Wilcox cross-drum boiler in itself, with its own superheater economizer and forced- and induced-draft fans. There are two sections on either side, the boilers being placed back to back. One stack serves the unit, and the coal- and ash-handling equipment is common to the two sections on the same side of the unit. If desired, any one or more of the sections may be operated independently. The sections are made in sizes ranging from 5000 to 14,500 sq.ft. of heating surface. Four of the largest sections operating at 400 per cent. of rating will carry 58,000 kw. This is equivalent to carrying one kilowatt on one square foot of steam-making surface as compared to four square feet at normal rating. That this arrangement is compact is evidenced by the fact that the unit occupies 7632 sq.ft. of floor space. It avoids an elaborate boiler-room building, as, with the exception of the coal bunkers, the unit is complete in itself.

STOKERS AND PUMPS

Shortage of fuel and its increased cost has resulted in the use of coal heretofore considered unfit for burning. Anthracite screenings and coke breeze, frequently mixed with bituminous coal, have presented new problems in connection with the underfeed stoker. Naturally, the chief difficulty is to dispose of the large amounts of refuse when forcing the boilers to high capacity. Improved ash dumps are proving a solution, some operated by power and others by hand, but all designed to handle greater quantities. In addition, the underfeed stoker is being adapted to burn the high-ash Middle West coals and lignite. Some installations have already made their appearance and have been giving good results.

To burn great quantities of anthracite the duplex stoker is becoming more common. With no bridge-wall and an adjustable opening between the stokers the continuous discharge of ashes is readily accomplished. With coal fed slowly through the retorts and a great quantity carried in the furnace, conditions are favorable for high combustion efficiency. To burn more fuel from one side of the setting and obtain the high boiler ratings now in vogue, increasing the size of the retort is another alternative. Designs are now ready in which the retort area has been enlarged 50 per cent. over present standards.

On the part of several builders there have been persistent attempts to apply forced draft to a chain grate. With a moving stoker, subject to the varying density of fuel bed common with bituminous coal, the problem has proved difficult and its solution so far unsatisfactory. With anthracite more headway has been made, as evidenced by the Cox chain grate, which shows considerable promise.

In boiler-feed pumps an interesting development in the direction of compactness and simplicity is the placing of a two-stage centrifugal pump in one casing and on a common shaft with a velocity-stage turbine. The unit will serve 3000 boiler horsepower, and with one-tenth the weight occupies about one-eighth the floor space required by a duplex reciprocating pump of the same capacity.

Another interesting development given publicity during the year is the use of two centrifugal pumps driven by one turbine for economizer service. Ordinarily, the pressure in the economizer is slightly greater than in the boiler, and with the pressures increasing as they have recently, it places a serious burden on the economizer. This may be relieved by using two pumps, one taking the feed from the heater and passing it through the economizer at comparatively low pressure, the other taking the water under pressure from the economizer and forcing it into the boiler. Under such conditions even old economizers could be used with safety in conjunction with high pressures.

As the boiler pressure goes up steam velocities have been increasing. At the Joliet plant the velocity at normal load in the turbine leads is 7200 ft. per min. There are instances in which this velocity has been exceeded and velocities 50 per cent. greater have been proposed. Such practice tends to reduce pipe diameters and minimize the cost of pipe-line construction. As the density of the steam increases, friction becomes greater and there is considerable pressure drop in the pipe line, which in turn reduces the capacity of the prime mover. When these two factors have been properly correlated, it may be found advisable to spend more money for larger pipes and fittings.

The increasing cost of coal and the concentration of power in larger units has resulted in more extensive use of instruments, particularly those of the recording type, in the boiler room. New instruments and combinations of older types are constantly making their appearance, so that the fireman in these days has the advantage the engineer has enjoyed for years.

INTERNAL-COMBUSTION ENGINES

Opinion seems prevalent that there is little or no activity in the gas-engine field. In smaller sizes of engine this is undoubtedly true, but there are now in course of construction a considerable number of large gas engines for at least four of the largest steel mills in the country. Some of these engines will exceed 4000 hp. and will be used for blowing and for driving electric generators. Fig. 3, although not as large as some of the blowing engines now under construction, is a fair example of what is being done. The dimensions of this engine are 84 x 60 in. on the air end and 46 x 60 in. on the gas end. It would look as though this type of prime mover is not ready to be forced into oblivion, although the steam turbine is now pushing it hard and, owing to its economy over a wide range of load, may eventually be the favorite for steel-mill work.

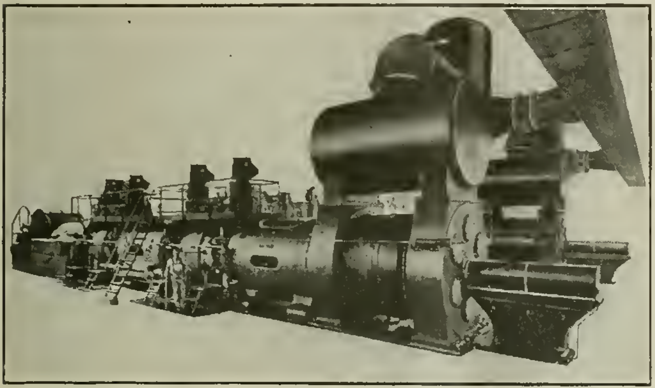


FIG. 3. MESTA TWIN-TANDEM GAS BLOWING ENGINE

Manufacturers of Diesel and other types of oil engines are working to the limit of shop capacity. Because of the high cost of fuel and the need for power by the industries, a surprising number of Diesel engines have been installed, some of them having capacities of 1000 hp. Demands for these engines in the South and Southwest still continue at an increasing rate, and on the Pacific Coast the marine field is apparently flourishing. Several firms that heretofore have built only stationary engines have lately brought out marine types. The entire output of at least two of our largest Diesel engine builders has been devoted to Government orders (for submarines) since the United States entered the war. A new design of high-compression four-cycle heavy-oil engine has been brought forth, and details of existing engines have been perfected.

Large numbers of gasoline and kerosene engines are being used by our forces in France for searchlights, portable lighting outfits, for driving compressors, for small repair outfits, etc. These are of the carburetor type, but are designed to use either gasoline or kerosene. For airplane service the "Liberty" motor has been one of the great accomplishments of the year.

POWER-PLANT LEGISLATION

Legislation relative to power plants has been active throughout the year despite the war. The Boiler Code of the American Society of Mechanical Engineers is now in force or about to be enforced in the following states: California, Ohio, Michigan, Wisconsin, Minnesota, Indiana, Pennsylvania, New York and New Jersey. Many other state legislatures favorably regard the Code; but other more pressing legislation or lack of financial resources prevented the adoption of the Code in these states.

The Municipal Regulations Committee of the American Society of Refrigerating Engineers has made favorable progress in the formulation of a safety code for refrigerating plants and by December, 1918, will likely hand to the society a finished code. The City of Troy, N. Y., now enforces a code drawn up with the assistance of this committee.

There has been little activity in the enactment of engineers' and firemen's license laws. The rules of the Board of Supervising Inspectors of Steam Vessels have been modified for the purpose of facilitating the entrance of men into marine service, particularly under the Shipping Board, though there are, it seems, obstructionist forces at work to wholly or partly defeat the purpose. Some interesting water-power legislation may come during the present Congress.

COAL, OIL FUEL AND SMOKE

Up to the end of September the bituminous-coal production for the country exceeded that for a corresponding period in 1916 by 10.5 per cent. This increase has been approximately maintained up to the end of the year, and it means about 50 million tons in excess of the 500 million produced in the previous year. More anthracite also has been mined, but notwithstanding this immense production there has been a decided shortage of fuel. Its delivery, depending upon congested railway facilities, was irregular, and to shorten the haul many users were obliged to accept the coal nearest at hand. Owing to the higher prices attempts were made to use in part inferior grades of fuel, such as culm, coke breeze and lignites, with varying degrees of success. The uncertain conditions caused many fuel users to consider storage, laying up a supply during the summer months when the demand is lightest and transportation at its best, to tide them over irregular deliveries during the heating season. In the last year, then, more than ordinary attention has been given to coal-handling apparatus, storage and the weathering of coal. Federal fuel administrators are doing everything in their power to encourage economy. It is realized that up-to-date firing methods and general improvement in operating conditions will save millions of tons of coal per year.

Oil fuel for power plants has come into extensive use even in New England, where under ordinary conditions it would not be considered. This has been due to the upsetting of transportation by rail and by water, the excessive cost of coal and its actual scarcity. In the year just closed the production was considerably in excess of that of 1916, which was 292,300,000 bbl., the greatest record in the history of petroleum.

Smoke abatement has been set back temporarily. The smoke in Chicago was never worse. New York is receiving its baptism of soot and ash from the burning of soft coal in furnaces designed for anthracite. Boston is in much the same situation, and even in Pittsburgh, where smokeless history has been made in recent years, conditions are not up to standard. Naturally, this is due to changes of fuel, the burning of inferior grades and the calling into service of boilers that have not been remodeled for smokeless operation. With the gradual readjustments that economy will demand the smoke situation will undoubtedly improve.

THE REFRIGERATION FIELD

Perhaps the most noteworthy progress in the refrigeration field during the year is the wide adoption of the high-speed compressor, using the thin-plate valve, or feather valve. One large and oldest company manufacturing refrigerating machinery has been turning out many high-speed compressors, not an order for a slow-speed machine having been received during the first half of its fiscal year. Other manufacturers are experiencing similar business orders in relation to the high-speed compressor.

Electric drive, particularly for compressors used for ice making, is receiving ever-widening application, especially in Chicago and New York.

The new refrigerating plant of the Merchants Refrigerating Co., New York, is of unusual interest. The compressors are of the York, three-cylinder, single-acting, piston valve, inclosed type, driven by synchronous motors of special design. The efficiency of these motors is stated to be 90 to 94 per cent., the starting torque 35 per cent. and the "pull-in" torque 30 per cent.

The installation has four units, a 50-ton (234 r.p.m.), a 100-ton and two 200-ton, the three latter running at 209 r.p.m. They are to be operated at 3 lb. back pressure and 155 lb. condenser pressure. They will operate compounded; that is, two cylinders of each machine will take in low-pressure gas and the other cylinder of the compressor will take this gas and boost it to the condenser pressure. After leaving the receivers, the liquid will go to a double-pipe cooler, where water will take out the sensible heat to within 1 deg. F. of the initial water temperature. The liquid then will go to accumulators, where its temperature will be reduced to the boiling point at the intermediate ammonia pressure. The vapor will be taken directly into the high-pressure cylinder. The piping is so arranged as to permit of operating either single or compound compression. All shells, including those of brine coolers, shell condensers, etc., are autogenous (oxyacetylene) welded. A more complete description of the plant will, it is hoped, soon appear in *Power*.

The booster compressor is exciting much comment, and the Ninth Street Terminal, Chicago, is a new and interesting installation. The plant has but recently been started, and performance data are not yet available. The new installation at the Consumers Ice Co., Chicago, is one of the first of the D. I. Davis low-temperature compression systems. A description of this plant is now ready for appearance in *Power*.

Welding, of course, continues to be of keen interest to refrigerating engineers, and it is cheering that all the various interests have formed the National Welding Council, which so far has displayed a most sincere and unprejudiced attitude in its aim to make autogenous welding safe for pressure vessels.

The first section of the American Society of Refrigerating Engineers has been instituted in New York City, and its success will probably lead to the organization of other sections in the large cities.

THE WATER-POWER SITUATION

Although the unfortunate condition of water-power legislation still remains unsettled, there has been considerable activity in the construction of new plants and extensions to existing installations. The Copco, California, plant for the Southern Pacific is nearing completion. It will have an initial capacity of 25,000 hp., which later will be increased to 50,000 hp. by a subsidiary station. The Southern California Edison Co. has announced that it will shortly add 42,500 hp. to its capacity at Big Creek and make further additions to the plants served by Huntington Lake.

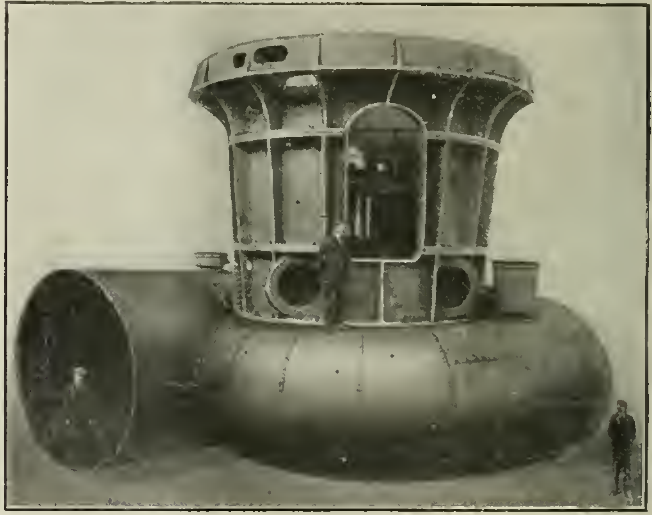


FIG. 4. S. MORGAN SMITH PIT LINER AND SCROLL FOR 16,500-HP. VERTICAL-SHAFT TURBINE

The Puget Sound Traction, Light and Power Co., is installing 25,000 hp. additional capacity in its White River Power Plant near Sumner, Wash. The Montana Power Co. is installing four 16,500-hp. single-runner vertical-shaft Francis type turbines in its Holter plant. The steel-plate scroll, the intake diameter of which is 12 ft., and cast-iron pit liner for one of these units are shown in Fig. 4. These machines will operate under a working head of 109 ft. and run at 150 revolutions per minute.

Work has continued on the 31,000-hp. single-runner vertical turbines for the Yadkin River development in

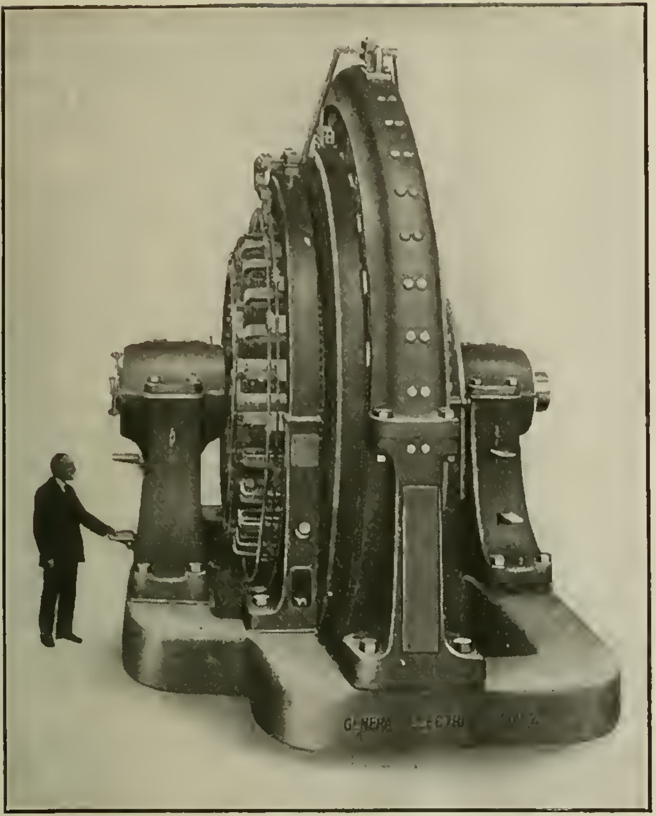


FIG. 5. GENERAL ELECTRIC 6825-KW. 25-CYCLE ROTARY CONVERTER

North Carolina, and numerous other large installations might be mentioned. Owing to the great power demands and the higher cost of fuel, several hundred thousand horsepower has been added to "white-coal" capacity during the year. In the way of improvements may be mentioned simplification and standardization of governors, development in runner design and reduction of hydraulic losses in intake and draft tubes.

Acquisition of the properties of the Ontario Power Co. by the Hydro-Electric Commission of Ontario was a significant step toward governmental participation in developing natural resources. When the Chippewa Creek-Queenstown Heights developments are completed, the commission will be the largest producer of water power in the world. Its work will be watched with interest in this country, as the adoption of a similar plan may be the solution for the existing controversy in this field.

Electrical Development

During the last year there has not been any marked change in the electrical industry over that of 1916. The manufacturers have been practically overwhelmed in trying to meet the demands on the industry for standard equipment, consequently the development of new types of machinery has been subordinated to these demands. However, a number of the large machines that were projected in 1916 were built and installed during 1917. Others again are still in the construction stage, as pointed out in the foregoing, in reference to the large turbine unit.

During the year 25-cycle rotary converters up to 6825-kw. capacity, Fig. 5, have been put in operation, and 60-cycle machines up to 5800 kw. in size have been installed. These machines are the largest of either type that have so far been built. One of the most important advances in the construction of self-controlled induction feeder voltage regulators is the 600-kv.-a. three-phase 60-cycle 13,200-volt unit, Fig. 6, installed by the Southern Power Co., to be connected to the low-voltage side of a 6000-kv.-a. bank of 44,000- to 13,200-volt transformers. This unit is equipped with radiators on the tank for cooling purposes similar to those used on self-cooled transformers.

The most interesting transformer unit of the year is probably the 44,000-volt to 6000-volt, 8000-kv.-a. oil-insulated self-cooled unit, Fig. 7, six of which were built for the Carnegie Steel Co. The radiators are constructed of a number of vertical flattened tubes welded into headers, which are flanged and bolted to the tank. The 24 radiators on each tank give an effective cooling surface of approximately 1,000,000 sq.in. Oil-insulated water-cooled units of over three times the foregoing capacity are under construction or being installed.

The Pacific Light and Power Co. has installed in its Eagle Rock substation at the end of a transmission line 241 miles long, a 15,000-kv.-a. synchronous condenser, Fig. 8. This is used to maintain constant voltage at the receiving end of this long transmission line, which is operated at 135,000 volts with grounded neutral at the power-house end. Before the condenser was installed, the no-load voltage at the receiving end was 211,000 volts. With the condenser in service the voltage at the receiving end of the transmission line is held practically constant under all conditions of load.

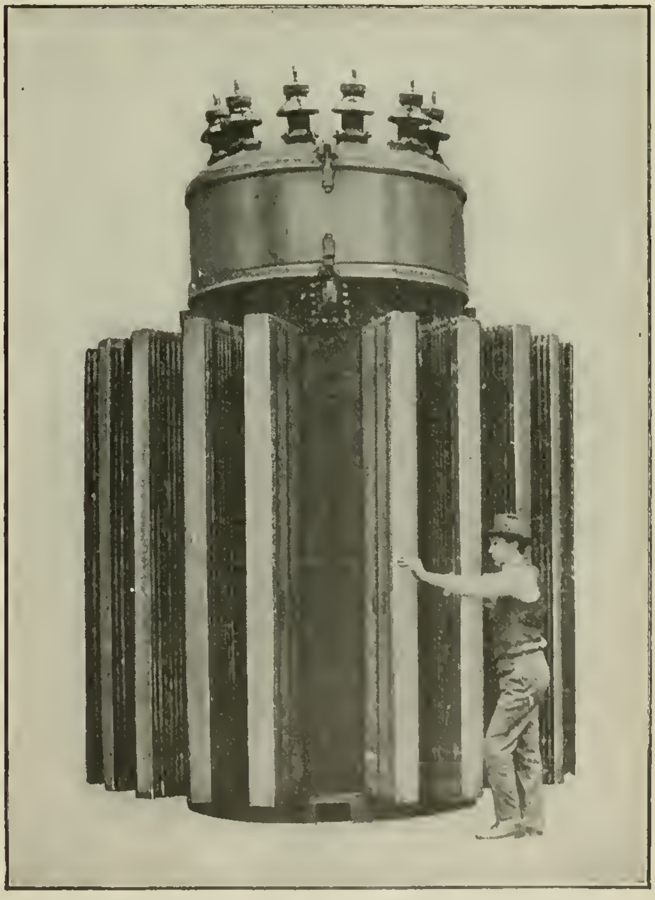


FIG. 6. WESTINGHOUSE 600-KV.-A. 3-PHASE INDUCTION FEEDER VOLTAGE REGULATOR

In the steel industry the application of electricity has continued to make rapid advances. Two of the chief applications are of reversing motors for rolling-mill main-roll drives and the electric furnace. There is in use at the present time approximately 690,000 hp. of main-roll drives in the United States, an increase of 400 per cent. during the last five years. These drives require very large motors. The reversing blooming-mill unit shown in Fig. 9 is one of the largest direct-current single-unit motors that has so far been built. It has a momentary rating of 10,000 hp. at 40 r.p.m. The machine is fully compensated and is shunt-wound. In spite of its great size, it can be accelerated at the rate of 50 revolutions per second. The motor is supplied with power from a flywheel motor-generator set, consisting of a 2000-kw., 500-volt generator, driven by a 2200-volt 2000-hp. induction motor. The flywheel weighs 100,000 pounds.

The vast increase in the use of electrical furnaces is evidenced by the fact that in this country, Jan. 1, 1916, there were 36 furnaces in use, having a capacity of 191 net tons, and requiring 90,000 kv.-a. At the present time the capacity has increased to approximately 1000 net tons requiring about 230,000 kilovolt-amperes.

The 250,000-kw. totalizing graphic meter, Fig. 10, built for the Keokuk plant of the Mississippi River Power Co., is the largest meter ever constructed. The instrument will give a graphic record of the output of the thirty 3-phase, 7500-kw. generators to be installed ultimately in this plant. To accomplish this thirty polyphase-meter elements, each made up of two single-phase units are used. The induction type of meter element is employed. The moving element consists of six aluminum vanes, all supported on a single shaft. All connections are carried to the top of the instrument to a circular terminal board having 240 binding posts. The chart is 12½ in. wide and printed in 12-hour sections and feeds at the rate of 3 in. per hour.

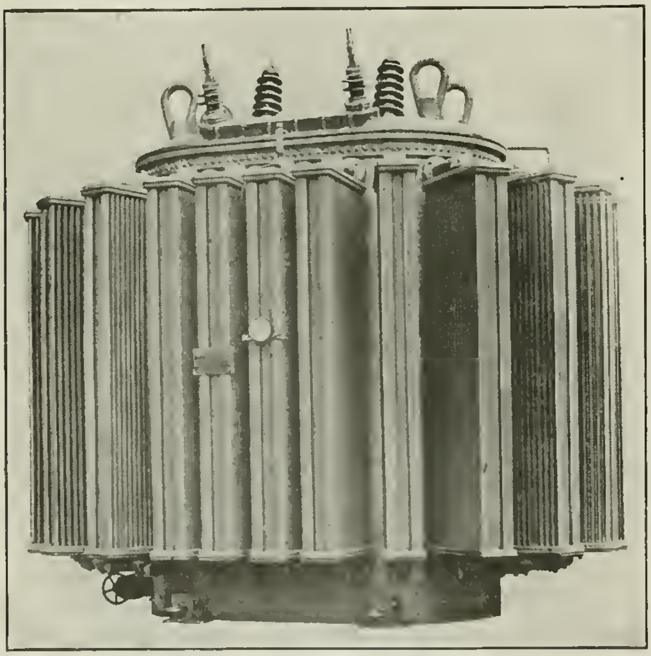


FIG. 7. GENERAL ELECTRIC 6000-KV.-A. OIL-INSULATED SELF-COOLED TRANSFORMER

Owing to the expansion of our industries, much of which came suddenly and is considered more or less temporary, there has been a great increase in the demand for power. Generating equipment, except on long deliveries, was almost impossible to get, with the result that the central station has been swamped in trying to supply a considerable portion of the excess power requirements. With the manufacturer it has not been so much a question of cost as obtaining quickly the power he needed to turn out war products. There is still a great deficiency in prime-mover capacity, and to improve this condition it has been suggested that private plants tie in with the central station, helping it out on the peak load and in turn taking current from it in the valleys, but standing by as reserve capacity needed in case of breakdown.

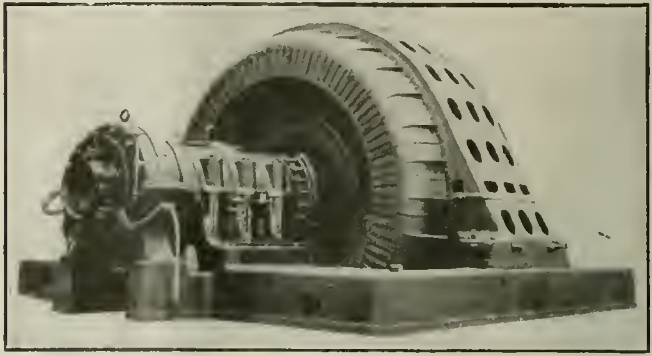


FIG. 8. WESTINGHOUSE 15,000-KV.-A. SYNCHRONOUS CONDENSER

Shortage of coal has aggravated the situation. It has instigated a great campaign for saving. By state fuel administrators, committees have been appointed to investigate the possibilities and to interest owners of private plants in this movement. The fireman is being flooded with instructions, and publicity committees are arranging for space in the press and competent lecturers, preferably engineers, to point out the many possibilities of saving in the private plant and the home.

Increase in the price of coal tends to enforce better economy in all stations, private and central. To meet the great demand for power and for economy in the use of coal it would appear that the time is ripe for readjustment. There is many a private plant taken over by the central station that could be operated more economically on its own basis. It could produce the power, light and heat needed with an expenditure of coal less than the independent electric and heating services now require. There are some private plants of which the reverse is true. The exigencies demand careful, unbiased analyses to determine in each case what is best for the common good.

Engineering Societies

The campaign that has been conducted for the last few years showing the need and the desirability of coöperation among engineers is at last bearing fruit. The demands of the war have hastened the movement. The Engineering Council of the United Engineering Society has recently come into being as a medium of coöperation between the four big national engineering societies. It is made up of five members from each body and four from the parent organization. The council has authority to speak on all questions of concern to engineers. Realizing that at present the big thing is war work, the council has organized a "War Committee of Technical Societies," which has been coöperating in every way possible with the Government. The American Boiler Manufacturers' Association has appointed a war-service committee to act as a point of contact between the industry and the Government, and practically every engineering association in the country has offered its services in one way or another.

Coöperation between the local sections of the various societies is also improving. Joint meetings, dinners and entertainments are becoming the rule. In this connection it might be added that plans are on foot for a building to house all engineering societies in Chicago. This in reality is to be an engineering headquarters second only to New York.

The American Society of Mechanical Engineers continues to conduct work of inestimable value to the field. The Boiler Code, now adopted by nine states and four cities, is being perfected and interpretations are sent monthly. The safety-valve regulations are in process of revamping, and the question of welding is receiving attention. In its visit to the Chicago section, the Council has initiated a practice contributing toward the nationalization of the society by eradicating the too-prevalent idea that much of the benefit of membership centers in New York. These visits are worth continuing.

A progressive step by the National Association of Stationary Engineers at its last annual convention was the setting aside of definite periods for welfare talks by the delegates dealing with their work and improvement of the organization. The society is devoted primarily to education, but heretofore much of the national convention has been taken up by routine business. The innovation was heartily approved, and it is safe to predict that each year will see more of the time of the convention given over to the watchword of the association.

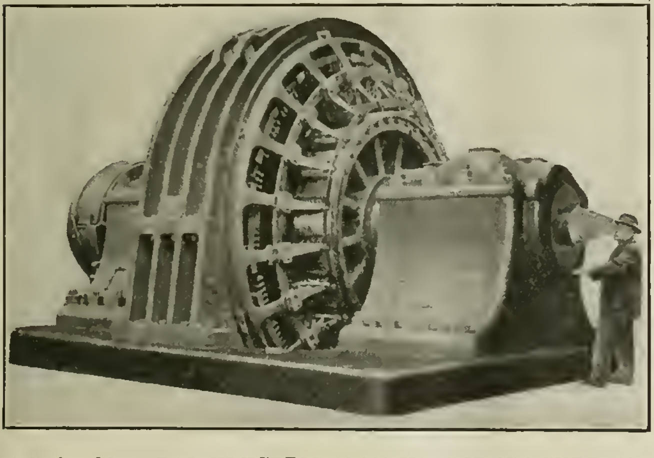


FIG. 9. GENERAL ELECTRIC 10,000-HP. DIRECT-CURRENT, REVERSING BLOOMING-MILL MOTOR

THE HONOR ROLL FOR 1917

For 1917 the honor roll is long and it is made up mostly by engineers engaged in the war, some in important work at home and others at the front. Of the latter many have already shown that they deserve high places in the list. For engineering achievement in private work mention should be made of Nikola Tesla, awarded the Edison Medal for original work in polyphase and high-frequency electric currents. Dr. Henry Marion Howe received the John Fritz medal for his investigations in metallurgy, especially in the metallography of iron and steel. Five gold medals were awarded by the American Museum of Safety for noteworthy achievement in the realm of safety.

Engineering societies closely related to the field honored the following men by election to the presidencies: Charles Thomas Main, American Society of Mechanical Engineers; E. W. Rice, Jr., American Institute of Electrical Engineers; J. W. Lieb, National Electric Light Association; John A. Wickert, National Association of Stationary Engineers; Ezra Frick, American Society of Refrigerating Engineers; Irwine J. Lyle, American Society of Heating and Ventilating Engineers; G. W. Martin, National District Heating Association.

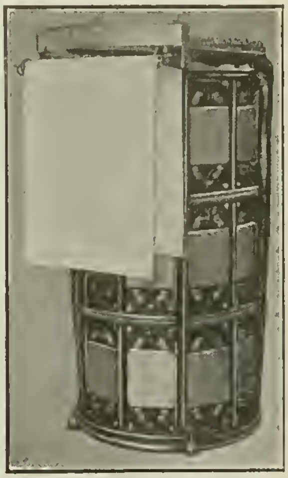


FIG. 10. ESTERLINE TOTALIZING GRAPHIC METER

NECROLOGY

It is pleasing to report that men of prominence in the field who passed away during the year were few in number. The columns of *Power* record the following: Alfred Blunt Jenkins, of Jenkins Brothers; Henry Gordon Stott, superintendent of motive power of the Interborough Rapid Transit Co.; George Ross, president of the Ross Valve Manufacturing Co.; James Terry, president of the Terry Steam Turbine Co.; Frank Lewis Bigelow, president of the Bigelow Co.; William G. Bee, vice president and general sales manager of the Edison Storage Battery Co.; James Fulton Cummings, an electrical engineer of international reputation: Albert F. Ganz, professor of electrical engineering at Stevens Institute of Technology; Arthur Kneisel, treasurer of the American Association of Engineers; Royal C. Peabody, president of the Combustion Engineering Co.; William P. Hancock, superintendent of the generating department of the Edison Electric Illuminating Co. of Boston; James F. Meagher, former president of the People's Gas, Light and Coke Co., of Chicago; George Harrison Klumph, late Western manager of the Green Fuel Economizer Co.; William D. Kearfott, president of the Kearfott Engineering Co.; Benjamin Murray Plumber, president of the Main Belting Company; Joseph F. Chuse, founder and manager of the Chuse Engine and Manufacturing Co.; Thomas Eugene Byrne, vice president and chief engineer of the Kings County Lighting Co., Brooklyn, N. Y.

Petroleum residual oil as fuel for Diesel engines is so scarce in the British Isles that users have had to adopt tar oil. They were just getting along nicely when the Minister of Munitions up and restricted the use of tar and other oils. And yet the "business as usual" howlers say there is plenty of fuel of all kinds.

New Method of Increasing the Evaporation in Boilers

By CARL HERING

A new thermal principle in the boiling of water is described. The thin film of gas on the flame side of a water-boiling vessel offers an enormously high resistance to the flow of heat. By means of lugs on the flame side of surface an artificial thermal resistance is established, which greatly increases the flow of heat, provided these lugs are properly proportioned.

IT IS well known that water may be boiled in a cup made of ordinary paper; also that a postage stamp may be pasted on the flame side of a metallic vessel in which water is being boiled and although the flame plays directly upon this stamp it will not be charred. It is perhaps less well known that when a second or third stamp is pasted over the first one, the outer ones will char. If there is a blister in a single thickness of the paper, that blister will char.

Gas Film on Flame Side of Vessel

The interpretation of this is that when very hot gases, like those of a flame, impinge upon the outside surface of any water-boiling vessel, which is constantly maintained at a far lower temperature by the water on the other side of it, a thin film of gas forms on the flame side of the surface which offers an enormously high resistance to the passage of heat through it; its specific resistance appears to be far greater than that of thermal insulators, yet all the heat which flows usefully from the flame to the water must traverse it; this film is therefore a very great obstruction to the flow of heat, and this method of heating is a very irrational one, although it is the usual way. The thermal resistance of the metallic walls of the vessel is so small in comparison that there is no appreciable gain in the heat flow by using copper tubes in a boiler in place of iron ones, even though copper conducts heat much better than iron.

If the temperature of the flame is taken at about 1350 deg. C. (2462 deg. F.) and that of the water is 100 deg. C. (212 deg. F.), there is a fall of temperature of about 1250 deg. C. through this film, which appears to be only about 0.005 in. thick; this means an extremely high thermal resistance, so high that it is a question whether it is a true resistance; but as it certainly acts like one, it may at least be here referred to by this term.

If this high-resistance film could be broken down, the heat would flow more rapidly from the flame to the water, which means that the water could be boiled faster or that the boiling vessels, like steam boilers, could be made smaller for the same steaming capacity; also that the losses of heat would be reduced, for if a given quantity of water could be boiled twice as fast, for instance, with the same flame, the heat losses will be reduced to a half, as they take place during only half the time.

One way to reduce the resistance of this film is to use a blast flame, which seems to mechanically carry away part of the film; a strong blast flame directed against the aforementioned postage stamp will char it; but this method is not generally practicable. The usual way is to increase the surface exposed to the flame, but doubling or trebling this surface while using the same flame does not necessarily double or treble the heat flow; if the volume of the flame is then also doubled or trebled, the amount of boiling will, of course, be increased proportionately, but this simply means doubling or trebling the whole boiler; this increases the quantity of heat transmitted but not the rate; nor does it increase the efficiency very much.

By studying the nature and properties of this high-resistance film the writer found that its resistance diminishes very rapidly when there is less difference of temperature between its two sides; namely, between the flame and the metal. In boiling molten zinc, for instance (about 950 deg. C.), instead of water, the resistance of this film would be very greatly reduced. It is probably also very slightly less in high-pressure boilers in which the temperature of the water is higher.

It seems to be analogous to the case in mechanics in which a heavy weight struck by a sharp blow will move only slightly, but when the same energy is exerted on it less violently, the body will be moved more freely by it; the resistance of the body against being moved (due to its inertia) becomes greater as the suddenness of the blow increases. Our present method of heating water may be said to be analogous to moving a heavy car by applying sharp hammer blows at the rear, in which case its inertia acts like a high resistance; this analogy, however, is only approximate.

Establishing Artificial Thermal Resistance

As the temperature of the flame is fixed, and it would be inadvisable to reduce it, and that of the water cannot be raised, there remains only increasing the temperature of the flame side of the vessel or boiler tube. This can best be done by interposing a thermal resistance between the flame side of the vessel and the water side, such that the flame side may become far hotter than the water side, say a red heat. The writer's researches have shown that when the usual flame impinges on a surface that is artificially maintained at a very much higher temperature than boiling water, say a dull-red heat, the resistance of this film is very greatly reduced; and that the artificially added resistance required to do this is far less than that of the film was, hence there is a great reduction in the total resistance and therefore a great gain in the flow of heat. It is a curious case in which the adding of still more thermal resistance in the path of the flow of heat diminishes the total resistance greatly. In mechanics a spring may in some respects be likened to a resistance to an opposing force, yet the addition of a spring between a violent push and a heavy body helps to overcome that effect of the inertia by which it acts like a high resistance.

These thermal relations are illustrated diagrammatically in Fig. 1. Let the vertical distances represent the thermal resistances in the path of the current of heat from flame to water, and the horizontal distances the temperatures of that side of the vessel which is exposed to the flame; that is, the side on which this film forms. The curve *a* then shows approximately how the resistance of the film diminishes as the temperature of that surface is increased.

To produce this increasing temperature on the flame surface, the added artificial resistance must be increased, as the water side always has the same temperature. The curve *b* represents approximately the respective artificial resistances which must be introduced to produce these increased temperatures. The total resistance, which is what governs the resulting flow of heat, will then be the sum of the ordinates of these two curves, giving a curve approximately like *c*; this curve shows that as more artificial resistance is introduced the total resistance falls, at first very rapidly, then reaches a minimum point and then rises again. The flow of heat will therefore first increase rapidly, reach a maximum, then fall again, showing that there is a point at which it is no longer advantageous to further increase this artificial resistance. The present researches indicate that this point seems to be reached when the temperature of that surface is about midway between that of the flame and that of the water; hence for water boiling this would be about 725 deg. C., which means a dull-red heat. This condition means that the drop of temperature in the artificial resistance is then equal to that in the film.

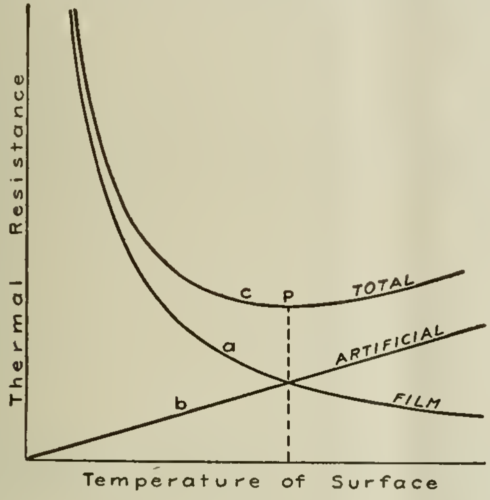


FIG. 1

FIG. 1. RELATIONS OF THERMAL RESISTANCES

A practical way to introduce this artificial resistance is by means of lugs on the flame side of the surface, which have such a length and diameter that the heat flow through them will maintain their hot ends at about a dull-red heat. In the writer's tests with lugs of the same diameter and increasing lengths, the flow of heat through them at first increased as they were made longer, and then diminished again after a certain length had been exceeded, thus corresponding to the curve *c*. When too long, their ends were at a bright-red heat.

It is an interesting and instructive experiment to solder some small nails or tacks with their heads against the outside of the bottom of a tin cup, then apply a large bunsen flame and notice how quickly and violently the water will boil directly over those nails as compared with the boiling over the rest of the surface of the cup. These lugs may be said to be a means for piercing this high-resisting film, allowing the heat to rush rapidly through these thermal openings.

The same thermal resistance may be produced by a long thick lug or by a shorter but thinner one, provided the ratio of the length to the cross-section is the same; and the quantity of heat flowing through each lug will of course diminish with its cross-section. Theoretically, therefore, the best condition would appear to be one lug of the diameter of the bottom surface of the vessel, or in other words, a very thick bottom, or very thick-walled boiler tubes. But it will be found that this thickness (corresponding to the length of the lug) would then have to be several feet, making this form of the resistance absurdly impracticable. The other extreme would be to have innumerable very thin short lugs, close together; this is impracticable on account of the expense, the frailty of such thin lugs, and the fact that when maintained at such a high temperature they gradually burn up. Between these extremes there are mean proportions which give the best results, considering the practical conditions.

EFFECTS OF VARYING SPACING AND SHAPE OF LUGS

Other effects are also involved. By spacing the same size lugs farther apart, the greater freedom of the circulation of the hot gases between them was found to increase the flow of heat through each lug, but as there were then less lugs per square inch of surface, the total heat flow in the vessel as a whole was less. It appears that the film is destroyed, or at least reduced, along the lateral surfaces of these lugs also, as the gases reaching the cooler parts are themselves cooler; hence the lateral surfaces take a more important part than a mere increase of surface. And the lugs may be made slightly conical so that their bases cover practically the whole surface, while their thinner ends are far enough apart to permit the free circulation of the hot gases. When placed radially on the outside of the tubes of a water-tube boiler, they may be cylindrical yet have their cooler ends close together and their hot ends farther apart.

Many comparative tests in which the time was noted for evaporating the same quantity of water over identical flames and in identical open cups, differing only in the size, number and shape of the lugs, showed that there were some best proportions at which the heat flow was greatest, as varying the proportions in either direction gave less good results. These tests also showed very decidedly that the view generally held that a gain by the use of lugs was due to the increase of surface is entirely wrong, which no doubt explains why the frequently suggested addition of lugs and similar surface-increasing devices has not come into general use; the principle was not the correct one. It is of course true that a greater heat-receiving surface is a good feature, but it will amount to little or no gain in the rate unless the thermal resistance of the lugs is properly proportioned. In one test the lugs were made of the same length and total cross-section, but had greatly differing surfaces by making one set very flat and the others round; those having the lesser surface actually gave decidedly the better results. The results in many tests were absolutely out of proportion to the surfaces, showing how greatly in error our former views were.

The desired condition is to have such a thermal resistance that when the flow of heat through it has become steady, the hot ends will be maintained at such a high temperature that the film resistance is greatly reduced. With the same resistance the difference of temperature at the two ends will therefore also depend on the flow of heat through it, as a large flow of heat through a low resistance may produce the same difference of temperature between the ends as a small flow through a high resistance; it is quite parallel to the electrical analogy. The proportions, moreover, are different for iron and for copper lugs. It is therefore not only a question of the resistance alone, but also of the resulting flow of heat; the problem of finding the best proportions is therefore not as simple as might at first appear, and the conclusions drawn from experiments must be carefully interpreted or they may mislead.

For instance, a thin coating of enamel or of some asbestos compound might be used as the artificial thermal resistance, but owing to its high specific resistance a very small heat flow through it would suffice to raise the temperature of the outside high enough to break down the film resistance; but as it is a large heat flow that is wanted, the artificial resistance should be made of as good a conductor as possible in order that it may require as large a flow of heat as possible to bring about this film-breaking temperature; the larger this heat flow, the lower need this artificial resistance be.

RESULTS OF TESTS BY OTHERS

During the earlier stages of the writer's researches some disinterested parties conducted some carefully made tests in which water was heated by the gas flames of ordinary cooking stoves in open vessels with various kinds of lugs, the amount of gas and its calorific value being determined; their best results were that the same quantity of water could thus be heated about twice as fast with about half the gas; since then the writer has obtained considerably better results.

Referring to Fig. 2, with lugs of the same diameter and of different lengths, as 2, 3 and 4, regularly spaced, the relative flows of heat through a lug were approximately those indicated by the vertical lines above them, that for 1 being the flow through an equal area of the bottom without any lug, therefore representing the normal practice of today. It will be noticed that for the greatest length, 4, the flow again became less. showing that the best length had been exceeded.

In Fig. 3 the lengths of all the lugs are the same, but their diameters are diminished. The vertical lines in this case represent the relative heat flows per unit cross-section of the lugs; lug 4 was the same as 3 in Fig. 2. Here again the last one, 6, showed that the best proportions had been passed.

In ordinary boiler practice the normal heat flow is generally given as three pounds evaporated per square foot of heating surface per hour, though this is sometimes exceeded, being said to be as high as 16 in some locomotive boilers, though probably at a considerable sacrifice of thermal efficiency.

The writer's researches were made in open, flat-bottomed tin cups, each having on its bottom a set of regularly spaced equal lugs, the proportions of the lugs being different for each cup, the one without any lugs being taken as the zero of reference. The same quantity of water was evaporated in each, with the same large though quiet bunsen flame, and the time was noted. Reduced to pounds per square foot per hour, some of the many results were as follows:

In the cup without lugs the heat flow corresponded to the evaporaton of about 17 lb. per sq.ft. per hour. This and not three pounds should be taken as the basis of the comparison with the lugs.

This rate being allowed for the portion of the bottom which is between the lugs, the rate through the lugs themselves was as high as 467 lb. per sq.ft. per hour, showing how the heat rushes through the thermal openings in this film made by the lugs when they are properly proportioned; this rate is about 27 times that for the cup without lugs, hence surprisingly great; the spheroidal state, which limits this rate, was not yet reached. The film resistance had then been reduced in effect to about two per cent. of what it was originally.

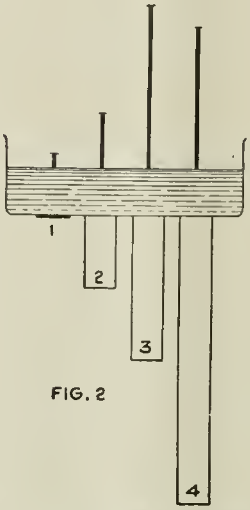


FIG. 2

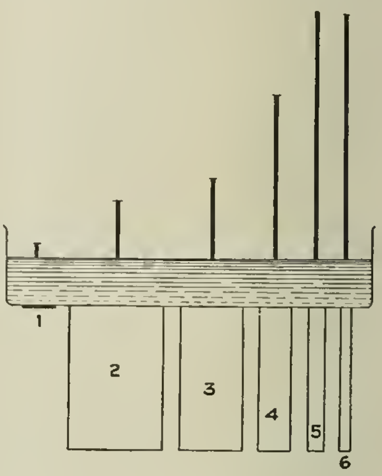


FIG. 3

FIG. 2. SAME DIAMETER AND DIFFERENT LENGTHS.
FIG. 3. SAME LENGTHS AND DIFFERENT DIAMETERS: FLOW PER SQUARE INCH SECTION

This shows how very much greater the heat flow through the properly proportioned lugs is as compared with the flow through an equal surface without lugs, and therefore how very greatly the resistance of this film in ordinary practice cuts down the transference of the heat to the water. In that particular test the lugs were spaced rather far apart, in order to find out what might be expected per lug when the hot gases have free circulation around them, and it is therefore of interest only in showing the possibilities and the correctness of the principle. This extremely high rate might perhaps be approached, say half way, in practice in the case of small-diameter boiler tubes in which the cooler ends of the lugs are as close together as possible and the hot ends far apart; but these lugs were rather too slender and numerous for practical purposes, except perhaps for very small boilers or water heaters.

With the same size lugs but spaced much closer together, thus getting less flow of heat per lug but more per square inch of total surface of the whole bottom, the result was about 60 lb. per sq.ft. per hour for the total bottom of the cup, which is still about 3½ times as great as for the cup without lugs.

These lugs were perhaps too slender and numerous for large boilers in regular practice, though perhaps not so for cooking utensils. Making the lugs four times as large in cross-section and using less than a third as many, the result was about 55 lb., hence only slightly less and still about 3¼ times that for the ordinary surface.

These results, surprising as they are, could no doubt be still further improved by further researches in this direction. There are other factors which also increase the heat flow, such as ending the lugs in points or edges, making them conical, etc.; moreover, heat seems to flow more readily from copper to iron than the reverse or than from iron to iron, hence copper lugs on iron vessels may give improved results; a moderate blast against the lugs also seems to have a greater effect than against a plane surface.

But even if in boiler practice and for cooking utensils, hot-water heaters, etc., the present rate could be only doubled, it would still mean that the same size of boiler would generate steam twice as fast and probably with even a slight gain in heat efficiency, and for household cooking utensils used with gas stoves it would mean heating twice as fast with half the gas. The bottom of the cooking utensils can be cast with the lugs, and in steam boilers the lugs can be electrically welded to the tubes, hence neither involve anything impracticable or costly.

Nugent Gravity Filter for Large Plants

In designing this oil filter accessibility and efficiency were the leading aims. Any part of the filter may be opened quickly for inspection, cleaning or repairs. The principle of operation is the same as that of the circular filter described in the Mar. 30, 1915, issue of *Power*. The new filter, which is square in section, is for large work, and can be made in capacities to filter 100 gal. per hour up to any size required.

Oil to be filtered enters through the inlet *A*, or it may be poured in by hand by lifting the lid to the screen chamber *K*. The oil flows through the special filtering material located between two vertical screens *R* in the top chamber and down through the pipes *L* into the settling and water-separating chamber. The latter is fitted with a steam-heating coil *G*, which runs around all four sides, also with lids to provide for inspection and cleaning while filtering is in process.

From this chamber the water flows up through a baffle box *O* and finally out through the discharge pipe *E*, as indicated by the arrows. This pipe is fitted with the observation fixture shown in either view. The oil rises in the settling chamber and overflows into the pipe *N*, passing down to the distributing header *P*, from which it is fed through stop-cocks to the filter bags. The header has caps at each end outside the filter, their removal facilitating inspection or cleaning.

The filter bags are oval in shape and are hung side by side on racks. Any set may be lifted out through the front door without disturbing the others. The bags are made of special filtering cloth. They cannot touch each other when full, nor can the contents overflow into the clean oil below, any excess being discharged into the outside troughs. Incandescent lamps placed at *H* illuminate the bag chamber.

The clean oil is drawn off at *B*, dirty oil and water at *C* and the clean oil overflows at *D*. Outlet *F* drains the settling chamber when repairs are necessary. The capacity of the filter shown is 500 gal. per hour, but, as previously stated, any size can be furnished from 100 gal. per hour up. William W. Nugent & Co., Chicago, Ill., are the makers.

Power Plant Burns Locomotive Cinders

The new power house of the large railroad station that has just been completed at Frankfort on the Main, Germany, despite the difficulties due to the scarcity of labor and material, is the first large railroad power station in the world to be operated entirely on the cinders taken from the locomotive. These cinders, according to the *Frankfurter Zeitung*, are piled in heaps from which an electric traveling crane runs directly to the boiler room.

Three boilers of 250 sq.m. (2691 sq.ft.) heating surface are fired by automatic underfeed stokers. Cinders alone or mixed with coal dust are used with a value of about 13,800 B.t.u. The steam is used to drive two turbines of 2000 hp. each, which generate current for the entire lighting and power equipment of the station. The foundation for a third turbine of the same capacity has been put in for future expansion.

FRONT AND END VIEW OF GRAVITY FILTER FOR LARGE POWER PLANTS

The Electrical Study Course—Elementary Single-Coil Dynamo

It is shown in this lesson how, when a coil of wire is revolved between the poles of a magnet, it has an alternating electromotive force induced in it and how this alternating voltage may be changed into a direct potential in the external circuit by means of a divided ring.

THE windings on the armature of a generator consist of a series of loops or coils grouped in various ways, depending upon the type of machine, voltage, etc. The simplest form would be one loop arranged to revolve between the north and the south pole of the magnet, as shown in Fig. 1. The ends of the loop connect to the rings R_1 and R_2, with brushes B_1 and B_2, resting on the latter to form a rubbing contact between the revolving loop and the stationary external circuit C. Considering the loop to revolve in a clockwise direction, as indicated by the curved arrow, the side of the loop under the N pole will be moving downward while the side under the S pole will be moving upward. The lines of force are from the N to the S pole; therefore, by applying the rule for the direction of the electromotive force generated in a conductor cutting lines of force, it will be found to be as given by the arrows on the two sides of the loop, which is away from the reader under the N pole and toward the reader under the S pole. This is just as it should be, since the lines of force are in the same direction under each pole, but the direction of the conductor under one pole is opposite to that under the other.

Factors Governing Value of the Voltage

By tracing around through the loop it will be seen that the e.m.f. generated in the side under one pole is added to that under the other pole. Or, in other words, we have the same condition as when two voltaic cells are connected in series, and if two volts are generated in one conductor, the two conductors in series will generate four volts. Hence, it is seen that one of the factors which govern the voltage of a given generator would be the number of conductors connected in series. For example, if instead of only one turn in the coil, as in Fig. 1, we have two turns in series, as in Fig. 2, and if the coil is revolved at the same rate and the magnetic density the same in both cases, then each conductor under a pole will have equal voltage generated in it. Again, by tracing through the coil, it will be seen that four conductors are in series; consequently, the voltage generated in the coil will be four times that in one conductor, or in other words the voltage increases as the number of turns in the coil is increased.

Another way to increase the voltage would be to increase the speed of the coil; that is, if the number of revolutions per minute made by the coil was doubled, the number of lines of force cut by each conductor would be doubled. Consequently, the voltage would be increased by two. A third way that the voltage generated in the coil may be varied is by changing the number of lines of force in the magnetic field. If the speed of the coil remains constant, but the strength of the magnetic field is doubled, then double the number of lines of force will be cut in a given time. The latter is the one way usually employed for varying the voltage of all modern generators and will be treated in a future lesson.

Current Reverses in External Circuit

In Fig. 1 the flow of the current is from conductor a to ring R_2 and brush B_2 through the external circuit C and back to brush B_1 and ring R_1 and back into conductor b, thus completing the circuit. When the coil has made one-half revolution, as shown in Fig. 3, conductor a will be under the N pole and conductor b under the S pole, as shown, with the result that the direction of the voltage generated in the two conductors is reversed. The direction of the e.m.f. in conductor a, Fig. 1, is toward the reader, but in Fig. 3 it is away; in b, Fig. 1, the direction is away from, while in Fig. 3 it is toward the reader. The result of this change in direction of the voltage in the coil is a change in direction of the current in the external circuit, as indicated by the arrowheads. From this it will be seen that on one-half of the revolution the current is flowing through the circuit in an opposite direction to that on the other half of the revolution; that is, the current is caused to flow back and forced through the circuit. If the voltage in the armature conductors change in direction as they pass alternate north and south poles there must be some position where the voltage is zero; this is indicated in Fig. 4.

When the coil is in the position shown in Fig. 4, it is moving parallel with the lines of force and is therefore not cutting them, and consequently not producing any voltage. From this point the voltage increases until the conductors are at the center of the polepieces, where they are moving at right angles to the lines of force and are therefore cutting the flux at a maximum rate, consequently producing a maximum pressure. For the next quarter of a revolution the voltage decreases to zero.

Electromotive Force or Current Curve

The series of values that the voltage or current passes through in the coil during one revolution may be expressed in the form of a curve, Fig. 7. The distance along the straight line between the two zero points of one curve represents the time required by the coil to pass the pole faces, or in Figs. 1 to 4, to make one-half revolution. The vertical distance between the line and the curve at any point represents the value of the voltage or current in the coil at that instance. The curve above the line represents current or voltage in one direction, while the curve below the line represents current or voltage in the opposite direction. A current or electromotive force that changes in direction in the circuit as shown in the foregoing is called an alternating current or electromotive force.

The voltage generated in the armature of all commercial types of generators is alternating, no matter whether the current in the external circuit flows in one direction or is alternating back and forth. If we want the current to flow in one direction in the external circuit, or, as it is usually called, a direct current or continuous current, some means must be provided to change the alternating voltage generated in the armature coil to one that is always in the same direction in the external circuit.

In Fig. 5 is shown a scheme that will maintain the voltage in one direction in the external circuit. Instead of the ends of the coils connecting to two rings, as in Figs. 1 to 4, they connect to the two halves of a divided ring. In the coil position shown, brush B_1 rest on segment S_1 and the current in the external circuit is in the direction indicated. When the coil has revolved a half-revolution as in Fig. 6, brush B_1 is resting on segment S_2, and although the current has reversed in the coil from that in Fig. 5, it is maintained in the same direction in the external circuit, as indicated by the arrowheads.

Although the voltage is applied in one direction to the external circuit, the current will not be of a constant value on account of the varying value of the voltage. What will be obtained is a current that flows in waves, as shown in Fig. 8 and is known as a pulsating current. To obtain a constant current for a given value of resistance in the external circuit, or, as it is usually called, a direct current, it is necessary to have a number of coils on the armature and the ring divided into as many sections as there are coils. This will form the subject of a future lesson.

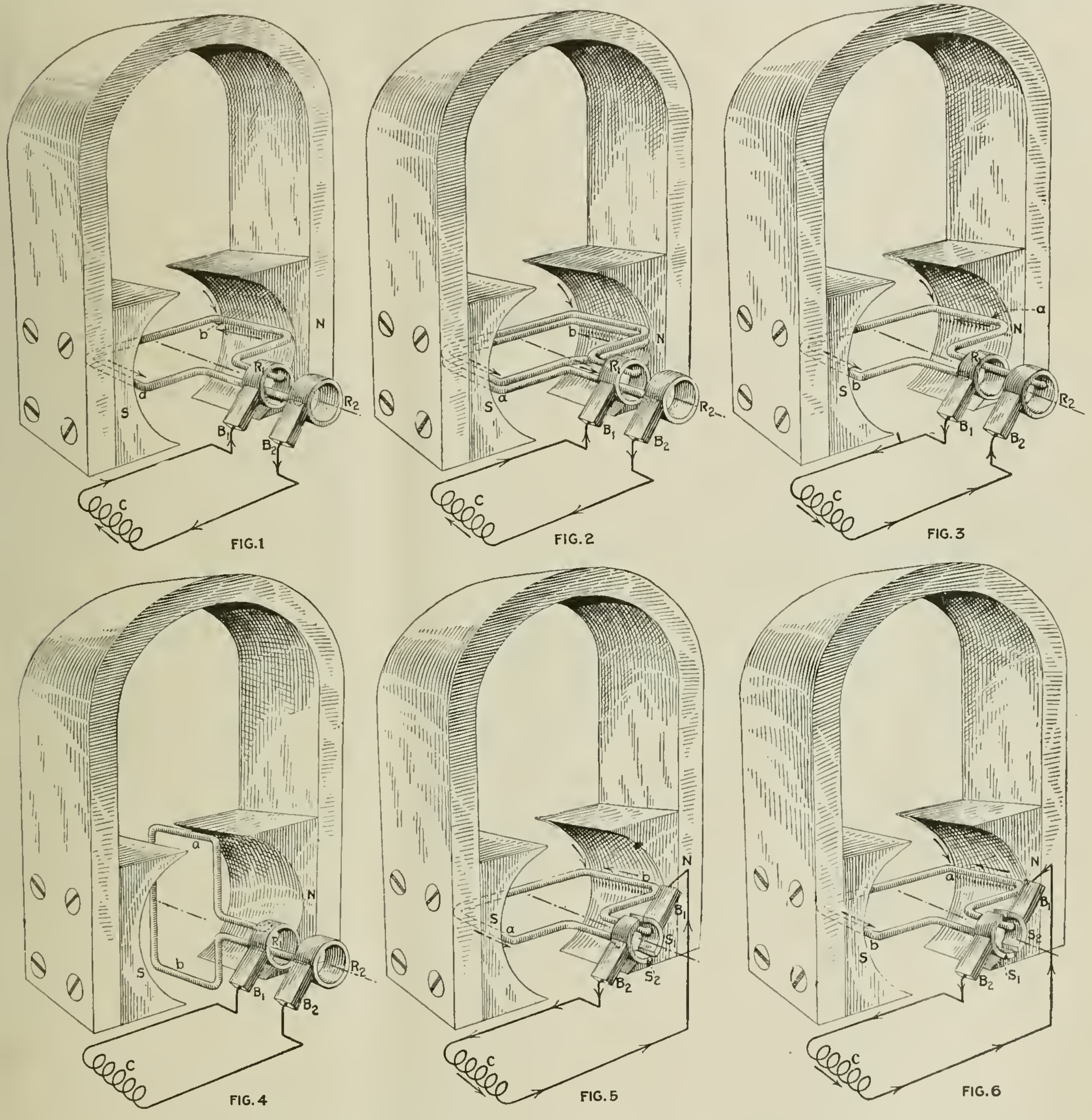


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 1 TO 6. ELEMENTARY ELECTRIC GENERATOR, CONSISTING OF ONE COIL AND HORSESHOE MAGNET

Fig. 9 shows the layout of the study problem given in the last lesson. The conductors from the source of power will have to be large enough to transmit a current $I = I_1 + I_2 = 150 + 125 = 275$ amperes. Referring to the wire table, it will be found that a 300,000-cir.mil, rubber-covered conductor is required for 275-amp. load. Between the first and second load, the conductors need only be large enough to take care of 125 amperes and according to the wire cable, a No. 0 wire may be used. The resistance of the circuit from the source of power to the first load is that of 700 ft. of 300,000-cir.mil conductor, which is $R = \frac{10.7L}{cir.mils} = \frac{10.7 \times 700}{300,000} = 0.025$ ohm. Volts drop in this part of the circuit is $E_d = RI = 0.025 \times 275 = 6.875$ volts, and the voltage available at this load is $E_a = E - E_d = 240 - 6.875 = 233.125$. The resistance R_1 of the circuit between the two loads is that of 550 ft. of No. 0 conductor, or $R_1 = \frac{10.7L}{cir.mils} = \frac{10.7 \times 550}{105,500} = 0.056$ ohm. Volts drop in this part of the circuit is $E'_d = R_1 I_2 = 0.056 \times 125 = 7$ volts, and the available voltage at the load is $E'_a = E_a - E'_d = 233.125 - 7 = 226.125$. The watts loss in the first section of the circuit is $W'_l = E_d I = 6.875 \times 275 = 1890.625$. In the second section the watts loss in the line is $W''_l = E'_d I_2 = 7 \times 125 = 875$, and the total watts loss $W_l = W'_l + W''_l = 1890.625 + 875 = 2765.625$. The watts supplied to the first load is $W'_a = E_a I_1 = 233.125 \times 150 = 34,968.750$, watts supplied to the second load is $W''_a = E'_a I_2 = 226.125 \times 125 = 28,265.625$, and the total watts supplied to the two loads is $W_a = W'_a + W''_a = 34,968.750 + 28,265.625 = 63,234.375$. The total watts supplied to the system is $W = W_l + W_a = 2765.625 + 63,234.375 = 66,000$. The total watts is also $W = EI = 240 \times 275 = 66,000$, which checks up with the foregoing value.

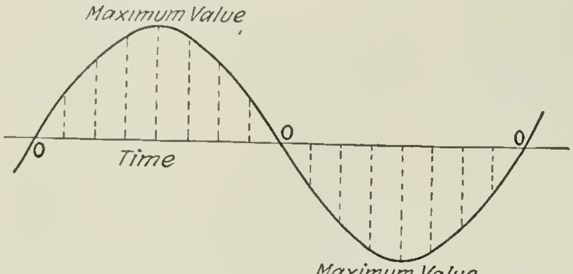


FIG. 7

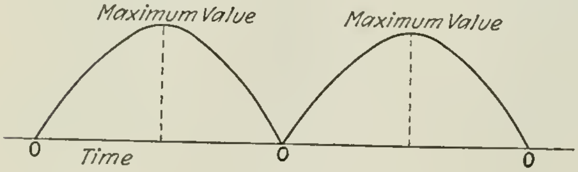


FIG. 8

FIGS. 7 AND 8. VOLTAGE OR CURRENT CURVES

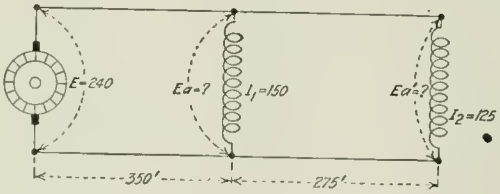


FIG. 9

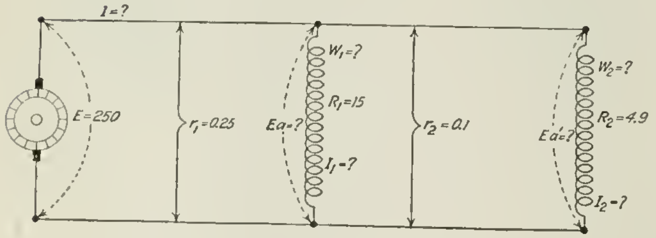


FIG. 10

FIGS. 9 AND 10. COMPLEX CIRCUITS

In Fig. 10, r_1 and r_2 refer to the resistance of the two line wires the arrows point to. In addition to finding the values indicated by the interrogation marks, find the total watts, kilowatts and electrical horsepower supplied to the system.

Taylor Condensation Meter

The desirable feature of a meter is accuracy and dependability for long periods of service. A meter that seems to possess these with other desirable characteristics has been designed by the Taylor Underground Heating System, Pittsburgh, Penn.

This meter (Fig. 3) contains, within a metal case, four copper and brass buckets (Fig. 1) attached to an anti-rust shaft which revolves in an anti-friction self-lubricating bearing. The turning movement of the buckets and the shaft is so sensitive that the addition of one-quarter ounce of water will move the full bucket when it is ready to dump. The buckets are held in the filling position by a locking device in the dial box of the meter until the proper amount of water has been delivered to the bucket being filled. Then the full bucket moves to the dumping position; the next bucket cuts in when the full bucket moves $\frac{3}{16}$ inch.

The locking device is shown in Fig. 2. Each bucket is provided with a cam, the surface of which gradually increases in radius in the direction of the rotation of the buckets and terminates at its highest end in a stop projection *A*, the outer edge of which projects beyond the peripheral surface of the cam portion. A camwheel *B* revolves on a pin in the arm *C* and runs on the surface of the camwheel. This arm is fulcrumed at *D*, and the other end of the arm engages, by means of a slot, with the pin *E*, which is carried by the cylinder *F*, which telescopes over a plunger *G* pivoted to the metal case.

The dashpot plunger is made with an air-inlet port *I*, which is controlled by a check valve *J*. An escapement port *K* is provided, the lower portion of which is designed to be moved into and out of register with the opening *L*.

The operation is as follows: Water of condensation enters the meter at one end of the storage chamber, where it strikes a baffle plate. From the storage chamber the liquid flows through an opening (Fig. 1) and is deflected by the curved bottom of the vertical bucket into the bucket to be filled, which is held in its filling position by the engagement of the roller *B* (Fig. 2) with the stop *A*. When the bucket becomes filled with a predetermined weight of liquid, which is regulated by the adjustment of the weight *O*, the resistance of the roller against the stop is overcome and the shaft and the bucket will revolve one-quarter turn, until the next bucket is in the filling position and the full bucket is discharging. It is evident that as soon as the full bucket begins to rotate, the following one ceases to divert the liquid into it, and the empty bucket will be brought into position to receive the discharge from the receiving chamber.

After the roller passes over this stop to the position shown at the right of Fig. 2, the shaft revolves through 90 deg. to bring the next bucket into the filling position. In this position the dashpot cylinder has been pulled upward so that the ports *K* and *L* are out of register. During the next 90-deg. movement of the shaft the cylinder will be moved downward as the roller rides up on the cam. When the roller reaches the position shown at the left of Fig. 2, the arm has moved downward until the slot in the end engages the pin *E*, when the cylinder *F* is forced down a short distance, quickly compressing the air until the roller is brought to a rest by engaging one of the stops.

The purpose of the dashpot is to act as a controlling device so that the meter will not trip until the predetermined weight of liquid has been collected in each bucket. It also guards against possible spinning of the bucket shaft after it has been released and insures the stopping of the next bucket at the correct filling position. The air that is trapped in the dashpot cylinder acts as a brake upon the camwheel until such time as the cylinder moves to a position to bring the ports *K* and *L* into register.

As the buckets and shaft make a complete revolution, there is no possibility of the shaft wearing flat, and the turning movement also eliminates the deposits of sediment in the bucket.

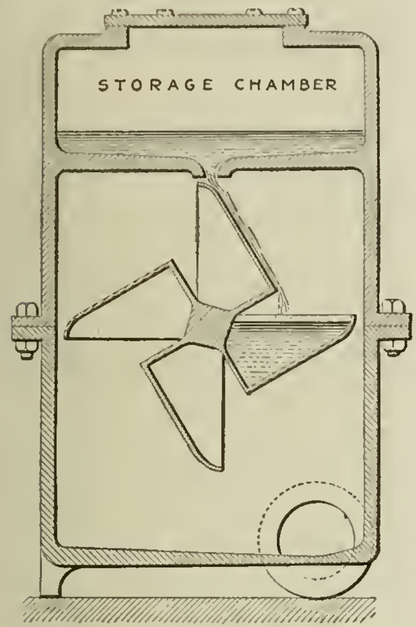


FIG. 1

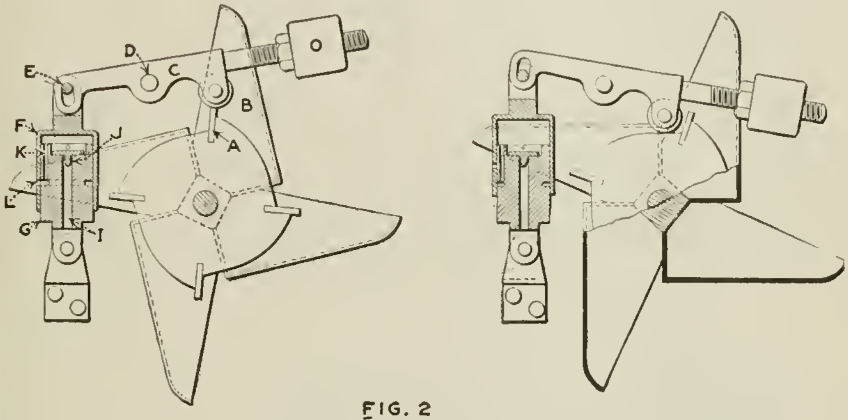


FIG. 2

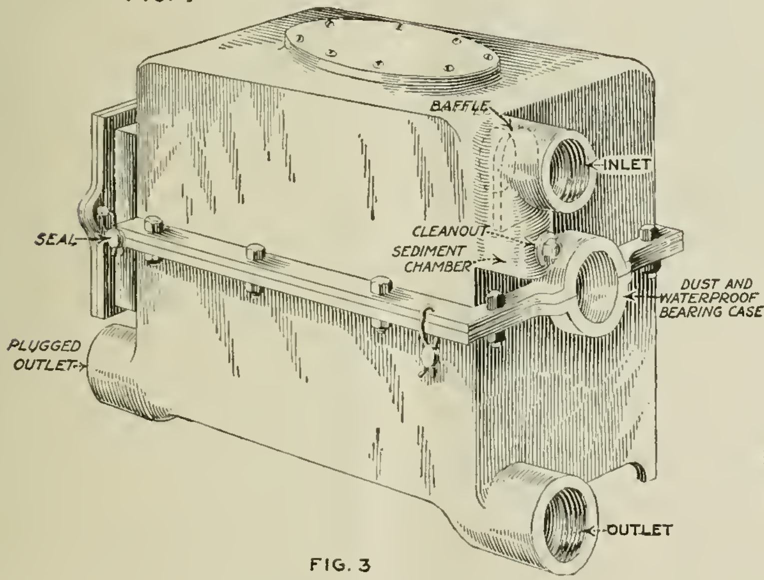


FIG. 3

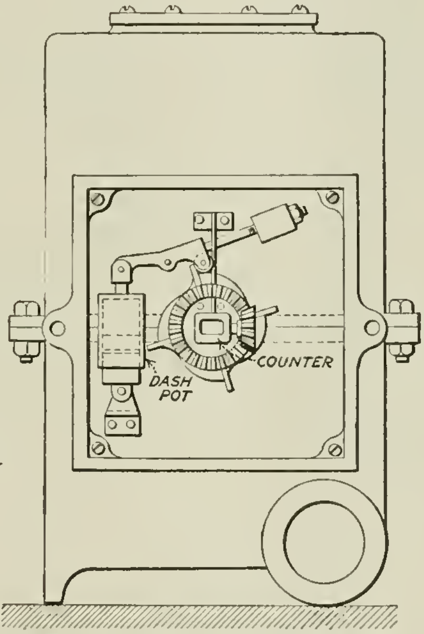


FIG. 4

FIGS. 1 TO 4. DETAILS OF THE TAYLOR CONDENSATION METER

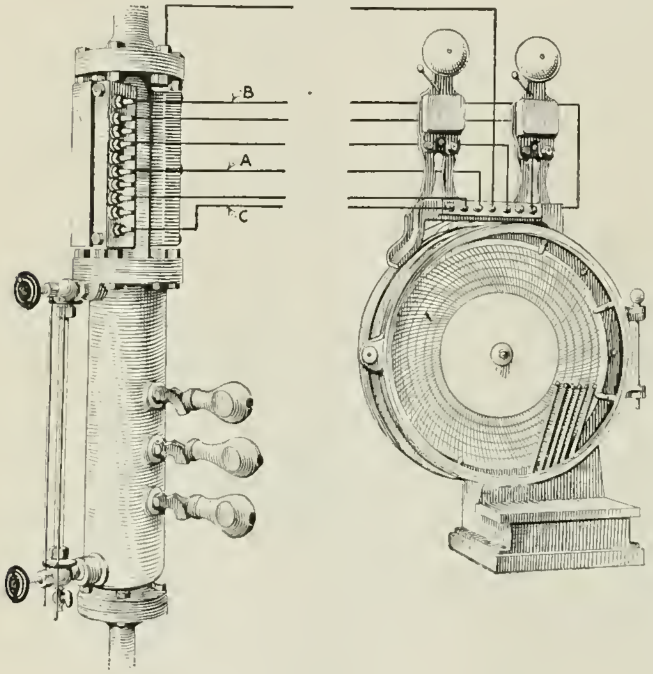
Fig. 1—Position of buckets when filling. Fig. 2—Details of locking device. Fig. 3—Meter box and connections. Fig. 4—Meter counting mechanism

All outlets are in the base of the meter, and therefore water will not remain in the bottom when the meter is not in operation. The count mechanism, Fig. 4, is inclosed in a damp- and dust-proof dial box to prevent corrosion. The meter reads direct; that is, if the dial shows 5000 it means that 5000 lb. of water has passed through the meter.

The meter is made in capacities from 400 lb. of liquid per hour to 200,000 lb. and is guaranteed to measure accurately to within one-half of one per cent.

Wight Electrical Boiler-Level Recorder

It is common to hear either the high- or the low-water alarm sounding in boiler plants. Water should not be allowed to drop too low because of the danger of burning the boiler, and when the water is carried too high there is the danger of priming and of slugs of water going over into the engine cylinder. Then there is the economic advantage in keeping the water level constant in that the feed water is put into the boiler only as fast as it is evaporated. Such regularity in pumping feed water also allows the maximum amount of heat transfer from the exhaust steam to the feed water in passing through the heater.



ELECTRIC WATER-LEVEL RECORDER

An instrument that has been designed to record the water level in a boiler, making a continuous record of extreme low, high and all intermediate levels, is manufactured by the Wight Electric Recorder Co., Cleveland, Ohio. This instrument consists of multi-recording pen arms and is equipped with both high- and low-level alarms. On the top of the water column is a contact chamber in which contact is made at the various terminals as the water level in the boiler changes. The contact mechanism is actuated by a noncollapsible float which is filled with gas, at approximately boiler pressure, which increases and decreases as the pressure on the outside of the float fluctuates.

The operation of the recorder is about as follows: Assume that the water level is at the middle gage of the water column, the float contact will make connection with the contact *A*, which is connected to a corresponding pen arm of the recorder. At extreme high-water contact is made with the connection *B* and with connection *C* at the low-water level; likewise with the remaining connections as the water may vary up or down. By this instrument a record of the water level carried during the 24-hour period covered by each chart is shown and at what time it was at any particular level.

The recording dial can be placed at any convenient point about the establishment, and the instrument can be used for a number of purposes, such as recording the trips of an elevator, skip hoist, mine skip or any other machine where a record of what it is doing is required.

Motor Sparked When Starting

By E. C. Parham

An armature coil that is short-circuited, as, for example, by two of the commutator bars being metallically bridged, will soon be burned out, because the voltage of the coil when in an active part of the field is considerable, while the resistance of the short-circuit is almost negligible. An armature coil that is open-circuited as, for example, by a broken or burned-off lead, will cause a spark to travel around with the commutator, the spark being maintained across the bars that include the open-circuit. Short-circuited coils are of comparatively frequent occurrence and so are open-circuited coils, but probably it is rarely that both conditions occur in the same coil, as they did in the following instance:

In regard to a 15-hp. 500-volt direct-current motor which was sparking, an inspector was informed that for more than a year the motor had been acting just as it was then. The commutator would show a traveling spark when the motor was being started, but as soon as the armature reached about half-speed, the sparking would cease. Inspection disclosed that one coil of the armature was entirely burned out as far as the course of the coil could be followed. Since the machine was taking only about one-third full-load current, and it was apparent that the motor would continue to run for some time as it had been running, and as it was essential that the machine be kept in operation, a new armature was ordered and the old one kept in service in the meantime.

When the new armature was installed, it was found that in the old one the ends of the affected coil were connected to adjacent commutator bars, the leads of which in some way became crossed, first short-circuiting the coil, then open-circuiting it. The open-circuit occurred in such a way that the two stubs that led to the commutator were apart as long as the armature remained at rest or did not exceed a certain speed. Above this speed, however, the stubs were forced against each other by centrifugal force, thereby bridging the bars that included the break and thus eliminating the traveling spark. A loose connection in the commutator frequently produces the foregoing effect.

Editorials

A National Engineers' License Law

A FEDERAL law providing for the examination and licensing of power-plant engineers in the same way that marine engineers are examined and licensed by the United States Board of Supervising Inspectors of Steam Vessels has been regarded as an impossibility under our Constitution upon the ground that it would be an unwarranted interference by the central Government with the internal affairs of the forty-odd sovereignties of which the Union is composed. So long as the preservation of the public safety was the only ground for such legislation, this contention was unanswerable, and it has been generally conceded that, in spite of the desirability of nation-wide and uniform requirements and practice, any regulation of this kind must be undertaken by the individual states.

But in these days when a common danger has emphasized the significance of common interests and the importance of general, over-all, inclusive efficiency, it is becoming apparent that there is a broader ground for inquiring into the operation of power plants in the communal interest. The immediately apparent motive for legislation against the use of unsafe boilers or the unsafe use of any boiler is the avoidance of killing and maiming people and destroying property in the immediate neighborhood. But the effect of a boiler explosion reaches much farther than this. In its reduction of man power, its interruption of production, its destruction of the fruits of labor, its addition to the burden of the community in caring for the injured and their dependents, it adds indirectly and in devious ways to the common cost of living. It is a defeat, a setback in the eternal conflict of man against the forces of nature; an impairment of his fighting force, a disaster with much more than a local significance.

The loss to the community, to the nation, from an occasional boiler explosion, considerable and desirable of prevention as it is, is insignificant as compared with the avoidable waste that is continually going on. Every ton of coal wastefully burned is an unnecessary impairment of the national resources and makes every other ton of coal and every unit of the product which it is burned to manufacture cost more.

The coal burned in the power plant of a shoe factory is an item in the cost of the product. If the product is sold at cost plus a fair profit, every purchaser of shoes has a monetary interest in the efficiency of the shoe manufacturer's power plant. In a time like this, when a shortage in the national coal bin is of such far-reaching, obvious and vital importance, the right of the nation to insist upon the economical use of fuel is practically unquestioned. Sixty-seven per cent. of the coal mined in this country is shoveled under boilers by about a quarter of a million firemen. It is claimed by those who have made a specialty of the subject that twenty-five per cent. of this could be saved by the exercise of a reasonable amount of care and an easily attainable amount of skill on the part of this quarter of a million men. Is it not conceivable that the people of the country in their collective capacity—that is, through the Federal Government—may insist that the steam plants of the country be operated efficiently as well as safely; and inasmuch as the effects involved are not confined by political boundaries but are nation-wide, that the supervision necessary to bring this about is a legitimate function of the Federal Government?

Save Coal in the Home

OF THE six hundred million tons of coal produced last year in this country, twenty per cent. was used for domestic purposes, and about fifteen million people shoveled this coal into their respective furnaces or stoves. The ordinary scoop shovel will hold about ten pounds of coal. At the prevailing market prices the small consumer had to pay five cents per shovelful for anthracite and for the same sum obtained double this amount of bituminous coal.

Such a small saving as one shovelful per day by each user would amount to seventy-five thousand tons, which for six months of the heating season, one hundred eighty days, increases to thirteen and one-half million tons.

The saving by each consumer is infinitesimal when compared to the total coal mined, but the aggregate saving is large. It is entirely possible to effect. More careful firing methods and overhauling of the furnaces to put them in first-class condition would do it. This particular case is only one of the many illustrations of what may be done when efficiency is the keynote and waste a crime. Under the circumstances it is the duty of every householder to reduce his coal requirements. One shovelful per day will work no hardship. It is a service that Uncle Sam will appreciate.

A New Principle in the Flow of Heat

IN AN article entitled "A New Method of Increasing the Evaporation in Boilers," on page 10, Dr. Carl Hering describes what might really be called a new principle in the flow of heat. The value of the legs of a pot as heating surface is one of the perennial subjects of discussion, and the use of knobs, projections and fins for increasing the absorption and radiation of heat is common, but Dr. Hering shows for the first time, to our knowledge, the underlying principle upon which such extensions should apparently be based, and by which their effectiveness may be greatly increased. When a flame plays against a relatively much cooler body, as that of an alcohol lamp against a beaker of water, there is formed a film of extinguished gas between the flame and the beaker, which cannot get away before it gets so cool that it will not char paper. The common experiment of sticking a postage stamp to the bottom of a tin dipper and boiling water in it without charring the stamp is a demonstration of this fact.

The author of the article in question found that the resistance of this film to the passage of heat diminishes rapidly with the difference in temperature between its confining surfaces; that is, between the hot surface of the beaker on one side of this film and the flame on the other side of it. The temperature of the flame is fixed, but that of the receiving surface can be increased by interposing a certain amount of thermal resistance between it and the relatively cool fluid. This, in effect, is what he says the "pot legs" should be made to do, and when they are proportioned in accordance with the principle described and the values obtained by Dr. Hering, they seem to add in a remarkable degree to the activity of the heat transfer. He maintains that his researches also show the older idea of increased surface to be false and misleading, which, if true, would show why others had been groping in the dark with but small gains.

Lightless Nights and Nonessentials

THE original Fuel Administration order on the dimming of electric signs, which was intended to restrict the use of fuel-consuming signs to the period between 7:45 a.m. and 11 p.m., has failed in producing the coal-saving results that were expected. There may be two reasons for this—that the users of the electric signs deliberately ignored the order regarding their use or that they continued to use them with the belief that no one else would obey the order and that the coal situation was not so serious as has been claimed.

It would seem that anyone at all interested in the fuel question would have come to the conclusion long before this that there is a fuel shortage, regardless of whether it is the fault of the mine producers or that of transportation. With factories shutting down in Pittsburgh, Cleveland and other cities because of a lack of coal sufficient to generate steam for power purposes, the fact of a coal shortage is being brought home in a manner that cannot be gainsaid, and coal users are beginning to realize that the coal question is a serious one throughout the country.

As a result of the noncompliance with the original order of the Fuel Administration, a new order has been issued and was put into effect on Sunday night, December sixteenth, when Broadway and other "white ways" throughout the country were made lightless. Under the new order two nights each week will be lightless nights, and these are designated as Sunday and Thursday. Under the new order the "white ways" of our cities are to disappear absolutely on the nights designated. The burning of lights contrary to the wording and spirit of the order will constitute a violation of the law, and steps will be taken by the Fuel Administration to mete out punishment to offenders.

The coal shortage has caused considerable unrest among the manufacturers of nonessentials, and perhaps the first city to bear the burden of the power shortage is Pittsburgh, under an order issued by Robert J. Bulkley on the authority of the Priorities Board.

Mr. Bulkley investigated the industries of Pittsburgh using electric power, and the new order as arranged will go into effect as soon as it is possible to get instructions from Washington designating the concerns that are making nonessentials, a list of which has already been compiled. The procedure, it is understood, will be merely to forward this list to the power companies and depend upon them to cut out electricity from these concerns, but the list may be revised from time to time. Munition plants will be given every privilege, and no further curtailment of their operation will be permitted.

To just what extent this measure of conserving coal for the necessary industries engaged in munition work will operate, cannot be foretold, and it is doubtful if the Government will favor arbitrary limitation of any industries except as a last resort, in the event of an acute shortage of coal. It stands to reason that when for any reason the coal situation in the country gets to a point where war interests are threatened with closing down, the nonessential producer will be obliged to suspend operations.

Business Editors at Washington

THE business press of the country talks to a large constituency in the language that its readers best understand and from the vantage point of an exponent of their interests. The esteem in which it is held by those in authority is evidenced by the fact that such people as F. W. Taussig, Chairman U. S. Tariff Board; Eliot Wadsworth, Vice Chairman American Red Cross; J. D. A. Morrow, Secretary National Coal Association; Harry A. Garfield, Fuel Administrator; Food Administrator M. L. Requa; Frederic A. Delano, Member Federal Reserve Board; Senator Francis G. Newlands, Chairman Joint Congressional Committee on Interstate Commerce; E. N. Hurley, Chairman of Shipping Board; Senator Atlee Pomerene, Member of Committees on Banking and Currency, Foreign Relations, and Manufactures; Dan C. Roper, Commissioner in Charge of Collection of Excess Profits; A. W. Shaw, Chairman Commercial Economy Committee, Council of National Defense; Dr. Anna Howard Shaw, Chairman Woman's Committee, Council of National Defense; and C. A. Richards, Chief Bureau of Exports, agreed to meet a delegation of some seventy-five editors of American business papers and give them in short addresses the high points in the work which they are doing. J. D. A. Morrow, Secretary of the National Coal Association, appeared in the place left vacant upon the program by the failure of Secretary Lane to appear, and M. L. Requa represented Mr. Hoover, who was unable to be present. Dr. Garfield's remarks on the coal situation will be found in another column.

President Wilson's taking over of the railroads will be generally approved. The transportation system of the country should be an entity operated at maximum efficiency, not as measured by the ratio of dividends to investment but by the ratio of service to cost. It may be that somebody's remark about unscrambling eggs may come home to roost.

The index to Volume 46 (the last six months of 1917) will be ready shortly and will be sent to all whose names are on the index mailing list. Any others who wish will be put on the list. A post-card request is sufficient.

Correspondence

High Speed of Steam Turbines

In connection with the question of steam-turbine failures, which is discussed in recent issues of *Power*, a statement of our practice and experience might be of interest to your readers.

The safe speed for our standard noncondensing wheel is so far in excess of the usual operating speed that we do not as a regular practice find it necessary to run any special overspeed test unless the turbine is to operate regularly at an unusually high velocity. The regular overspeed run which we make for the Government is 25 per cent. over the normal rating. The maximum test speed at which we can operate our different rotors is so far above this value, however, that we seldom approach it. These maximum test speeds vary from 4000 to 7000 r.p.m., depending on the diameter of the wheel.

When it is considered that for condenser-auxiliary drive, boiler-feed or boiler-draft service operating speeds for direct-connected units seldom exceed 2500 r.p.m. and for 60-cycle alternator speeds, 3600 r.p.m., such high-test speeds allow a wide margin of safety.

It is possible to injure any wheel by sufficiently overspeeding it, and it is highly important that the design of a wheel be such that if it is accidentally run to this speed as little damage as possible will result. To insure maximum strength, the Terry rotor is cut from solid steel, even the buckets being milled from the solid steel. The semicircular notch in the center of the bucket incidental to manufacturing proves a further source of strength and safety, due to a reduction in blade weight and stresses. When the speed is approaching the danger point, the corners of the bucket next to the semicircular slot begin to bend upward. These will strike on the edges of the reversing chambers and will usually give warning before anything very serious occurs. The web is made much stronger than the blades, so that should the turbine overspeed for any reason whatsoever, the individual blades would shear out, resulting in decreased speed before reaching the danger point for the web. The blades are very light, therefore the worst they can do is to injure the nozzles and reversing chambers. We have actually run machines to destruction for experimental purposes, and found that when this occurs no part of the turbine rotor will come through the casing. Although we have more than 4000 turbines running, we know of only one case in which anyone has been injured by a wheel bursting and that by a type we no longer build.

Some time ago, while making tests on our multi-stage condensing machines, we took a wheel which was then standard and ran it to destruction. The blades were one-third longer than any blade of equal shape we are now using. The wheel disk, was, however, of the same type as now used. At approximately 5200 r.p.m. the buckets came out of their fastening. Since that time improvements in the strength of our blade fastening have made it three times as strong as at the time of the test. We are using no blades as heavy as the ones that were in the first wheel and are limiting the speeds on this particular diameter of wheel to 4000 r.p.m. in the multi-stage machine. As constructed now, these wheels will safely stand a test speed of approximately 6000 revolutions per minute.

In addition to having a high factor of safety for the wheel, in the standard noncondensing turbine there are no close side clearances to be maintained and there can be no fouling of the blades due to a slight axial wear or misadjustment. Even if the bearings wear down, the moving blades cannot strike on the stationary blades, as they are protected by a substantial rim that projects beyond the blade. The only thing that can strip the blades is serious overspeeding or the presence of some foreign substance.

J. Breslav., Sales Eng.,
Terry Steam Turbine Co.

Hartford, Conn.

Suggested Designs for Centrifugal Machinery

I was interested in reading C. E. Pratt's letter on "Suggested Designs for Centrifugal Machinery" and his comments on the steam motor in the Nov. 20 issue of *Power*, page 704.

Mr. Pratt suggests going a step farther with the design than suggested by the Steam Motors Co., by doing away with the bedplate and having the pump and turbine bolted together by vertical flanges. This design is quite feasible and has been already adopted by one or two manufacturers. But when we attempt to make a rabbeted fit at this point, it must be borne in mind that this is not so easy as it looks for the reason that these two flanges will be machined in separate shops, which is a different proposition to machining both flanges to one set of gages.

Again, this arrangement necessitates a special pump, whereas with the design suggested in the steam motor a standard pump is used without any change in existing patterns.

I do not quite understand Mr. Pratt's reference to a third bearing, in the second paragraph of his letter. He asks: "Why not do away with the third bearing, leaving in this instance the prime mover entirely overhung?" This is exactly the way the steam motor is designed, and there are only two bearings in the steam motor combination, as he will note if he looks over the original article.

Regarding the question raised by Mr. Pratt as to why more manufacturers do not build both ends of the unit, the answer is that this is an age of specialization and a concern which devotes all its energies to manufacturing one particular line of apparatus is in a better position to perfect that than if it built several different lines. Mr. Pratt goes on to say that this would, in most cases, solve the problem of assembling two machines, in addition to having only two bearings for the complete unit. As already mentioned, this is what we have with the design of the steam motor. We do not assemble two machines together in the true sense of the word, as the steam motor automatically becomes part of the equipment to which it is attached and has the advantage, which Mr. Pratt feels is very important, of having only two bearings for the complete outfit.

I am entirely in sympathy with Mr. Pratt's ideas regarding standardization, and he will find a paper devoted in a great measure to this subject, presented before the American Society of Mechanical Engineers at its annual meeting in December, 1917. [This paper will soon appear in *Power*.—Editor.]

W. J. A. London, Engineer.
Springfield, Mass. The Steam Motors Co.

American Blowing Engine in Italy

One of the remarkable events taking place in Italy today is the supplanting of German machinery by American products. The war is teaching Italy that an exchange of her surplus products for American goods is preferable to the pre-war dumping system.

Throughout the country one meets American engineers assembling or erecting American machinery. In Turin over one hundred Baldwin locomotives have been delivered recently, and in Brindisi more locomotives are being assembled, and the chain is complete from the Alps to the southern Adriatic. An American engineer, Henry Louis Hammerle, is erecting for the Mesta Machine Co., of Pittsburgh, a monster blowing engine at the Ilva steel works in Bagnoli, near Naples. This blower, the largest in Italy, is designed to deliver 37,100 cu.ft. of air per min. to the blast furnaces where Elba Island iron ore is reduced. The bedplate alone weighs 160,000 lb. and is larger than any other casting ever imported into or manufactured in Italy. It was with much difficulty that the engine was stowed for shipment aboard a tramp steamer, and it was then buried under a load of coal. Its total weight, including the flywheel, is 1,200,000 lb. The flywheel is 24 ft. in diameter and weighs 160,000 lb. The cylinder is 46 in. diameter and 60-in. stroke.

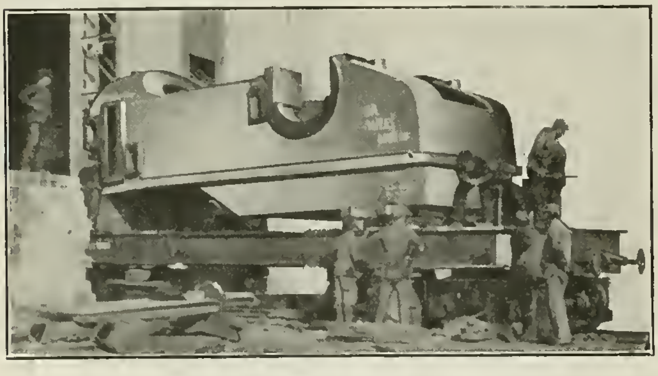
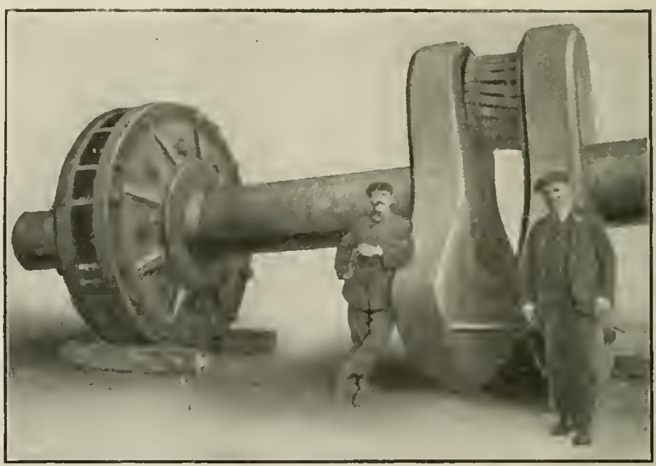


FIG. 1. UNLOADING THE ENGINE BEDPLATE AT THE PLANT

The Italian buyers are pleased with the complete oiling system of the engine, since it saves 75 per cent. of the oil, a matter of great importance in Italy. The foundations beneath their other engines are saturated with wasted oil. Italy produces no lubricating oil or coal, and very little iron, and Italian manufacturers are forced to look to other countries for these materials. Nearly all the oil and steel now come from the United States. One firm has used 300,000 tons of American steel since the war began, and another, a munitions plant, is using 2400 tons a month. About two- thirds of Italy's coal comes from England and the remainder from America. The present price of coal is one thousand lira ($130) per ton. American products find a welcome in Italy even under the present almost prohibitive freight rates.



CRANKSHAFT AND HUB OF FLYWHEEL

The illustrations show the bedplate and crankshaft of the blowing engine referred to in the foregoing.

Paris, France. A. R. Decker.

The Engineer and the Union

Referring to the letters that have recently appeared concerning the engineer and the union, I think the unions are good enough in their way, but are lacking in one important respect; namely, almost anyone can call himself an engineer and join the union. The unions should have an examination as strict as that of the license examiners, so that the employer can have no justification in objecting to the higher wages demanded, considering both the safety of his plant and his pocketbook. So many employers have been stung that one can hardly blame them for their objection to employing uncertified men.

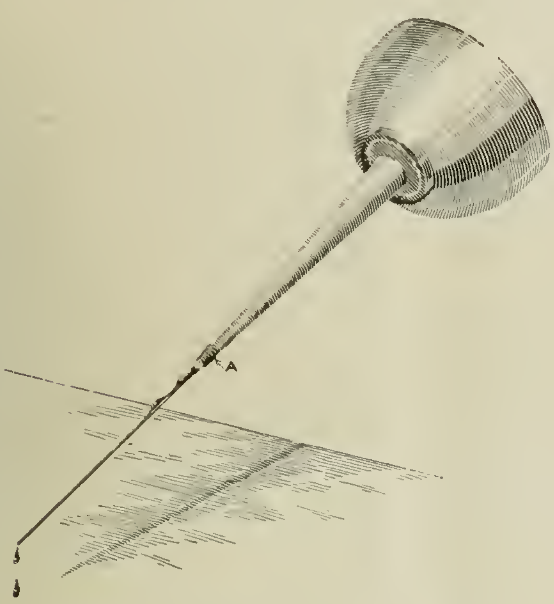
But another unfortunate side of the question is, that with the present scale of wages there is not much encouragement for a young man to keep plugging for a higher position with the responsibilities and cares of the chief engineer. We can't all be bosses, so all we can do is to train for the position and be ready when the opportunity arrives. In the meantime we should have a wage sufficient to maintain ourselves, with a few of the good things of life on the side.

These are views I have heard expressed by engineers in different parts of the country. Something should be done, and the greater the publicity the subject can be given the better. I would like to see conditions changed, but it will probably take a long time.

Emmett, Idaho. George R. Dye.

Extension Oil-Can Spout

In the issue of Oct. 30, page 603, Mr. Forray shows an extension for an oil can for oiling parts above reach without climbing a ladder. A convenient way to oil parts below reach when no long-spout oil can is at hand is by attaching a stiff iron or copper wire to the spout of an ordinary oil can as shown in the illustration. As the oil comes out of the spout it will follow the wire to the point intended. D. R. **Hibbs.**



WIRE EXTENSION ON OIL-CAN SPOUT

New York City.

Bad Packing Conditions Overcome

I experienced a lot of difficulty trying to hold the piston-rod packing in an engine under my charge. I cast two rings of babbitt to fit the rod closely and go into the stuffing-box. One of these was put in the bottom or back end of the stuffing-box, then soft packing and last the second ring of babbitt.

With the gland tightened up only moderately, the packing does not leak and the engine runs splendidly.

Altman, W. Va. **John French.**

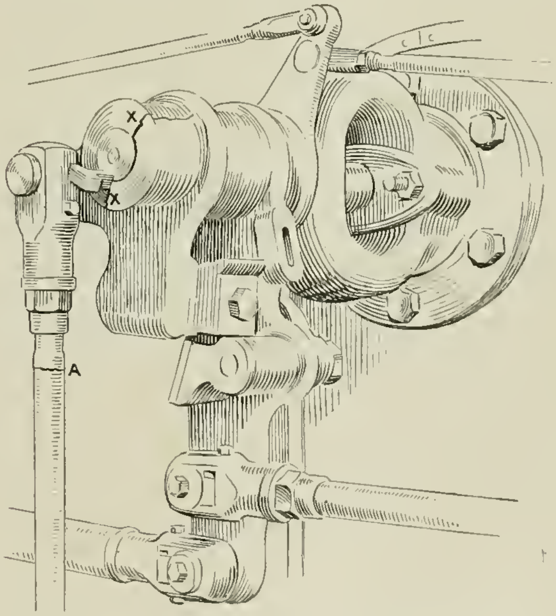
Valve Gear Broken by "Blocked" Valve

One unit of a large power plant is a 700-hp. simple Corliss engine. One noon hour, after most of the plant crew had finished lunch and were sprawled around the engine room waiting for the starting whistle, a blood-curdling racket, described as a cross between a cat serenade and a hog-killing squeal, started in a corner of the room. The lights danced and the brushes on the generator flashed and squealed; so the men "scooted" out by the shortest route through doors and windows and, after reaching what they considered a safe distance, turned to see if the whole power house was following.

The chief, one assistant and one oiler were the only ones who stood their ground, though in truth they were all shaky in the knees, and they began a cautious investigation to determine where the unearthly sounds originated. They seemed to come from the corner where the feed-water heater was located, and while they were gathered around the heater for a moment there was a howl at the commutator of the large engine unit running in parallel with two smaller ones, followed by several flashes, and the circuit-breaker "kicked" out. The chief shut off the throttle and noticed that the dashpot rod was broken at *A*, as shown in the illustration, and that the steam arm was gone—had dropped into the oil pan under the valve gear so that the bare valve stem was staring him in the face.

The steam arm had been broken across the hub, as indicated by *X* in the sketch. In attempting to turn the valve closed, it was found impossible to do so, but it moved freely in the reverse direction, and when the bonnet and valve were removed it was found that a piece of the threaded end of a pipe had dropped into the steam chest and worked into the port when the valve opened, and prevented it from closing, and of course something had to let go; in this case it was the steam arm.

The explanation of the noise was then simple, for the steam valve being wide open, every time the exhaust valve opened, the steam at full boiler pressure rushed into the exhaust line that ran under the floor as far as the heater, where a tee connected it with the vertical riser to the back-pressure valve. Evidently, considerable water had accumulated in this tee during the light load period at the lunch hour, so that when the live steam rushed through, it caused the terrific racket and the engine could work only on one end, so the governor was unable to control the speed and voltage and the circuit-breaker went out with the usual fireworks. A new dashpot rod was made and the broken steam arm was oxyacetylene welded and rebored, after which it served the purpose as well as ever. The repairs were made and the engine was ready to run in three hours after the accident. E. W. **Miller.**

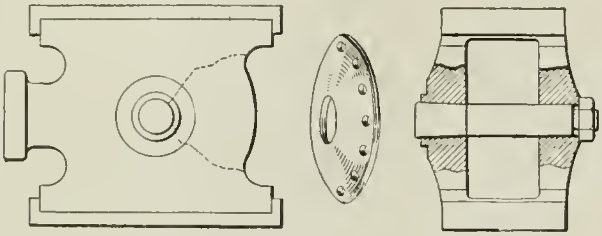


STEAM ARM AND DASHPOT ROD BROKEN

Minneapolis, Minn.

Repairing a Broken Crosshead

The wristpin of a Corliss engine (18 x 42) was worn, so we placed the crosshead in a wheel press to remove the pin, as it had been pressed in, but in doing so the crosshead was cracked as shown by the dotted lines in the illustration. The crosshead was clamped firmly, chucked in the lathe and the side turned off, leaving a half-inch boss, or shoulder, around the eye. Then a piece of ½-in. boiler plate was shaped, as shown, with the hole in the center a little smaller than the boss on the crosshead. After being heated in a forge, it was placed on the crosshead and hammered to a good fit. When cold, it had drawn the parts together so closely that the cracks could hardly be noticed. Holes were then drilled around the patch and tapped out for capscrews, making the job entirely secure.



FLANGE SHRUNK ON A BROKEN CROSSHEAD

Braemar, Tenn. J. W. Stanley.

Change of Water Supply for Air Pump

In answer to L. F. Forseille's request, page 703 of *Power*, Nov. 20, relative to changing injection piping to air pump, I offer the following: I take it that the increase of 75 deg. F. of the injection water referred to by Mr. Forseille is the range between the cold water of winter and the warmer water of the summer months.

In designing the air-pump runner the builder would figure on capacity with the warmest water it was to handle in operation, which would be in the summer, and as a drop in temperature in the colder seasons would increase the air-runner capacity, the manufacturer would not worry about that. When the air runner is handling water of a given temperature, it discharges it with a certain velocity, assuming the runner to have a fixed peripheral speed.

At this temperature, volume, weight and velocity the slugs of water exert a certain velocity head, which is transformed into pressure head in the diffusion nozzle upon leaving the runner and so overcomes the discharge head the runner works against.

Now, if we consider that the air runner is designed to discharge a certain amount of air in the summer months with water at 80 deg. F., and we increase the temperature to 110 or 115 deg., as the suggested increase would do, we necessarily increase the volume of the water for a given weight, and this lighter water by volume limits the ability of the runner to store enough kinetic energy in the slugs of water to overcome the forces acting against the water.

In concluding I would suggest increasing the pump speed, as a small increase in speed will probably secure the desired results. R. B. Goold.

Leadville, Colo.

Water Too Hot for Feed Pump

At one time it was my good fortune to act as watch engineer in a small modern central station situated on one of the Great Lakes. There were four vertical water-tube boilers of 5000 sq.ft. of heating surface each, often worked to 300 per cent. rating. The engine room contained two 1000- and one 2500-kw. turbo-generators, exhausting into jet condensers when desired, but in winter the exhaust was used to supply a district heating system. There was one motor-driven three-stage centrifugal boiler-feed pump, with a rated capacity of 200 gal. per min. and also a turbine-driven pump of the same size and capacity, but the turbine was unable to drive the pump fast enough even with the governor cut out of service, so it was little used. There was one other pump of the duplex type, used for general service, which could be used as a boiler feeder, but was of a light pattern and not suitable for such hard work.

One morning in midwinter when the mercury was at zero, I went on watch at 8 o'clock and found everything going at top capacity, but pretty soon things began to happen in rapid order in the boiler room—the feed pump failed to supply enough water, and it went out of sight in all four gage-glasses. You can imagine my feelings at finding this condition and all the pumps working. I recalled that the chief once remarked in a casual way that an engineer was expected to keep the plant running and not to see how quick he could shut it down.

Fortunately, I remembered in time that the delivery of a centrifugal pump falls off rapidly with a rise in temperature of its feed water, and finding that the water in the open heater was unusually hot, I lost no time in opening the bypass on the heater and sent cold water to the pumps. Then I went into the boiler room to watch results, which were not long in coming, for the water bobbed up in one glass after the other and the excitement was over. This was my first experience with a centrifugal boiler-feed pump, and I knew all the time that the capacity of a centrifugal pump changed with a change in temperature—but I didn't think, which is the trouble with a lot of us. R. B. Goold.

Leadville, Colo.

Climbing a Smoke-Stack

I saw three fellows climb a stack that had no ladder on it in a way that seemed to me far from safe. They passed a rope four times round the stack, then hooked three pullies on, at equal distances apart and each pulley on a different turn of the rope. Next, they pushed the ropes up the stack by means of long poles. When they had them up as far as they could reach, they were drawn up to the pulleys in "bos'n chairs" by other men on the ground. They then pushed another set of ropes up in the same way after making themselves secure to the first set. By repeating this process several times they reached the top of the stack.

Of course the coming-down part was easy as they were let down by the men below from a pulley on some kind of a grappling hook on the top of the stack like painters use on a house, and after they got down this was thrown off the stack. D. R. Hibbs.

New York City.

Inquiries of General Interest

Relative Properties of Copper, Iron and Zinc Wires—What are the relative properties of copper, iron and zinc wires for use as electrical conductors? M. L.

The relative electrical conductivities for equal cross-section are as 100 for copper, 17.4 for iron and 27.2 for zinc wire. The relative specific gravities are as 8.93 for copper, 7.86 for iron and 7.15 for zinc. The tensile strength per square inch of cross-section of copper wire is about 50,000 lb., of iron wire about 100,000 lb., and of zinc wire about 18,000 pounds.

Deflection of Water Tubes Away from Heat—What causes tubes of water-tube boilers to become bent away from the fire? J. A. S.

The most plausible reason given for deflection from the fire is that greater temperature attained by the fire side of the tube causes a greater expansion of length, and having elongation of the tube resisted by the headers, greater expansion on one side causes the tube to act like a strut or column that is eccentrically loaded, resulting in deflection of the tube away from the side that, from greater elongation, receives the greatest stress of longitudinal compression.

Cost of Leakage of Steam—What would be the daily loss from continuous leakage of steam at 100 lb. boiler pressure through an aperture of 0.1 of 1 square inch for 10 hours per day, where under actual conditions the evaporative economy of the boiler is 7 lb. of water generated into steam at 100 lb. gage pressure per pound of coal and the cost of coal $6 per ton of 2000 lb.? P. H.

Napier's approximate rule for the flow of steam into a pressure less than 58 per cent. of the initial absolute pressure is: Flow in pounds per second = absolute pressure × area of aperture in square inches ÷ 70. Accordingly, the discharge would be approximately $(100 + 15) \times 0.1 \div 70 = 0.1643$ lb. of steam per second, and the loss would amount to

$$\frac{0.1643 \times 60 \times 60 \times 10}{7} \times \frac{\$6}{2000} = \$2.53 \text{ per day.}$$

Height of Settings of Return-Tubular Boilers—What are the advantages of high boiler settings over low settings for horizontal return-tubular boilers, and what considerations determine the limit of height? H. C.

With higher settings the gaseous products of cumbustion and volatile matter liberated from the fuel are not cooled so immediately after rising from the fuel bed by coming in contact with the boiler heating surfaces that are much lower in temperature. Consequently, there may be more perfect combustion of the gases attended by higher temperature. In addition to the extra cost of higher settings, considerations that limit the height of the boiler are that the higher the boiler the less heat will be received from the fire by direct radiation, and although the heat of the fire which is not directly absorbed by the boiler is beneficial in improvement of combustion and in increasing the temperature of the gaseous products of combustion, for the same amount and condition of boiler-heating surface there will be higher temperature and therefore more waste of heat in the chimney gases. Hence the height of boiler most beneficial to economy of fuel will depend on the dimension of the boiler, kind of fuel, force of draft and rate of firing.

Actual, Apparent and Equivalent Cutoff—What is the difference between actual, apparent and equivalent point of cutoff of a steam engine? F. N. C.

In the operation of the engine, the actual point of cutting off is the point that marks the fractional part of the stroke which has been completed at the instant when the admission valve in closing to cut off the supply of steam has just covered the port. The apparent point of cutoff may be the point that appears to be the actual point of cutoff from observation of the operation of the engine or from measurements and known relative adjustments of different parts of the valve gear; or the fraction of stroke that is assumed to be completed at the beginning of the expansion line on an indicator diagram. Equivalent point of cutoff is the earlier point in the stroke where actual cutoff would take place so as to cause the expansion line of an indicator diagram to pass through the point of beginning of the actual diagram, or practically coincide with the expansion line of the actual diagram, provided there had been no reduction of the initial pressure during admission, and cutoff had occurred instantaneously or, in other words, assuming theoretically perfect admission and cutoff.

Minimum Number Threads for Screwed Pipe Connections—What number of threads of a pipe or nipple should screw into a fitting or a threaded pipe connection of a boiler? G. M.

Screwed connections should have the minimum number of standard pipe threads required by the A. S. M. E. Boiler Code for threaded openings in boilers for 1-in. pipe or larger, as per the following table:

MINIMUM NUMBER OF PIPE THREADS FOR CONNECTIONS TO BOILERS

Size of pipe connection, In.	1 & 1¼	1½ & 2	2½ to 4 inclusive	4½ to 6 inclusive	7 & 8	9 & 10	12
Number of threads per in	11½	11½	8	8	8	8	8
Minimum number of threads required in opening	4	5	7	8	10	12	13
Minimum thickness of material required to give above number of threads, in	0.348 = 11/32 +	0.435 = 7/16 −	0.875 = 7/8	1 = 1	1.25 = 1¼	1.5 = 1½	1.625 = 1⅝

If the thickness of the material of a boiler is not sufficient to give the designated number of standard pipe threads, there should be a pressed-steel flange or steel plate properly constructed and riveted to the boiler so as to give the required number of threads.

Lift of Valve To Obtain Full Opening—How much must the disk of a globe valve be raised off the seat to obtain full opening or the same cross-section of valve opening as the cross-sectional area of the diaphragm opening? J. D.

When the valve disk has a flat seat for covering a square-edged opening of the diaphragm, the area of the valve opening = circumference of the diaphragm × rise of the valve. Calling d = diameter of the diaphragm opening and l = lift of the valve, the cross-sectional area of the valve opening would be $\pi \times d \times l$. As the cross-sectional area of the diaphragm opening would be $\frac{1}{4} \pi d^2$, then for equality of areas, $\pi dl = \frac{1}{4} \pi d^2$, or $l = \frac{1}{4} d$; that is, for equal areas the lift must be equal to one-quarter of the diameter of diaphragm opening. When the valve seat is beveled to an angle of 45 deg., for equality of areas the lift of the valve must be about 36 per cent. of the diameter of diaphragm opening. It is not to be assumed, however, that equal projected areas in the different forms of valve seat will give the same coefficient of discharge, for that is influenced by the direction of flow of the gas, vapor or liquid in passing through the valve and also by the size, roughness and form of the shell or globe and the form and finish of the disk and its seat.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Recent Developments in Air-Pump Design*

By E. P. JONES

Reviews the chief progress in the design of air pumps from the Edwards reciprocating type to the newest multijector pump of Maurice Leblanc, which has many advantages over the well-known Leblanc hydraulic air pump. The paper is one of the most valuable yet presented on this auxiliary so important to turbine economy.

WITH the earliest types of surface-condensing equipment it was usual to employ one pump for removing both the condensate and air from the condenser. This pump was known as a "wet" air pump, and a good example of this type is the Edwards air pump, one of the most efficient of its class. The chief advantages of this type of pump are: (1) Low power required for driving; (2) positive action and consequent stability; (3) ability to cope with excessive air leakages. While the Edwards pump is still an excellent pump for units up to, say, from 3000 to 4000 kw., it must be remembered that, with the ever-growing size of power units, its disadvantages should be kept in view. For large units with Edwards pumps it is necessary that they should run at a very low speed, and consequently they are very cumbersome and take up a large amount of floor space.

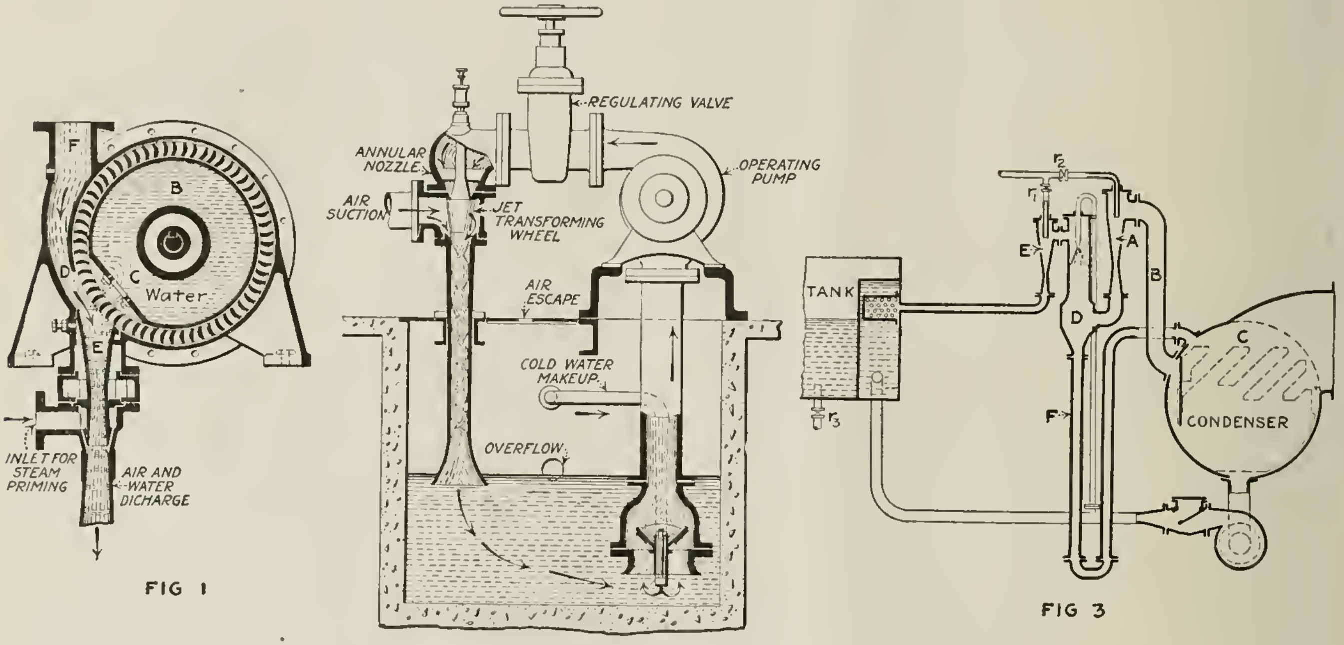


FIG 1

FIG. 2

FIG 3

FIGS. 1 TO 3. TYPES OF AIR PUMPS AND THEIR CONNECTIONS

Fig. 1—The Leblanc air pump. Fig. 2—Worthington ejector air pump. Fig. 3—French type of ejectair air pump

With jet plants the Edwards pump is sometimes used as a dry air pump. It is necessary, of course, to provide a small quantity of water for sealing purposes. Volumetric efficiency in this pump varies considerably with the degree of vacuum required and decreases as the vacuum increases from about 50 per cent. at 3½ in. absolute pressure to 18 per cent. at 1 in. absolute pressure. Another system is that in which a dry air pump of the reciprocating type is used to remove the air and uncondensed gases and a separate pump to remove the condensate. The advantages and disadvantages of this system are the same as for the Edwards air pump, but the efficiency is rather better.

Previous to the introduction of the steam turbine condensing-plant equipments were furnished with air pumps of one or other of the types mentioned, but as soon as the turbine became a commercial proposition it was necessary to look for a type of pump having features specially adapted to its requirements. With turbine installations it is essential to use a high vacuum in the condenser, whereas with steam engines of the reciprocating type a vacuum of more than 26½ in. was seldom required. In fact, it is questionable whether using a vacuum higher than 26½ in. would not be considered a disadvantage. With the turbine, however, a vacuum less than 27 in. is rarely asked for, and sometimes the specified figure is as high as 29.25 in. with the standard barometer reading of 30 in. In considering these figures, due allowance must be made for the altitude of the place. The most economical vacuum for a turbine installation depends on a variety of things, and each case has to be considered on its merits.

On reference to steam tables it will be seen that an increase in vacuum from 27 in. to, say, 29 in., other conditions, as air leakage, remaining the same, necessitates an increase in the capacity of the air pumps from 1.00 to 3.25, which for a large installation with Edwards or reciprocating dry air pumps is a very serious matter. Therefore various types of rotary pumps, which are specially suitable for dealing with large volumes of air at low tension, have been designed since the adoption of the steam turbine, several of which have proved very successful. The general design of these pumps is much the same, in so far as they use a certain quantity of what is termed "operating water," for which various devices have been invented to cause this water to move in such a manner as to entrain the air from the condenser and discharge it to the atmosphere. Perhaps one of the best-known rotary dry air pumps is the one invented by Prof. Maurice Leblanc. It has been used to a large extent all over the world, and its action is shown by Fig. 1. This pump is capable of maintaining a very high vacuum, and for this reason, coupled with the fact that it

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*From a paper before the Institution of Engineers and Shipbuilders, Scotland, reported in "Engineering" (London), Sept. 7 and 14.

is very simple in construction and not likely to get out of order, it has been largely used for turbine installations. It cannot be claimed for this pump—or, indeed, for any type of rotary air pump—that it can successfully deal with an excessive air leakage, but consideration will show that this quality is not essential in the case of turbine installations where air leakage is reduced to a minimum by the adoption of steam- or water-sealed glands where the shaft passes out of the turbine casing. With a surface-condensing plant it is only possible for air to be brought into the system by the feed water and carried over with the steam, or by leaking in at the joints. With jet plants, the air brought in with the injection water has to be allowed for in addition to the above, and it is for this reason that the air pump on a jet plant requires to be larger than that for a surface-condensing plant doing the same steam duty.

The power required to drive these pumps is rather higher than that required for an Edwards or other good type of reciprocating air pump, and consequently a good deal of attention has been paid recently to another type of pump which would incorporate the simplicity and compactness of the rotary pump and the low-power consumption of the Edwards and other reciprocating pumps. The general trend of thought seems to have been in one direction, and there are now on the market and in commercial use air pumps operating on the ejector principle. Nearly all the leading condenser manufacturers now construct air pumps of this description.

THE NEW EJECTOR AIR PUMP

The Worthington Pump Co., Ltd., London and Newark, manufacture a patent hydraulic vacuum pump on the ejector principle, as illustrated by Fig. 2, which consists of: (1) The injection head, (2) the air-suction chamber, (3) the rotary wheel, (4) the throat and tail pipes. The operating water passes between two nozzle rings, and the cone of water passes between the body of the wheel and the outer sleeve, impinging on the inclined surfaces of the vanes, thus imparting a rotary motion to the wheel. To operate the pump it is necessary to provide a certain amount of sealing water, which is supplied from a tank situated as conveniently as possible to the pump. The sealing water takes up a certain amount of heat from the air and water vapors withdrawn by the air pump, and a piping arrangement is provided for withdrawing a certain amount of this water by means of a bypass connection on the operating pump discharge, this bypass being fitted with a controlling reflux valve. The quantity of water withdrawn in this manner is replaced by makeup water drawn from the circulating inlet-piping or an independent supply, thus cooling the water used in the cycle of operation. This apparatus is doing regular service on one of the turbo-alternator groups at the Glasgow Corporation Power Station at St. Andrew's Cross. A number of installations have also been supplied to other concerns.

Willans & Robinson, of Rugby, manufacture the Willans-Muller ejector air pump, which is operated by the circulating water, either on the series or shunt system. With the series system the whole of the circulating water passes through the ejector before entering the condenser. With the shunt system only a portion of the cooling water passes through the ejector, and, after use, is returned to the pump suction or the source of supply. A third method of operating this ejector is by the separate-pump system, in exactly the same manner as described in referring to the Worthington pump. The whole plant is very similar to that made by the Worthington Pump Co. The Glasgow Corporation has a set of this apparatus at work at Pinkston Power Station, and good results have been obtained, and a second set is just being installed at St. Andrew's Cross.

Another type of ejector air pump is that manufactured by Hick, Hargreaves & Co., Ltd., Bolton, under license from the Mason Breguet, Paris. This is really two ejectors working in series, with an auxiliary condenser placed between the first and second stage of the ejectors. A number of these air pumps, termed "ejectairs," have been supplied to, or are under construction for, the French Navy. Referring to Fig. 3, it will be observed that the primary ejector *A* is placed in direct communication with the main condenser *C*, and extracts the aërated vapor, being operated by a single steam jet or nozzle r_2. The mixture of steam and partly compressed vapor is then discharged to the auxiliary condenser *D*, and the water returned to the main condenser to be dealt with by the extraction pump. The second-stage ejector *E* is coupled up to the auxiliary condenser, and draws the air away, discharging it to the feed tank. An automatic air-inlet valve is fitted to the auxiliary condenser, to regulate the absolute pressure therein. It is claimed that taking air from the atmosphere in this manner materially assists the stability of the plant, and also renders it more flexible. These *ejectairs* are designed for working with steam pressures at 55 lb. per sq.in. or above, and with a special arrangement of nozzles lower pressures can be used in the primary ejector, although the advantage of this is not apparent if it is impossible to work the other ejector under the same conditions, neither is it clear whether this can be accomplished or not.

The curves, Fig. 4, show the performance of an *ejectair*. Steam to the ejectors had an absolute pressure of 125 lb. per sq.in., and the steam consumption is given as 194 lb. per hour, of which 129 lb. is recoverable. The apparatus worked in conjunction with a small jet condenser, dealing with 94 gal. of injection water per minute. Curve 1 gives the vacuums obtained with water leaving the condenser at a temperature of 91.4 deg. F. (33 deg. C.), and the auxiliary condenser out of action; curve 2 the volume of air dealt with in cubic feet per hour; curve 3 the vacuums obtained with given air leaks, and the water leaving the main condenser as for curve 1, but with the auxiliary condenser supplied with cooling water at 66.2 deg. F. (18 deg. C.); and curve 4 the volumes of air dealt with under the same conditions. It was calculated that the air coming in with the injection water and at leaky joints amounted to 1.102 lb. per hour (0.5 kg.).

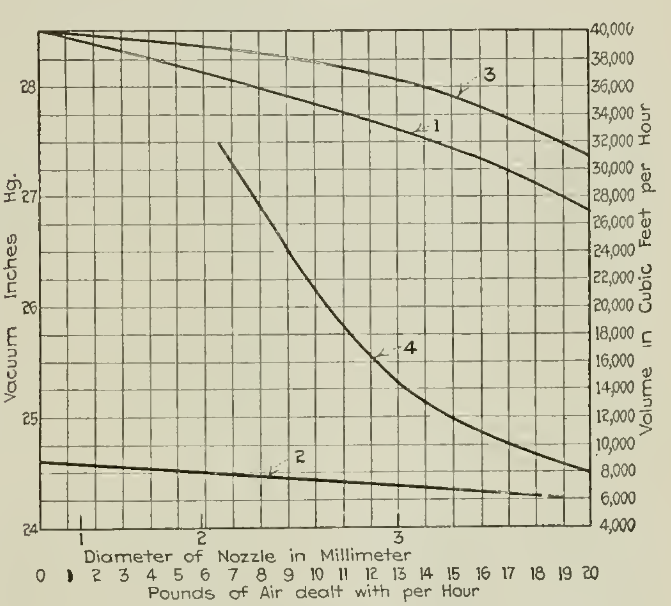

FIG. 4. PERFORMANCE OF AN EJECTAIR

The British Westinghouse Electric and Manufacturing Co., Ltd., Manchester, and the Mirrlees Watson Co., Ltd., Glasgow, manufacture an ejector air pump, under license from the Société Anonyme Westinghouse, Paris and Le Havre, which is another invention of Maurice Leblanc. It is the outcome of many months of arduous research work, during which time innumerable difficulties were surmounted by the inventor, with the result that a really first-class ejector air pump has been evolved. Figs. 5 and 6 show the general arrangement of this apparatus. It will be noticed that the pump is arranged to work in two stages, and the steam is admitted to the second stage of the ejector by opening the stop valve *C*. Immediately *C* is opened, steam fills the annular space behind the nozzle plate, and finds its way into the throats of the group of nozzles *Y* attached to this plate; it then passes along the steam pipe which supplies the first-stage nozzles *X*, which are also attached to a nozzle plate. The supply of steam in this set of nozzles is controlled by the stop valve on the steam-supply pipe. The pump is connected to the condenser at the branch *D*, which is the air-inlet branch. At the entrance to each of the steam spaces fine wire-gauze strainers are fitted to prevent any foreign matter, which may have primed over with the steam from the boilers, from entering the nozzles, thereby intercepting any stoppage in the nozzle throats, and consequently a loss of vacuum. These nozzles are securely locked to the nozzle plates. The mixture of air and steam is discharged at the mouth of the cone *Y* and led away to the boiler-feed tank, so that the heat units contained in the operating steam can be reclaimed by heating the feed water. To start the pump to work, it is only necessary to open up the steam valve *C*, and the vacuum will at once begin to increase in the condenser or other vessel to be evacuated. When the vacuum gage becomes stationary, the first-stage steam-inlet valve is opened up to bring the vacuum to a maximum. A very ejector, which might be considered negligible. Beyond this, the whole of the heat in the steam can be utilized to heat up the boiler-feed water, and in order to obtain full benefit from the apparatus it is highly desirable to use the discharge from the ejector for heating purposes of some description. Thus both the steam and air can be made to do useful work. In view of this it must not be forgotten that when an ejector of this type is specified as requiring so many pounds of operating steam per hour, this is only the apparent quantity; the actual quantity is really far less, since the great majority of heat units in the steam are still available for further work. The actual heat units recovered can easily be calculated from steam tables, since it is known that the steam and air leave the ejector at a pressure of from 10 lb. to 12 lb. per sq.in. by gage. It will be observed that with a Leblanc multijector an auxiliary condenser is not required, and in this respect it differs materially from the "Berguet" *ejectair*. The employment of an auxiliary condenser has the disadvantage that the total

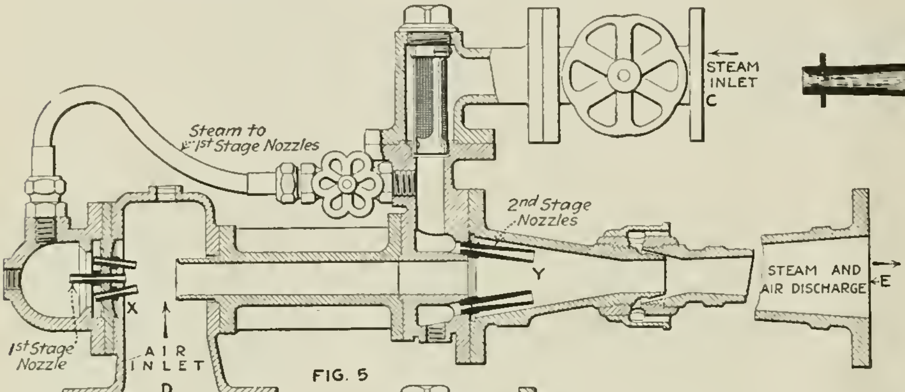

FIG. 5

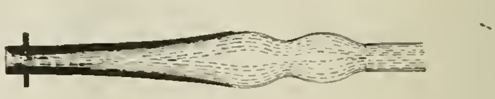

FIG 7

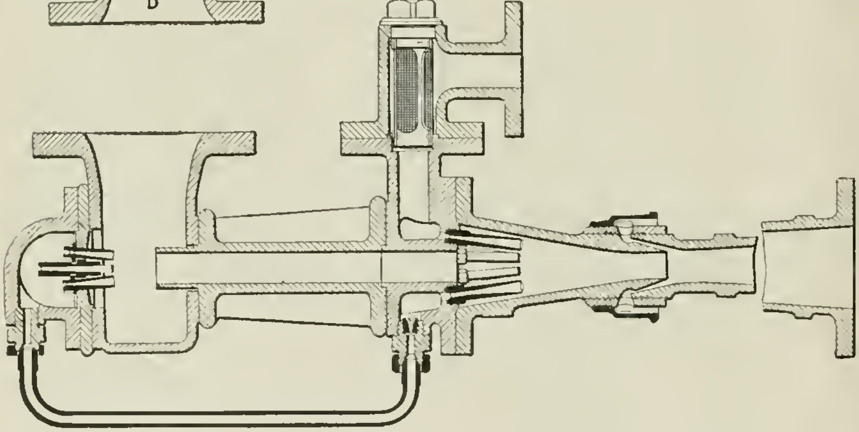

FIG 6

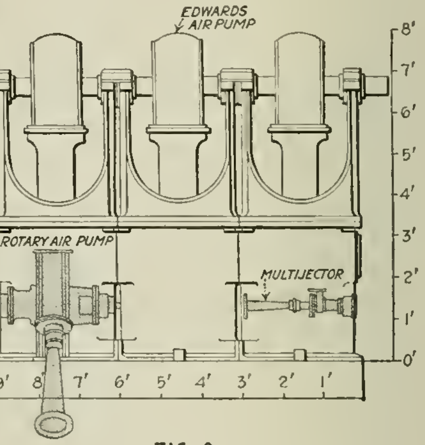

FIG. 8

FIGS. 5 TO 8. MAURICE LEBLANC'S LATEST MULTIJECTOR AIR PUMP AS MADE BY THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.

Figs. 5 and 6—Two forms of the Leblanc ejector. Fig. 7—Behavior of flow from the nozzle. Fig. 8—Showing comparative sizes of Edwards, Leblanc rotary and the multijector types of air pumps for a given capacity

important feature in this pump is the absence of moving parts. The simplicity of the apparatus is even more remarkable than that of the Leblanc rotary pump.

The advantages claimed are as follow: (1) Extreme simplicity; (2) the small amount of energy required for operating purposes; (3) the high efficiency obtained; (4) ease with which starting can be effected, and the small amount of attention required while at work; (5) ability to produce the highest possible vacuums; (6) stability. In scanning these claims we can pass over the first, which as already mentioned, is obvious; there are simply two steam valves to open. The second deserves some consideration. The operating steam in passing through the nozzles decreases in pressure, and consequently in temperature, and also, after passing through the nozzles, does work in accelerating the velocity of the air, increasing its temperature and compressing it. There is also a small amount of heat lost due to friction in passing through the diffuser portion of the heat units of the steam used in the first-stage ejector, which amount to an appreciable percentage of the total heat units used on the whole apparatus, are dissipated and lost. The makers give this percentage as about 33. Another reason for dispensing with the auxiliary condenser will be apparent from the following. In all steam-operated ejectors one of the difficulties that have to be contended with is the fact that the steam leaves the nozzles at a velocity varying from about 3000 to 3600 ft. per sec., while the velocity of the fluid to be entrained is practically nil. This is the cause of considerable loss of efficiency in any ejector, but if an auxiliary condenser be used the defect is doubled, because the velocity of the fluid to be entrained, which has been imparted to it by the operating steam during its passage through the first-stage ejector, is dissipated and lost as soon as it enters the condenser. The cooling water used on the auxiliary condenser has to be dealt with by the condensate pump, thus increasing the power absorbed by the plant. When working with surface condensers, this water must be of good quality, as it has to be returned to the boilers.

The third claim relates to efficiency. It is well known that ordinary single-stage ejectors only work well when the compression ratio is as 1: 7, and it is partly for this reason that the Breguet Co. has introduced the auxiliary condenser, so that the vacuum obtaining in this condenser is about 25.6 in. with the barometer at 30 in., the compression being approximately as 11: 76, or, roughly, 1: 7. The over-all efficiency of this plant is, therefore, apparently still further reduced, because air is admitted from the atmosphere into the auxiliary condenser, which is under a vacuum of 25.6 in., and this, together with the air from the condenser, has also to be ejected by the secondary ejector to the atmosphere.

When Professor Leblanc set out to design his ejector he foresaw the possibility of using an intermediate condenser, but he also appreciated its disadvantages and decided to do without it if at all possible. At the same time he knew that it was essential to use two stages in order to get a stable and efficient ejector. With this end in view, certain steam nozzles were designed on the lines of the formulas of Professor Rateau, and the action of the steam issuing from these nozzles when under high vacuum was directly observed. The result is shown by Fig. 7. The steam issuing from the mouth of the nozzle expands and contracts alternately, ultimately assuming a section of constant area. It was found that a number of these nozzles grouped together gave far better results than a single nozzle of the same throat area as the group of nozzles. The reason for this is to a large extent due to the fact that the alternate increasing and decreasing of the cross-sectional area of the steam stream is minimized by the contact of one steam stream with the next, when groups of nozzles are employed, and this helps considerably to increase the surface available for the entrainment of the air and gases. This entrainment is carried on mainly by friction, and it will be seen that if an appreciable amount of gas has to be dealt with, the frictional surface exposed to the gas has to be as large as possible. It is also inversely proportional to the density of the gas or fluid.

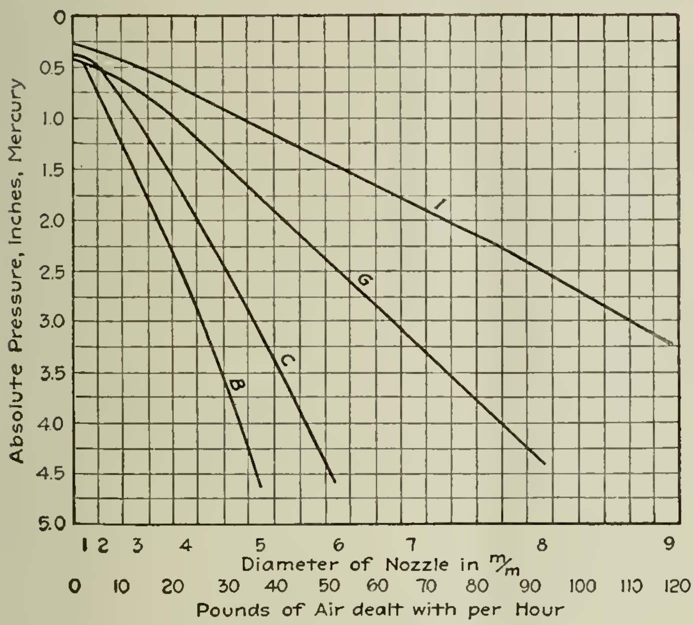

FIG. 9. CAPACITIES OF VARIOUS SIZES OF MULTIJECTOR PUMPS

The number and size of the nozzles depends entirely on the space available in the diffuser, and keeping within the limits of workshop practice. The smallest number employed by the Mirrlees Watson Co. is three, each of which has a throat diameter of 1 mm. These are first-stage nozzles. On the largest size of pump, and in the second stage, the number of nozzles is 30, and these have a throat diameter of 5.2 mm. when using operating steam at 90 lb. per square inch.

Professor Leblanc, in his paper of 1911 to L'Association Technique Maritime, says that "the operating steam entrains the air by friction. During entrainment it is the velocity of the steam which is utilized, and not its kinetic energy."

Calling M the weight of operating steam used per second, V its velocity at the outlet of the nozzles, m the weight of air drawn in per second, and W the velocity of the mixture of air and steam, then

$$MV = (M + m)\ W$$

The ratio of the kinetic energy, $\frac{mW^2}{2}$, of the air drawn in to the kinetic energy, $\frac{MV^2}{2}$, contained in the operating steam as it comes out of the nozzles can therefore be stated as

$$\frac{mW^2}{MV_1^2} = \frac{mM}{(M + m)^2}$$

so that when $\frac{m}{M} = 1 \quad \frac{1}{2} \quad \frac{1}{3} \quad \frac{1}{4} \quad \frac{1}{5}$

$$\frac{mM}{(M + m)^2} = 0.25,\ 0.222,\ 0.187,\ 0.160,\ 0.139$$

This shows that if the utilization of the kinetic energy is to be the basis of the design, then for maximum efficiency it is necessary to bring the ratio $\frac{\text{air dealt with}}{\text{operating steam used}}$ as near to unity as possible.

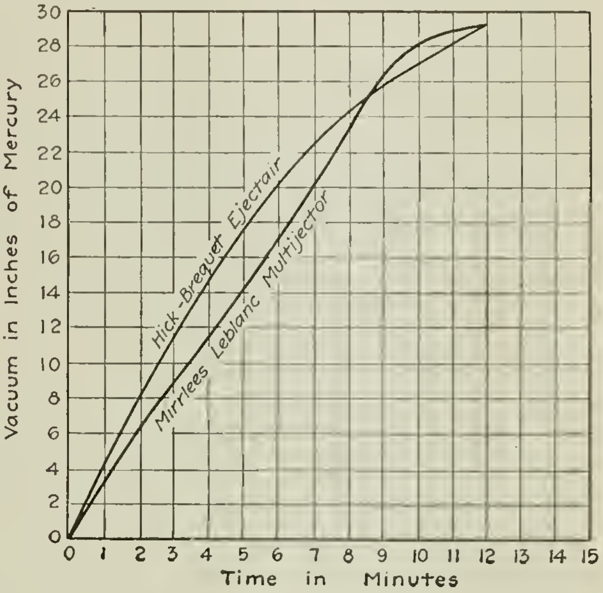

FIG. 10. TIME REQUIRED TO START HICK-BREGUET EJECTAIR AND MIRRLEES-LEBLANC MULTIJECTOR

M. Leblanc continues: "We tried to diminish the loss of kinetic energy by producing at the entrance of the diffuser a higher vacuum than was necessary, so that the fluid drawn in came in contact with the operating steam with a considerable velocity. If the efficiency of the diffuser could be brought almost to unity, we could add considerably to the over-all efficiency, but this has been found to be impracticable. Following on this, it was suggested to use puffs of steam after the manner of steam coming out of locomotive chimneys, but the complications involved in making arrangements for stopping the inlet of air during each puff were such that it would have been easier to use a centrifugal compressor. Afterward we tried to compensate for the bad efficiency due to frictional entrainment by transforming heat into kinetic energy in the nozzles. Superheating the operating steam, although so useful for turbine work, is, however, not good for an ejector, because it is more difficult to effect compression in the diffuser, which outweighs the advantages obtained in the nozzles. The next scheme was to use hot water in the nozzles, but this also proved unsuccessful."

After numerous other trials it was decided that entrainment by friction was most economical, and various types of diffusers and different groupings of nozzles were experimented with, until the present ejector, as shown in Figs. 5 and 6, was decided to be the most suited for condenser work. To go through the various stages in detail which led up to this design would take up too much time. With the form of ejector adopted it has been found that the efficiency of the nozzle is on an average 85 per cent., while that of the diffuser is 70 per cent. It will be seen that this ejector agrees very well with the ideal ejector which Professor Leblanc had in his mind. The first stage, which consists of a small group of nozzles, serves a triple purpose, inasmuch as it effects a certain amount of compression, heats up the entrained air, and gives it considerable velocity, and consequently an increase in momentum. The second stage has a larger number of nozzles, and it is here where the major portion of the work is done, the air being compressed from approximately 26 in. vacuum up to something more than atmospheric pressure. To be more accurate, the steam used in the first stage is about 5 per cent. of the total.

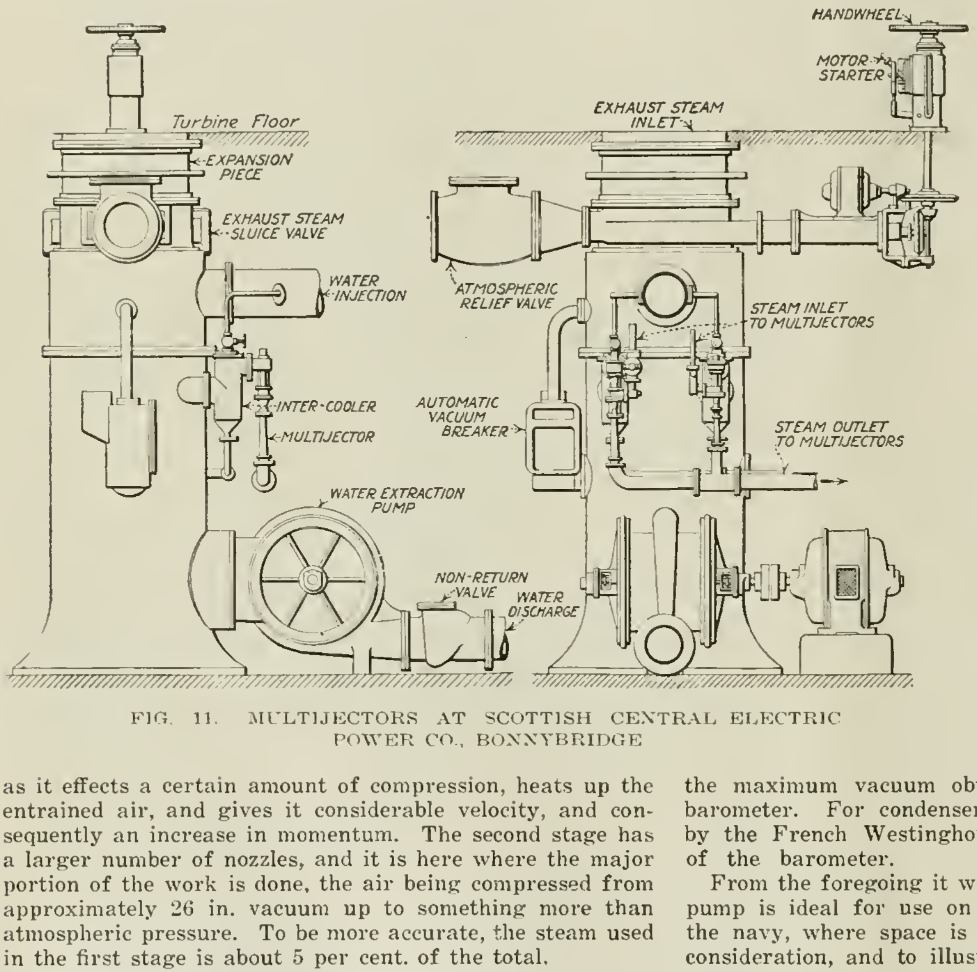

FIG. 11. MULTIJECTORS AT SCOTTISH CENTRAL ELECTRIC POWER CO., BONNYBRIDGE

In support of the fourth advantage which this air pump is supposed to possess, the following figures were obtained on the French torpedo-destroyer "Boutefeu." The turbines were stopped, but steam was on the glands. The volume to be evacuated was about 635 cu.ft. After 1 min. the vacuum was 6 5/16 in., 2 min. 15 in., 3 min. 22 13/16 in., 4 min. 25 9/16 in., 5 min. 26¾ in., and 6 min. 27 9/16 in. The theoretical vacuum corresponding to the temperature of the water, 67.1 deg. F.; namely, 28¼ in., was attained in 11 min. It was also arranged later to allow certain known air leakages to enter the condenser. With a 5-mm. nozzle, which passes 36.2 lb. of free air per hour, the vacuum dropped only ⅜ in. With a 15-mm. nozzle, which is equivalent to 326 lb. of air per hour, the vacuum was 21¼ in. With an inch cock full open it took 11 min. for the vacuum to fall to 12¼ in., at which figure the mercury column remained steady. On closing the regulating valve below the nozzle, the vacuum at once rose and attained the maximum almost immediately. There is a central station near Glasgow where this type of apparatus is at work with a multijet condenser. Sometimes when changing machines there is liability partially to lose the water for a minute or so, but none of the staff ever have to trouble about the ejectors, and as soon as the water comes back again the vacuum at once builds up, and the set is never shut down through failure of the air pumps. As a matter of fact, in the case above stated, it is highly probable that during the period that the water supply to the condenser is very small there is an air passage between the water spaces of the other condensers in the station and the multijet plant which would allow of a very excessive quantity of air getting into the condenser on load. This also shows that stability, the sixth claim, is another salient point. That high vacuum can be obtained is proved by the fact that this apparatus is now being used in the French Navy and mercantile marine, as well as on some land installations for refrigerating purposes, and installations are at work where the maximum vacuum obtained is within 1 mm. of the barometer. For condensers the best results yet obtained by the French Westinghouse company are within 5 mm. of the barometer.

From the foregoing it would appear that this type of air pump is ideal for use on board ship, and particularly in the navy, where space is so valuable and weight of such consideration, and to illustrate this point Fig. 8 has been produced, and represents to the same scale an Edwards air pump, Leblanc rotary air pump, and Leblanc multi-

TABLE I. OFFICIAL TEST OF NO. 18 M. J. CONDENSING PLANT WITH MOTOR-DRIVEN WATER-EXTRACTING PUMP, 1-SIZE "G" AND 1-SIZE "I" MULTIJECTOR AIR PUMP INSTALLED AT THE SCOTTISH CENTRAL ELECTRIC POWER COMPANY, LIMITED, BONNYBRIDGE

Duty—50,000 lb. steam per hour.
Vacuum—28.5 in. (barometer 30 in.).
Injection water—3,800 gallons per minute, temperature 65 deg. F.
Air pump capacity—84 lb. air per hour with guaranteed vacuum and water temperature.
Large ejector to operate condenser alone on loads over one-third and up to two-thirds full load.
Small ejector to work alone on loads of one-third full load and under.
Both ejectors to work on loads over two-thirds full load.

	Load				Vacuum			Steam Press. on Ejectors			Injection Water		Extraction Pump			
Time	Volts	Amps.	P.F.	Kw	Turbo.	Condr.	Barometer	"G"	"I"	Steam Press. on Turbine	Inlet	Outlet	Press. Gage	Amps.	Volts	R.P.M
8.45 p.m.	6,350	130	0.75	1,070	28.1	28.2	29.8	120	Shut off	152			5	58/60	440	480
11.0 a.m.	6,350	266	0.7	2,000	28.5	28.5	29.66	122	130	152	43	70.0	4	60	440	480
12.0 m.	6,350	280	0.7	2,152	28.6	28.5	29.63	122	125	152	43	70.0	4½	59	440	480
12.5 p.m.	6,400	270	0.7	2,090		28.2	29.63	Shut	125	152	43	70.0	4½	59	440	480
2.15 p.m.	6,400	325	0.75	2,700	28.2	28.25	29.59	125	160	150	43	72.5	5	62½	440	480
2.45 p.m.	6,450	345	0.76	2,970	28.2	28.3	29.59	125	157	157	43	72.5	5	62½	440	480
3.0 p.m.	6,500	280	0.74	2,330	28.2	28.4	29.6	122½	160	153	43	65.5	4	62½	440	480
3.30 p.m.	6,500	230	0.7	1,182	28.5	28.5	29.6	120	150	154	43	65.5	2	23	440	480

jector for a steam duty on a surface condenser of 40,000 lb. per hour, water at 60 deg. F., vacuum 28½ in., and barometer 30 in. The weights are approximately 20,832 lb., 4480 lb., and 97 lb., respectively. For land work it is equally suitable, and will soon supersede the rotary pump in many power stations. For sugar refineries, chemical and other allied works it should prove exceptionally attractive and take the place of many reciprocating dry air pumps.

It may be advisable to point out here that this pump is purely a dry air pump, so that for surface condensers an additional water or condensate pump is still required, and for jet plants the usual extraction pump.

Fig. 9 shows the air-dealing capacity of various sizes of multijector pumps taken from the actual tests. The maximum vacuum in each case is equivalent to the theoretical, the slight difference at the origin of the curves being due to the different test conditions.

The table of tests, I, is taken from a plant installed at the Scottish Central Power Station at Bonnybridge at a date six months after the plant was put on commercial load. This company has just decided to order another plant, and has specified Mirrlees-Leblanc multijector air pumps.

Fig. 10 shows the time taken to start up a Hick-Breguet *ejectair* and a Mirrlees-Leblanc multijector.

There is no doubt that considerable improvements have been effected in air-pump design during the last few years, nevertheless there is still room for further progress, and it is to be hoped that when the British engineer has time once again for research work we shall have to drop all our present-day notions of efficient air pumps for a type which will render all others obsolete.

Fig. 11 shows installation of multijector air pumps at Scottish Central Electric Power Co., Bonnybridge.

Secretary for Joint Activities of Engineering Societies

For economy of administration and the furtherance of coöperation among organizations representing the profession, the United Engineering Society, the Engineering Foundation and the Engineering Council recently decided to join in one suite of offices in the Engineering Societies' Building and engage a joint secretary. For this position the engineer selected is Alfred Douglas Flinn, now deputy chief engineer of the Board of Water-Supply of the City of New York.

The United Engineering Society was formed some years ago by the National Societies of Civil, Mining, Mechanical and Electrical Engineers to coördinate joint activities and provide for holding property in common. This body acts as the holding company for the four founder societies and is landlord of the Engineering Societies' Building in New York, in which the founder societies have headquarters. In it also is vested the title to the library housed in the same building, which, with the recent addition of the collection of the American Society of Civil Engineers, is now the most important engineering library in the country.

The Engineering Foundation Board was created, as a department of the United Engineering Society, to administer the endowment made by Ambrose Swasey three years ago for the support of engineering research for the benefit of the profession and of humanity. The large sum of money he gave will form, it is hoped, the nucleus to which other gifts will be added.

The last of the three organizations which are to have a joint secretary is the Engineering Council. For years it has been recognized that there were certain activities affecting engineers which could not be properly handled by any one of the individual engineering professional societies. To meet this need there was created during the past summer the Engineering Council "for the proper consideration of questions of general interest to engineers and to the public, and to provide the means for united action upon questions of common concern to engineers."

Mr. Flinn was born in New Berlin, Penn., in 1869, and was graduated from Worcester Polytechnic Institute in 1893. In August, 1895, he became a member of the engineering staff of the Metropolitan Water-Works, Boston, and remained with that organization until 1902. He rose steadily until he became principal office assistant under the chief engineer, Frederic P. Stearns, in charge of designs of the Wachusett Dam and other structures coming under the authority of the Metropolitan system. During the latter years with this organization he also lectured on water-works and sewerage in Lawrence Scientific School, Harvard University.

On leaving the Metropolitan Water-Works Commission, he became managing editor of the *Engineering Record*, and continued in that capacity until August, 1904, when he was appointed general inspector of the Croton Aqueduct Commissioners. About a year later, upon the organization of the Board of Water-Supply of the City of New York, which was established to build the new Catskill Aqueduct and its appurtenant structures, he became department engineer in charge of the headquarters department. He continued as department engineer until August, 1914, when he was made deputy chief engineer. He has continued in that capacity until his election to the secretaryship referred to in this article.


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ALFRED DOUGLAS FLINN

Mr. Flinn brings to his new position a broad executive and organizing experience. He is a member of the board of direction of the American Society of Civil Engineers and chairman of its committee on publications.

In relation to modern engineering no one man can be expected to possess a working familiarity with the whole. In a particular sense all engineers are specialists, though many have a more comprehensive grasp than others. To produce the best it is above all things essential that our knowledge exceeds the demands of the task in hand. It is therefore urged that the most effective method by which to acquire the needed broadening of knowledge is by continual reading and study; otherwise—notwithstanding individual attainments—the best become "outsiders" and back numbers.

Dr. Garfield on the Fuel Situation*

I shall be duly appreciative, gentlemen, if I may be privileged to answer questions, as far as I am able, rather than to undertake to set forth to you matters concerning the Fuel Administration.

The United States Fuel Administration was appointed by the President of the United States in accordance with the provisions of an act of Congress known as the Lever Act. Food and Fuel were provided for by that same act. In the 25th Section of that act, provision was made for the Fuel Administrator. The President has given the Fuel Administrator all the power that he himself possesses under the act.

In setting up an organization, the difficulty was one that you gentlemen will appreciate, who have at any time engaged in projecting an organization to carry out some large purpose, especially if the carrying out of that purpose has run with the period, or run with the activity of organization. To build your house and live in it at the same time is no easy task. We were compelled to adopt a working hypothesis to govern us in our organization and to proceed upon that hypothesis, in the hope that our plan would be a workable one.

Organization Scheme

Briefly, we set up the Federal control here in Washington, appointed the State Fuel Administrators in each of the states of the United States and in the District of Columbia, requested each one of those fuel administrators in turn to appoint county and municipal administrators, vested in the state fuel administrators full power to distribute the coal within the state, made it clear that so far as the county and municipal administrators and their committees were concerned, the administration here at Washington delegated full power, both in appointment and in control to the state fuel administrators. It was, you see, in a measure, a United States—there was the Federal, the state, the county and the municipal administration.

I am the more impressed with the significance of this organization just at the present time, because in my native state (Ohio) there has been some difficulty reflected in the morning papers, owing to the fact that Governor Cox, with an admirable zeal for distributing coal to the people and institutions of Ohio, has crossed the lines of the Federal Fuel Administrator, Mr. Johnson, thinking thereby to accomplish a good purpose. But it is very easy to see that if coal upon the tracks consigned in one direction is taken, as it may be, under the law, by the representative of the United States Fuel Administrator and diverted to an immediate need, it is impossible that there shall be anything other than confusion, if some other authority runs across that plan and undertakes also to divert coal.

Let me touch upon one policy that is reflected in the organization, and, at the same time, has intimately to do with meeting the problem presented. The United States Fuel Administration isn't responsible for the way coal is deposited in the earth. If we take the right view of it, I think we will admit that mankind is there beholden, as in all other things, to the Creator of the Universe. The coal is deposited throughout the United States in various regions, and obviously to allow our State Administrators to draw upon that coal and limit them, won't do, because in a place like Ohio, for instance, where there is coal in abundance, the State Administrator would be able to supply the people of Ohio abundantly, and might, if he were selfishly disposed, neglect those who were in states in which no coal was deposited. Therefore, from the beginning, I have pursued the plan that in governing production and distribution from the mines, the Federal, that is, the United States Fuel Administrator, must be the director. On the other hand, when it comes to distributing the coal within the borders of the state, that is a matter much better left to the State Fuel Administrator.

Speaking of bituminous coal, we are this year producing something like 50,000,000 tons more coal than we produced last year, and last year was a record year. Some of you will then say: "Why is there a shortage?" Because we needed 100,000,000 tons more than last year. The extra 50,000,000 tons which we needed, but have not had, amount to the same thing as if there were a shortage of supply. The extra demand, as you will appreciate, comes from the fact that the United States is at war, that our manufacturing enterprises must be supplied with coal, that the railroads of the country, taxed beyond their powers, must have more coal to operate as they are now operating, to say nothing of the normal increase in the call for domestic coal.

There are three factors entering into the production—first, the operators, then the mine employees, and third, the railroads. Unless each one of those is working at efficiency, we will not have maximum results in output.

About the time the Federal Fuel Administrator was appointed, the bituminous interests of the country got together and formed a national organization. Undoubtedly that organization has desired things which the Federal Fuel Administrator hasn't been able to furnish; possibly that organization may entertain ideals of policy that do not appear in the same light to the Federal Fuel Administrator, but if that latter is true, I haven't yet discovered it.

A large part of my time was spent during the first two months, and indeed much of my time is still occupied, with bringing together operators and representatives of labor, who, in certain fields of the country, are not able quickly to adjust their differences, and I have just one theme that I always present to those gentlemen when they come together, and it is this: Whatever our controversy, wherever the right lies, make sure that production continues and be not interrupted by reason of your dispute. That theme cannot be overemphasized.

Labor Has Done Its Part

I also wish here to pay tribute to labor, because the leaders, the conservative element in labor, has caught the idea not because it was enunciated by me (because I was only one voice saying the same thing), but because it is the spirit of our people at the present time that in prosecuting this great war, in meeting the emergency which we are called upon to meet because of it, labor, realizing these facts, has come forward in the very best of spirit, saying that it will not permit labor to cease to do its part. Wherever there is a failure in that program, it is because of the inevitable radical element that we find in every business in every country.

Now, I am very far from saying that no good comes out of radicalism. Human nature is so constituted that there are always some at the extreme right and some at the extreme left of every proposition; but in a time of emergency, when action is necessary, when we must spend less time in deliberation, when it is not feasible to educate everybody, as it is in times of ordinary conduct of affairs, it is perfectly obvious that the extremes must be brought together and action taken, even though the conservative thinks that we are going to wreck and ruin, and even in spite of the fact that the radical believes we are not going nearly far enough. So then, the radical element in the whole field has been a disturbing element, but it has been held in check by the great mass of the workingmen in the coal fields, and with relatively slight interruptions production has gone forward.

Now, it is a significant fact, speaking of the anthracite field, that with the total amount of labor in normal times, something like 175,000 men and boys at the mines were reduced by 25,000 because of the draft and because of the fact that employment elsewhere has appeared more attractive. But in spite of the fact that there are only 150,000 men and boys laboring in the anthracite field this year, against the 175,000 normally, the anthracite mines have produced something like 20 to 22 per cent. more coal than they produced a year ago. That plainly is a

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*Address delivered before the Editorial Conference, Washington, D. C., Thursday, Dec. 13, 1917.

tribute both to labor and to those who are conducting the mines.

There is an element in human nature that we ought not to lose sight of, and though it is painful to comment upon it, gentlemen, it is necessary to comment upon it; the selfishness of human nature, the disposition, to use a common phrase, to hog things. Now, there has been a great deal of that sort of thing this year. It has extended into the households, people buying more coal than they quite needed; it has found its way more naturally into the factories, anticipating an increase of business, and the result is that some, many indeed, have more coal than usual, some have more coal than they need for the entire year, and some less provident, possibly because they could not provide the store ahead, are without coal.

DISCUSSION

J. Chase: Are our rivers being used to their fullest extent in the shipment of coal at the present time?

Dr. Garfield: The rivers are not being used to their fullest extent; one may say the same thing as to the railroads, but in the case of the rivers, the accustomed channels for the distribution of coal had been provided otherwise. Now, whether the railroads have in times past, by the law of protection, gotten more than their due share of the coal transportation, I am not prepared to say. I know that when it came to the question of using the rivers we were not equipped to make the maximum use of them that should have been made. And, of course, there was no time to provide the extra equipment. That is being provided for more and more, however, now.

Mr. Frost: Why is it that coastwise towns like Providence, R. I., have to pay more for coal than interior towns like Worcester and Springfield?

Dr. Garfield: Because the freights by water have gone up largely because of the fact that the ocean-going tugs have been requisitioned by the navy.

May I say in that connection that the Governor was in my office and I gave him the information (Governor McCall, I refer to), that I have just arranged within a few days with the Secretary of War and with the Secretary of the Navy coöperating, and with E. N. Hurley, of the Shipping Board, that we shall have the supply of ships necessary to transport our coal by water.

The Secretary of War stated to me that if it became necessary to do so, he would detail mine layers, too good for the operation, as a matter of fact, but nevertheless quite sufficient, to pull the barges around from the tidewater ports here to New England. Also Mr. Hurley is directing that certain boats brought down from Montreal shall be put into the New England trade; and further than that, I am making a request (this looks forward to another season) that the new shipbuilding corporation shall build for us tugs that will be ready for service by the time next season comes around.

Mr. Williams: Regarding the matter of utilities, I understand that they are put in a priority class for consumption and not for storage. I read in the paper this morning that two plants operating in large industrial centers are without a sufficient supply of coal and have asked industries to close down. What will the Fuel Administration do with utilities in that matter, and to what extent will this supply be for current use?

Dr. Garfield: The moment we receive the information that a public utility is out of coal, or in danger of being out of coal within a few days, we issue the orders to send coal to that utility.

Mr. Williams: Well, the Washington papers stated that in the Baltimore and Pittsburgh sections the Government had to request industries to close down—industries using electrical power—because of the shortage of coal. I know that the priority order puts the utilities in a class where they can get coal for current consumption (that was issued by the Food Administration, I believe); now, the point I'd like to ask is how soon can these companies get coal and to what extent will they be kept in a supply of coal, so that such an emergency will not arise and so the shipyards will not be closed down?

Dr. Garfield: Any utility that will inform us of its impending lack will receive supplies of coal; that is, we will issue the orders right off to divert to those utilities enough coal to keep them going.

Now, a severe spell of weather, such as we have just had, may defeat the arrival of that coal in time, but all we can say about that is that that is liable to happen any season, and furthermore that the utility should speak far enough ahead and speak in the right form.

A mistake is made by not coming to the right place. If the utility will let the State Fuel Administrator know the necessity, and the State Fuel Administrator will thereupon inform this office here, immediately orders will be sent out to certain specified mines.

A. L. Findley: May I ask, Dr. Garfield, as to the status of the proposal to pool quantities of the mines?

Dr. Garfield: The Ohio pool is the one that has, so to speak, the best stock. Homer Johnson, the Fuel Administrator for Ohio, brought the suggestion to me (whether it originated with him or with the operators in Ohio, I can't say), about the Ohio pool. It is a terminal pool, as distinguished from a pool at the center. It is working out, so far as I can learn, well. It is only in the early days of its organization.

Mr. Findley: I wondered whether a manufacturer who had a partial supply of fuel for his gas producers, for example, and for his byproduct too, and ordinarily bought a supply of coal in the market, whether his own supply of coal would go into a pool supply in case there was a pooling, or whether the pooling of the coal would be a pooling of the merchant supply, or whether the mine or his company would have to throw supply of coal into the pool.

Dr. Garfield: The whole supply would go from the shipper; that is, the operator, the mine would go into the pool.

Mr. Findley: If you were a producing consumer of coal your own coal would go into the general pool and you would only get perhaps a part of the coal that you yourself produced; that is, your normal supply might be reduced?

Dr. Garfield: I am not informed whether those who are producing coal entirely, exclusively for their own use, have consented to go into the pool or not. Perhaps Mr. Morrow, knows. Have you any such, Mr. Morrow, in the pool?

Mr. Morrow: I can't answer that specifically, but the point of his question, so far as it relates to byproduct coal, may be answered in this way: Byproduct coal needed in any plant will not be moved. That coal ordinarily moves in solid trainloads, and will not be interfered with. That refers to companies who have their own mines. They are not included in the pools now, but later on may be included.

W. C. Baker: Mr. Morrow in his address to us emphasized the effect of car shortage in reducing the output of the mines, and the question was being discussed as you came in, to what extent various causes were operating to produce that car shortage. I'd like to inquire to what extent there is congestion in the tidewater and other important terminals. Is it not a fact that a large amount of freight is tied up in the terminal yards and makes it very difficult to have coal cars promptly and ties them up too long a time in their shipment, so that they are slower getting back to the mine?

Dr. Garfield: Undoubtedly that contributes to it. When a crowd of vehicles and cars are tied up at a street corner, it is difficult to determine which car or vehicle is producing the trouble—they are all producing it. And yet, it is true that the congestion at the terminals is one large contributing factor, perhaps the largest of any.

Mr. Taylor: To what extent does the authority of the Fuel Administration extend in ordering a mine to ship coal to the transportation company?

Dr. Garfield: I think it extends a good deal further than some other. The reading of the act is that the Fuel Administration has control of the apportionment and shipping of coal—I haven't hesitated, therefore, but another section states that all the agencies of the Government shall perform such service as the Fuel Administrator may require of them. If the railroads were controlled by the Government, the task would be simple, I could then issue the order. Railroads being in private hands, I can ask for priority orders and make requests of them, but I haven't any power to force the railroads to do a thing asked for.

M. C. Robbins: Mr. Morrow expressed the opinion that the reason for the coal shortage is the lack of cars by the railroads. You mentioned an important reason for the coal shortage: the demand for 50,000,000 tons of coal to be produced. From other sources, it has been said that the fixing of the low price for bituminous coal has discouraged the output of a great many mines. I'd like to ask if all three of these things are the cause, or if there is any difference in importance in these three things.

Dr. Garfield: Undoubtedly the fixing of a lower price than the operators had hoped would be fixed, played its part, and yet I can't prove it. It looks as if the proof went the other way. The President's order went out on Aug. 21, and the second order on Aug. 23. The reports of production for the weeks beginning with, I think, the 18th and straight along for the next few weeks, increased each week; there was a larger production each week than the preceding week, and a larger production than the year before. So it is difficult to say that the appearance of the President's order fixing the price halted production. In fact, only in one week since the President's order has come out, was there a drop that was materially below the production of last year, and the average is considerably above.

Mr. Frost: I am in some way connected with the public schools of our city. Tomorrow we have to determine whether or not we shall declare a vacation for the winter for the purpose of conserving coal. I'd like to know what Dr. Garfield's opinion is on that important matter.

Dr. Garfield: My judgment about that is that it is very poor economy, unless we are actually forced to do it, in a community to shut down schools.

R. Sherman: Can you tell us anything about how much coal is saved by cutting out electric illumination at night?

Dr. Garfield: I wish I could give you accurate figures. I am disappointed in the results. I think the result was less productive of saving than we expected it would be, and I shall change the order; but I don't propose by any means to give up the idea of saving in the United States on signs and white ways. We want to interfere less with business and accomplish better results.

Mr. Baldwin: Dr. Garfield, I'd like to present this matter, where an industry depends upon its own power for this service, but has difficulty in obtaining its coal, and the proposition is made by the public service corporation for shutting down its plant; are the chances better for the company to unite with the public-service corporation engaged in furnishing electricity for power than to depend upon the Fuel Administrator for the necessary coal to keep the plant running, when, as a matter of fact, this same coal could be burnt in either instance?

Dr. Garfield: I doubt if one could answer that clearly, except in a specific case. I should say, nevertheless, attempting to answer it generally, that there is more economy in working through public utilities; but if, on the other hand, your public utility is already overloaded, obviously you have got to resort to some other way. If your public utility is so located that it has peculiar difficulty in getting its coal supply, one would answer the question otherwise, so that while I would answer it in that way in general, I would have to recognize the existence of several exceptions.

Mr. Tipples: I'd like to ask if the price had been higher and production at the mines greater, would it be of any value, under present conditions, or are we producing all the coal that we can handle?

Dr. Garfield: That question is a very pertinent one, because it is obviously true that if the roads are now clogged and can't deliver what we have on the rail, how much worse position would they have been in if we had produced more coal from the mines. I think that the transportation system of the country, as it stands today, is not able to take care of more than is now being produced. I think it may be possible to transport more under the arrangements which are now in the making.

Mr. Stone: Is a comprehensive plan in the making providing a release of ocean tugs for coastwise and Lake traffic to meet conditions next fall and winter?

Dr. Garfield: Yes, it is.

Mr. Black: To what extent have the public-service commissions been willing to coöperate with plans of your department in regard to the economy suggested by you for public utilities?

Dr. Garfield: No sufficient return has been received yet to answer that. So far as I know, there is no disposition to do other than coöperate.

Mr. Lockwood: Has anything been done to increase the production of power for industries by use of water power?

Dr. Garfield: No efforts are being put forth to introduce any substitutions of that kind, because they won't meet with the present emergency. Where there are hydro-electric operations, however, the request, of course, is that they depend as far as possible upon the water power, and indeed they would do it without our asking, because it is a cheaper way. There are many good plans of various kinds that could be introduced if we had time to introduce them. I want to say in that connection that report came to me last week that a good many of the hydro-electric operations in the country (this person happened to have come from the South) have stocked up with more coal than they need under the circumstances, so I suspect that that is one of the places where coal has been taken on in larger quantities than it need be.

A. I. Findley: Do you consider the coal shortage more difficult than the fuel-oil shortage just now, whether you are considering substituting fuel oil for coal in industry.

Dr. Garfield: I should say that fuel oil is in the long run less serious; the coal is more serious because it happens that our large munitions factories are depending upon coal, not for fuel oil—that is, in larger proportion.

Essex Power Plant Shut Down

At 5:30 Wednesday morning, Dec. 19, one of the instrument potential transformers on one of the 25,000-kv.-a. units (No. 1 unit) in the Essex Power Plant of the Public Service Electric Co., Newark, N. J., broke down and caused a very destructive burnout of the generator cables between the machine and oil switch. Although the trouble amounted to practically a short-circuit of the generator terminals, the unit was not injured. Nevertheless, the nature of the burnout made it impossible to get the machine back into service.

At the time of the trouble the two 25,000-kv.-a. units, which are at present installed in this station, were in service and carrying a load of 36,000 kv.-a. When No. 2 unit picked up the overload, its turbine developed a knock that was considered serious enough to shut the machine down so as to investigate the trouble rather than take a chance of more serious developments. This left the station dead and compelled the company to reduce its system's load by 25,000 kw., which could not be taken care of by the other plants on the system. By putting jumpers from No. 1 unit to the switches on No. 2, No. 1 machine was back into service by 2:30 in the afternoon, and by 4:30 the next day the trouble was cleared up and both machines back into service, which is a remarkably short time to make repairs of this magnitude.

When No. 2 turbine was opened, what appeared to have been a rub on one of the wheels was the only indication of what had caused the knock. This was remedied and the turbine put back into service without further developments.

The next morning after the accident at the Essex Plant, the company had to curtail its service for a short period at its Marion plant, owing to low steam pressure, on account of the heavy overload this plant was carrying during the peak period and the poor quality of coal that they have been forced to use.

The company, like many other central stations in this country, has all its spare capacity contracted for, in an endeavor to meet the heavy demands placed upon it by the many new industries that have grown up to supply the war needs of the nation. This, combined with the difficulties of obtaining deliveries of new equipment and an adequate coal supply, has brought about anything but an assuring condition in many cases.

At the present time a 35,000-kv.-a. unit is being installed at Essex and will be in service in a few weeks. This will give the company reserve capacity for some time to come and guarantee against a recurrence of the recent embarrassment.

Obituary

Charles J. Klein, designing engineer for the Cutler-Hammer Co., and a prominent electrical inventor, died suddenly at his home in Milwaukee, Wis., on Sunday night, Dec. 16. Mr. Klein was born in New York City 55 years ago and went to Milwaukee from the New York office of the Cutler-Hammer Co. in 1908. He was an intimate friend and co-worker of Thomas Edison for many years. He is survived by a son and a sister.

Frank Martin, well-known as an engineer and contributor to "Power," died on Christmas Eve of pneumonia after an illness of two weeks. As an operating engineer, Mr. Martin had a full experience. He was a master electrician in the United States Navy, having been stationed at the Brooklyn Navy Yard. For a number of years he was chief engineer of the Hard Rubber Co., College Point, N. Y., and served for a period as master mechanic of the American Thread Co., Willimantic, Conn. A few years ago Mr. Martin went to Honolulu as chief turbine engineer for the Marconi Wireless Telegraph Co. He returned to the United States about two years ago, after which he took a needed rest. At the time of his death he was first assistant chief engineer for the New York Steam Co. He also held the rank of chief machinist's mate in the Naval Militia when he died. Mr. Martin was an honorary member of Brooklyn No. 8, N. A. S. E., and a Master Mason, Oceanic Lodge, Honolulu. He is survived by his wife. Death came while Mr. Martin was in the New York Hospital. Services were held Friday, Dec. 28, at Stephen Merritt Chapel, Eighth Ave., New York City.

Personals

W. R. Jennison has been appointed Southeastern representative of the Hoppes Manufacturing Co., of Springfield, Ohio. with offices at 407 Bisbee Building, Jacksonville, Florida.

Robert E. Dillon, who has been in charge of the steam-testing division of the standardizing and testing department of the Edison Electric Illuminating Co., of Boston, has been appointed assistant superintendent of the generating department.

Fred Greanoff, formerly assistant superintendent at the Duluth Boiler Works, has resigned to engage in a similar business of his own at Buffalo, N. Y. Before leaving, Mr. Greanoff was presented with a gold watch and chain and stickpin by the employees of the Duluth Boiler Works.

J. C. Bannister has been made a vice president of the Walworth Manufacturing Co., of Boston, Mass. He was successively foreman in the tapping department of the Haxton Steam Heater Co., at Kewanee, superintendent of the pipe-finishing mill and chief engineer; superintendent of the Kewanee Boiler Co. and later manager of the Kewanee works.

D. J. Angus, who recently purchased an interest in, and associated himself with, the Esterline Co., of Indianapolis, Ind., as treasurer, has taken over the responsibility of the engineering department and of the design and development of new lines of instruments and apparatus. Prior to his connection with the Esterline Co., he was associated with J. W. Esterline in consulting-engineering work.

C. H. Andrews, assistant to president and chief engineer of the North Carolina Public Service Co., Greensboro, N. C., has been appointed general superintendent of the Southern Utilities Co., which corporation operates electric, gas and ice properties throughout Florida, under the management of the J. G. White Management Corporation, New York City. He will assume his new duties on Jan. 1.

L. L. Hebberd, for the last four years associated with the consulting engineering firm of Vaughn & Meyer, of Milwaukee, Wis., in charge of the mechanical-engineering department, is now with the Consolidated Water Power and Paper Co. as mechanical engineer and superintendent of steam power. His headquarters at present are at the Interlake Pulp and Paper Co., an affiliated company, at Appleton, Wisconsin.

Engineering Affairs

The Society of Automotive Engineers will hold a meeting in New York on Jan. 10 and one in Chicago on Feb. 1. Four engineering authorities on aviation—Maj. Jesse G. Vincent, father of the Liberty engine; Col. Clarke, Capt. Howard Marmon and H. M. Crane—will handle that part of the subject at the New York meeting. The Chicago meeting, which will be held at the Hotel Sherman, will be devoted entirely to farm-tractor subjects, and the war dinner will be held the same evening at the New Morrison Hotel.

The Engineering Society of York, Penn., elected the following officers for the ensuing year at its recent annual meeting: President, James Rudisill; vice president, Chauncey D. Bond; secretary, M. Haller Frey; treasurer, Harold A. Russell; directors, George A. Jessop, Charles L. Berger and Howard J. Longenecker. The annual reports show that considerable progress has been made during the past year and there has been a considerable increase in the membership of the organization.

The Evening Students Association of the Polytechnic Institute, of Brooklyn, N. Y., held its third annual smoker on Saturday, Dec. 22, in the gymnasium of the institute. There were fully three hundred in attendance. Chairman Price, of the entertainment committee, outlined the purposes of the association. Prof. Charles A. Green, director, welcomed the audience in a brief speech. The entertainment included boxing, wrestling, tumbling and humorous addresses by John Rogers, Doctor Foy and Jack Armour, of "Power." Fred Bucholtz was the master of ceremonies. Refreshments were served.

The American Association of Engineers held a meeting at Washington on Dec. 14, the object being to form a coöperative movement to assist the Government to secure desirable and qualified technical engineers. Among those present were: Admiral F. R. Harris, Admiral Baird, Major Zimmerman, of the Engineers' Depot, and Major Harrison. Capt. D. S. Hays, of the U. S. Engineer Corps, described how the organization rose from a small beginning to its present size. The following were elected officers of the Washington Chapter: President, F. R. Weller; first vice president, A. S. Grossberg; second vice president, Harry Stevens; secretary, Capt. D. S Hays; treasurer, O. M. Sutherland. The association is a member of the Chamber of Commerce of the U. S. A., and is coöperating with all the chambers of commerce throughout the country.

The Society of Automotive Engineers will hold a special meeting on the afternoon and evening of Jan. 25. The afternoon session will be held at the society's headquarters, 29 West 39th St., New York, and the dinner and evening session will be held at the Automobile Club of America, 247 West 54th St. The afternoon session will be devoted to the consideration of engines for motor boats; one of the subjects will deal with the Diesel engine and the other with engine design for submarine chasers, etc. James Craig, of the Craig Engineering Co., will speak on "Developments and Improvements in the Diesel Engine in the United States." E. A. Riotte, of the Standard Motor Construction Co., will give an address on "Engineering Fundamentals in Low-Speed Engines for Motor Boats." In the evening Erwin Chase, engineer of the Submarine Boat Corporation, will speak on "Equipping Our Transports with Motor Boats." Henry R. Sutphen, of the Submarine Boat Corporation, will give a talk on standardization in boat construction. It is planned to have a special movie film prepared for the evening, showing submarine chasers, coast patrols and other boats which use the explosion-type engine.

Miscellaneous News

Ordnance Department Wants One Hundred Draftsmen to fill positions paying from $800 to $1800 per year. Civil-service examinations for these positions will be held in Chicago, Jan. 8, 9 and 10. Positions will be permanent. Applications should be filed with Milward Adams, Secretary Civilian Personnel Committee, Ordnance Department, offices State Council of Defense, Chicago, Illinois.

The Goulds Manufacturing Co., Seneca Falls, N. Y., has put into effect, beginning Jan. 1, 1918, a bonus system whereby all hourly, piecework and salaried employees rated at $40 a week or under, will receive quarterly a bonus of 10 per cent. on their total salary for the previous three months. This bonus is contingent upon a stipulated amount of time being put in at actual work during the year, and is aimed to encourage full-time work.

The Little Miami Light, Heat and Power Co., of Cincinnati, Ohio, has instituted condemnation proceedings under the right of eminent domain for rights for a $1,500,000 hydro-electric system in the Little Miami River district between Plainville and Morrow. It intends to build fifteen dams on the Little Miami River. There will be no lock system in connection with these, the only openings to be fish chutes. The corporation expects to develop 10,000 hp., which will be used outside of the City of Cincinnati proper. It also proposes to develop other territory bordering along the river, a distance of 30 miles.

The Woman's Committee for Engineer Soldiers has been formed in Washington, D. C. Mrs. William M. Black, wife of General Black, Chief of Engineers, is president; Mrs. Charles Keller, vice president and chairman; Mrs. W. W Harts, secretary; Mrs. Ulysses Grant, 3rd, treasurer. The object of the Woman's Committee is to see that no engineer soldier leaves this country without the proper knitted garments and to send garments to those already "over there." The National Committee in Washington is to be headquarters for units all over the country and by purchasing yarn in large wholesale quantities should be able to get better prices and deliveries. The dues are $1 a year, and a very earnest appeal is made to every man and woman interested in the engineers of the Regular Army, National Army, the Railroad, Forestry, Camouflage, or Labor regiments, to join this organization or to send contributions of money for wool or finished knitted garments, to supply these hundred thousand men. Address Mrs. William M. Black, 1730 I St., N.W., or Mrs. Ulysses Grant, 3rd, 2204 R St., N.W., Washington, D. C.

To Train 50,000 Men for New Ships—The "Gov. Dingley," a coastwise passenger steamer until recently in the Boston-Yarmouth, N. S., service, has been chartered by the United States Shipping Board Recruiting Service, of which Henry Howard is director, with national headquarters at the Boston Custom House, for a training ship for crews for the new merchant marine. She is the second training ship chartered here, the first one being the "Calvin Austin," which recently went to Halifax as a relief ship as her first mission for the Shipping Board Recruiting Service. Like the "Calvin Austin," the "Gov. Dingley" will have her base at the new Federal Wharf at East Boston. She will accommodate a "class" of 500 seamen, firemen, oilers, water tenders, cooks and stewards, who will be given intensive instruction by experts to fit them for places in the new merchant marine. The training of 50,000 men on training ships during the next year will be directed by the new Sea Training Bureau, with headquarters at the Boston Custom House, and with Capt. Eugene E. O'Donnell, supervising inspector, Fifth District, U. S. Steamboat Inspection Service, as supervisor. Capt. James P. Stevenson, until recently marine superintendent of the United States transport service, is executive head under Captain O'Donnell. Headquarters of Mr. Howard, at the Boston Custom House, are being flooded with applicants for enrollment on the new training ships.

Trade Catalogs

Esterline Graphic Efficiency Instruments. The Esterline Co., Indianapolis, Ind. Booklet No. 370. Pp. 12; 6 x 9 in.; illustrated.

Safety Switches and Cut-Outs. The Palmer Electric and Manufacturing Co., Boston, Mass. Bulletins M13 and M17; pp. 4; 6 x 9 in.; illustrated.

New Clutch Drive Rochester Automatic Lubricator. Greene, Tweed & Co., 109 Duane St., New York. Booklet showing different installations of this lubricator.

Class "Y-C-E" Duplex Direct Connected Electrically Driven Air Compressors. Nagle Corliss Engine Works, Erie, Penn. Bulletin No. 30. Pp. 12; 6 x 9 in.; illustrated.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Dec. 28, 1917	One Year Ago	Dec. 28, 1917	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7:35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Dec. 28, 1917	One Year Ago	Dec. 28, 1917	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Dec. 28, 1917	One Year Ago	Dec. 28, 1917	One Year Ago
Pea	$5.05	$4.00	$5.80	$5.50—5.60
Buckwheat ..	4.30—5.00	2.75	5.75—6.00	4.75—5.00
Rice	3.75—3.95	2.20	4.75—5.00	3.00—3.25
Barley	3.25—3.50	1.95	3.70—3.95	2.25—2.50
Boiler	3.50—3.75	2.20	4.00—4.50	....

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)...........	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Dec. 28, 1917	One Year Ago		Dec. 28, 1917	One Year Ago
Buckwheat ...	$3.15–3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65–3.65	1.25	3.65	2.15	3.35
Boiler	2.45–2.85	1.10	3.55	2.00	....
Barley	2.15–2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Dec. 21, 1917	One Year Ago	Dec. 21, 1917	One Year Ago	Dec. 21, 1917	One Year Ago
6-in. lump..	$2.80	$3.00	$2.80	$2.60	$2.80	$2.25–2.50
2-in. lump..	2.80	....	2.80	....	2.80	2.00–2.25
Steam egg...	2.80	3.00	2.80	....	2.80	2.00–2.25
Mine-run ...	2.55	2.75	2.55	2.60	2.55	2.00–2.25
No. 1 nut...	2.80	3.00	2.80	2.50	2.80	2.00–2.25
2-in. screen.	2.30	2.75	2.30	2.50	2.30	2.00–2.25
No. 5 washed	2.30	2.75	2.30	2.75	2.30	2.00–2.25

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ark., Marianna—The Citizens Service Co. has applied for permission to build an electric-lighting and power plant here.

Ky., Whitesburg—W. C. Daniels & Son are having plans prepared for the erection of a transmission line from here to Mayking.

Mo., Appleton—City plans election in January to vote on a $15,000 bond issue to improve its electric-lighting plant. W. B. Rollins & Co., 209 Railway Exch., Kansas City, Engrs.

N. J., Bloomfield—The Power Specialty Co., 111 Bway, New York City, has had plans prepared for the erection of a new plant on Locust Ave., here. Estimated cost, $31,000.

N. J., Jersey City—Swift & Co., Union Stock Yards, Chicago, has had plans prepared for the erection of a 50 x 50-ft. addition to its power house on 9th St., here.

N. J., Perth Amboy—City plans to extend its street-lighting system for which $25,000 has already been appropriated.

Ohio, Cleveland—The Municipal Electric Light Co. plans to improve its plant including the installation of new equipment involving a switchboard, generator, boilers and engines. About $700,000 will be expended. R. Hoffman, City Engr.

Ohio, Columbus—The Columbus Railway, Power and Light Co. has petitioned the Public Utilities Commisison for permission to issue $1,276,000 in capital stock and bonds; the proceeds will be used in additions and improvements in connection with its new plant. H. W. Clapp, Gen. Supt.

Ohio, Salineville—City voted $25,000 bond issue for the erection of an electric-lighting plant.

Okla., Commerce—The Triangle Mines Co. plans to install an electric-lighting and power plant. N. C. Barry, Pres.

Penn., Hazleton—The Harwood Electric Co. is having plans prepared for the erection of extensions to its plant.

Penn., Philadelphia—Wallace & Co. plans to build a 28 x 95-ft. power house on 81st St. and Island Rd. Estimated cost, $10,000.

Penn., Somerset—The Johnstown & Somerset Ry. plans to install new equipment in its 300-kw. substation. U. S. Houck, Supt.

Tex., Ft. Worth—The Fort Worth Power and Light Co. has increased its capital stock from $3,860,000 to $4,360,000 and plans to install new equipment in its power plant including a new 23,000-hp. steam turbine generator. A. H. Duncan, Mgr.

Va., Lynchburg—The Retail Merchants' Association plans to install an electric-lighting plant.

Va., Petersburg—The Petersburg & Appomattox Electric R.R., Sycamore St., is having plans prepared by F. A. Bishop, Arch., for the erection of a 1-story central heating plant at Lakemont, near here. J. A. Baird, Supt.

Wash., Everett—City is having plans prepared by Burn & McDonnell, Engrs., 400 Inter-State Bldg., Kansas City, Mo., for the erection of a power plant. Estimated cost, $800,000. Noted Oct. 2.

Wash., Kalama—The Kalama Lumber and Shingle Co. plans to improve its plant, including the installation of a new boiler plant and other machinery.

Wash., Puget Sound—(Bremerton P. O.)—(Official)—Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, Puget Sound, under Schedule No. 1638; 1000 ft. rubber-insulated interior communcation cable; 1000 ft. lighting and power wire; 10,000 ft. single-conductor lighting and power wire; 5000 ft. two-conductor lighting and power wire.

Wash., Seattle—Skinner & Eddy, 150 Massachusetts St., has been granted a permit to erect a power plant. Estimated cost, $3000.

Wash., Shelton—The Shelton Light and Power Co. has petitioned the County Commissioners for a franchise to build and operate a transmission line from its plant at Goldsborough Creek over the county roads.

W. Va., Fairmont—The Greater Fairmont Investment Co. is considering plans for the erection of a 10,000-kw. generating station.

Wis., De Pere—The Western Manufacturing Co. of De Pere plans to build a boiler house. Estimated cost, $45,000.

Wis., Gresham—City plans to install an electric-lighting plant and water-works system.

Wis., Janesville—The Janesville Electric Co. plans to build an addition to its power house.

Wis., Madison—City is having plans prepared for the erection of a substation on Sprague St., in the Wingra Sewer District. E. E. Parker, City Engr.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T .fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			⅜-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T .P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	..
Current taps	.35	50

CHRISTMAS TREE LIGHT OUTFITS—For 110-volt lighting circuits the price is as follows:

	Per Set
8-light outfit with colored lamps complete	$2.00
16-light outfit with colored lamps complete	4.00
24-light outfit with colored lamps complete	6.00
32-light outfit with colored lamps complete	8.00
For 3½-volt battery circuits:	
8-light outfit with colored lamps complete	1.50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$21.50
No. 16 cotton twisted	29.00
No. 18 cotton parallel	24.00
No. 16 cotton parallel	36.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	39.40
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No. 18 cotton Canvasite cord	21.75
No. 16 cotton Canvasite cord	32.00

LOOM—Price per 100 ft., in coils:

	Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$10.50	$12.50	$16.00	$24.00
12	15.50	17.88	21.00	35.16
10	21.75	24.50	27.50	48.50
8	30.50	33.75	38.25	67.00
6	....	....	58.76	...
5	....	....	69.20	.
4	....	...	83.10	
3	....	..	100.00	..
2	....	.	121.25	
1	....	.	148.75	
0	....	..	191.60	..
00	....	....	233.75	.
000	....	....	286.00	..
0000	....	...	349.50	...

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$11.40	$14.75	$28.90	$13.50	$16.00	$26.00	$11.50	$17.90	$36.40
10	23.30	26.50	52.55	26.00	29.00	....	30.80	34.30	67.69
8	33.10	36.70	73.20	35.00	40.50	....	42.85	46.85	..
6	....	56.20	....	....	65.35	....	69.60	74.10	..
4	....	80.55	....	....	93.65	....	101.75	106.05	.
2	....	120.30	....	....	140.50	....	156.50	163.00	
1	....	156.25	....	...	182.50	..	201.00	209.50	
0	....	187.05	....	....	241.00	....	276.00	285.00	
00	....	252.65	....	...	294.50	...	317.00	330.00	
000	....	309.35	.		369.50	..	417.00	428.50	
0000	....	376.75	....		439.50	...	508.00	516.00	..

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$69.70	$74.80	$0.1672	$0.1786	$0.0616	$0.0658
¾	92.00	98.90	.22	.235	088	.094
1	136.00	146.20	.3256	.3478	1144	1222
1¼	184.00	197.80	.4185	.4496	.1581	1698
1½	220.00	236.50	.558	.5994	.1953	.2098
2	296.00	318.20	1.023	1.10	.2604	.2797
2½	468.00	503.10	1.674	1.80	.372	.3996
3	612.00	657.90	4.464	4.79	.558	.5994
3½	763.60	818.80	9.86	10.59	.744	.7992
4	926.50	991.90	11.39	12.23	.93	.999

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼in., 100; 1½- to 2-in., 50.

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$70.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.30	100	75	$0.65	$0.70	..
15	.27	.30	100	100	1.00	1.05	24
25	.27	.30	100	300	3.00	3.10	24
40	.27	.30	100	500	4.50	4.65	12
50	.27	.30	100	750	6.00	6.25	8
60	.36	.40	100	1000	7.00	7.25	8

Standard package quantities are 10% from above prices. Yearly contracts ranging from $150 up allow a discount of 17% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb
Rubber tape, ½-lb rolls	45c. per lb
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c. per lb

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2⅝-in.	70c. per ft.
Common, 2½-in.	40–10%

Air

	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.55	$0.30	$0.25

Steam—Discounts from list

First grade... 30% Second grade... 30-5% Third grade... 40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50–10%	Best grade	25%
Standard	40%		

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	35%
Denver	40%	35%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.77
Asbestos for high-pressure steam	1.54
Duck and rubber for piston packing	.88
Flax, regular	.66
Flax, waterproofed	.99
Compressed asbestos sheet	.99
Wire insertion asbestos sheet	1.21
Rubber sheet	.55
Rubber sheet, wire insertion	.88
Rubber sheet, duck insertion	.44
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided, and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.65 to .70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard Thickness Per Lin.Ft	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		15% off
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Chicago	St. Louis	Birmingham	Denver
Cup	5¼	5.6	8½	10½
Fiber or sponge	6	5.9	15	15
Transmission	6	5.9	10	15
Axle	4	3.3	3	5
Gear	4½	6	5½	5½
Car journal	3½	3.75	5	5

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Dec. 28, 1917	One Year Ago		
White	11.00 to 13.00	10.00 to 12.00	16.00	14.00 to 15.00
Colored mixed	8.50 to 12.00	7.00 to 9.00	14.00	10.00 to 12.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13¼	$35.00	13¼ x 20½	$45.00

In Chicago they sell at $30@33 per 1000.

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Dec. 28 1917	1 Year Ago	Dec. 28, 1917	1 Year Ago	Dec. 28, 1917	1 Year Ago
Raw in barrels	$1.28	$0.96	$1.25	$1.00	$1.25	$1.03
5-gal. cans	1.38	1.00	1.40	1.10	1.35	1.13

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Dec. 28, 1917		1 Year Ago		Dec. 28, 1917	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50	10.50
12½-lb. keg	11.75	11.25	10.75	11.25	10.75	10.75
100-lb. keg	11.25	11.50	11.00	11.50	11.00	11.00
1- to 5-lb. cans	13.25	13.00	12.50	12.50	13.00	12.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	30%	40%*
Tinned	30%	30%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York ..... $7.00 Cleveland ..... $6.85 Chicago $5.50

Coneheads, same sizes:

New York ..... $7.10 Cleveland ..... $6.95 Chicago $5.60

AMMONIA—Below are prices per lb. in cities named:

	New York	Chicago	St. Louis
26-deg. U.S.P. carboys of 100 lb.	16c.	12c.	....
26-deg. U.S.P. drums of 1000 lb.	14c.	10c.	12c.

Anhydrous ammonia in 100-lb. cylinders costs 30c. per lb. in St Louis, Chicago and New York.

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$50.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	....
Magnesite brick, per net ton	135.00 to 145.00	....
Chrome brick, per net ton	135.00	....
Deadburned magnesite brick, per net ton	85.00 to 90.00	....
Special furnace chrome brick, per net ton	60.00 to 70.00	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $50.
Birmingham—Fire clay, $25 to $30; Denver, $23, per 1000.
Chicago—Second quality, $25 per ton.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	5¼c.	4½–4¾c.
Mexican heavy, 12-14 Baumé	7c.	

Note—There is practically no fuel oil in Chicago at present time.

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Dec. 28, 1917	One Year Ago
New York	$15.00	$7.50
Cleveland	15.30	7.50
Chicago	15.00	5.75

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St Louis	Denver
6 in. by 30 ft	$5.59	$4.94	$4.94	$4.3[illegible]
7 in. by 30 ft	7.40	6.60	6.60	5.80
7 in. by 35 ft	10.70	9.60	9.60	8.55
8 in. by 35 ft	12.20	10.90	10.90	9.65
7 in. by 40 ft	12.35	11.00	11.00	9.75
8 in. by 40 ft	13.75	12.15	12.15	10.65
8 in. by 45 ft	18.20	16.20	16.20	14.30
8 in. by 50 ft	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$6.00
12-in. butts, 6-in. tops, length 30-40 ft.	8.50
12-in. butts, 6-in. tops, length 41-50 ft.	9.50
14-in. butts, 6-in. tops, length 51-60 ft.	17.00
14-in. butts, 6-in. tops, length 61-71 ft.	18.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh; basing card of Nov. 6, 1917, for steel pipe and for iron pipe:

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
BUTT WELD					
⅛, ¼ and ⅜	44%	17%	¾ to 1½	33%	17%
½	48%	33½%			
¾ to 3	51%	37½%			
LAP WELD					
2	44%	31½%	2	26%	12%
2½ to 6	47%	34½%	2½ to 4	28%	15%
			4½ to 6	28%	15%
BUTT WELD, EXTRA STRONG PLAIN ENDS					
⅛, ¼ and ⅜	40%	22½%	¾ to 1½	33%	18%
½	45%	36½%			
¾ to 1½	49%	36½%			
LAP WELD, EXTRA STRONG PLAIN ENDS					
2	42%	30½%	2	27%	14%
2½ to 4	45%	33½%	2½ to 4	29%	17%
4½ to 6	44%	22½%	4½ to 6	28%	16%

Note—National Tube Co. quotes on basing card dated Apr. 1.

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42.8%	40.1%
3½ to 6 in. lap welded	18%	38.8%	36.1%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	27.8%	25.1%
3½ to 6 in. butt welded	List	24.8%	22.1%

Malleable fittings, Class B and C, from New York stock sell at list price. Cast iron, standard sizes, 15 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

	Per Net Ton		Per Net Ton
1 in.	$340	1¾ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

POWER

Vol. 47 NEW YORK, JANUARY 8, 1918 No. 2

HELPFUL HINTS

Team Work in the Plant

The tendency toward specialization has penetrated the power plant no less than every other establishment devoted to productive service. As organizations are perfected, the duties of individuals are often restricted as to responsibility, and where this policy is carried to extremes, men are sometimes tempted to lose interest in each other's work. The larger efficiency of the service suffers accordingly, and can only be restored by team play. Upon the personality of the chief engineer much depends in this connection.

No plant can be organized solely like a machine and achieve the best results. Conditions are different from those in the mill or shop, where a tangible product is passed rapidly through the establishment, seen of men as it goes from step to step, ponderable and real. We cannot operate a power plant on the piecework basis. Between certain periods a measure of relief comes to the staff on duty; at other times the pressure rises and puts a heavy strain on part of the force. When these strains are noncoincident a little extra help may accomplish wonders.

Just because a fire wall separates the engine and boiler rooms shall the men on either side of the brickwork assume that they have little in common? There is no more reason for insularity here than for hostility between engineer and fireman on the locomotive or for cross-purposes between the army and the navy.

If a turbine breaks down at a critical period of the load, necessitating the immediate attention of the turbine-room force, and additional assistance is needed from the fireroom, no matter for what purpose, let it be cheerfully rendered. "I wasn't hired to do this!" is one of the most miserable points of view that a human being can take in facing an emergency call on his services. It is as good a recipe for staying in the mediocre class as can be quoted, and puts a man in a group of which he should be ashamed to be a member.

Diametrically opposed to this attitude is the cooperative spirit shown by the chief when, in a critical time, he strips off his coat and vest and "mobilizes" every ounce of ability and strength he possesses at the scene of trouble; of the construction superintendent who doesn't hesitate to go into a manhole with a dress suit on in order to clear up trouble for which he is ultimately responsible and which is costing his company a month's salary every hour that service is interrupted; and of the assistant engineer who doesn't balk at coal passing for a quarter-hour in case the regular force is overloaded through the sudden illness of one of its members on the job.

The operating records and the atmosphere of friendly collective effort in many plants bear witness to the team work therein. Much of this cooperation never gets into the log sheet and is known to only two or three men most immediately affected. It counts on the unit costs, however; and important as it is to define the responsibilities of individuals, it is wise not to attempt to limit their range of mutual helpfulness.

The smaller the station, the more give and take there naturally is between the operating men on duty; but even in the larger plants there is room for the practice of a personal "readiness-to-serve," which goes a long way toward maintaining good records in station performance.

Contributed by H. S. KNOWLTON, *Cambridge, Mass*

Operation and Maintenance of Elevators—Winding-Drum Machines

By R. H. WHITEHEAD

The various parts of a modern winding-drum-type elevator machine and their function are described. Two classes of machines are considered; namely, those located overhead and those installed in the basement or on a lower floor.

A COMPLETE installation, using the winding-drum type of elevator machine, is shown in Figs. 1 and 2. In Fig. 1 the machine is set on overhead beams at the top of the hoistway; in Fig. 2 on a concrete foundation in the basement or lower floor. The particular feature that characterizes this type of installation is the spirally grooved drum *D* which winds or unwinds the ropes to the car *C* and to the drum counterweight *DW*. When raising the car, the car ropes are wound up on the drum and at the same time the ropes to the drum counterweight unwind, thus lowering the latter. In this manner the weight of the car and the load in the car are partly counterbalanced by the drum counterweight.

Besides the foregoing method of counterbalancing, in some cases, as in the illustrations, a car counterweight *CW* is provided, the ropes for which lead directly from the car to an overhead sheave *S* or sheaves, as the case may be, and thence to this separate counterweight. This, of course, takes a certain amount of load from the car ropes leading to the drum and thereby makes it possible to handle a heavier load than would be the case otherwise. The amount of counterbalancing and its distribution between the car counterweight and the drum counterweight depend on the speed, load and service of the elevator. The counterweights are carefully adjusted by the elevator manufacturers to secure the most economical results for the particular condition, when the installation is first made. However, the car counterweight under any condition must be less than the weight of the empty car, and the total amount of counterweight is generally equal to the weight of the car plus 25 to 40 per cent. of the speed load.

Arrangement of Counterweights

As shown in Figs. 1 and 2, the car counterweights and drum counterweights both run in the same set of hoistway guide rails *HG*. They are entirely independent, however, the weights for each being contained in separate frames. It is necessary to slot or recess the weights in the top or car-counterweight frame so as to permit the passage of the ropes to the bottom or drum-counterweight frame and to slot the ends of the top and bottom frame weights in each frame to engage the guide rails. The drum counterweights are placed in the bottom frames and the car counterweights in the top, and the ropes are adjusted so that the frames are about six inches apart. This arrangement is necessary in order to prevent the addition of the drum counterweight to the car counterweight in the event of the possible breaking of the drum-counterweight ropes, as under this condition the car with a light load would be seriously overbalanced.

Where the drum-counterweight ropes pass through the car counterweight, they are inclosed in steel tubes to prevent abrasion as there is a small difference in the relative movement of the two sets of counterweights when starting and stopping the car. An adjustment of the rope lengths should always be maintained so that the weights bottom before the car strikes the overhead work and so that the car fully compresses the spring bumpers *B* shown in the pit at the bottom of the hatchway, Fig. 1, before the counterweights come in contact with the overhead work. Allowances should be made for a sufficient margin of overtravel to take care of the inertia of the machine and weights.

Counterweight Compensation

In Fig. 1 a chain *H* is shown attached to the bottom of the car and the drum-counterweight frame. As the car rises in the hoistway, the ropes to the overhead work become shorter and the ropes from the overhead work to the weights become longer, with the result that the weight of the ropes on the car side becomes less and increases on the counterweight side. This produces a constantly changing amount of counterbalance for which it may be advisable to provide compensation. Where the rise is less than 150 ft., the unbalancing of the ropes makes little difference, but for higher rises it is advisable to provide a chain counterbalance, as shown in the figure, which neutralizes this shifting of the rope weight and keeps the counterbalance constant, thus saving in the power consumption of the elevator. Where chain counterbalance is provided, the links of the chain are generally interwoven with sash cord to eliminate noise.

The elevator cab shown is set in a steel frame or "sling." This sling consists of top channels *F* forming a crosshead, two bottom channels forming the safety plank *P*, upright channels *U*, called stiles, connecting the crosshead and safety plank with a platform mounted on the latter and braced to the stiles with tension braces *TB*. Gusset-plate bracing *G* is shown between the crosshead and stiles. The car and car-counterweight ropes connect by thimbles to the center of the crosshead. At the ends of the crosshead channels and safety plank are the adjustable-spring guide shoes *A*, which are slotted and fitted with gibs to engage the main guide rails *M* in the hoistway. The guide shoes are each attached to a stem inserted in a holder and held by a bracket on the crosshead and safety plank. The shoes are arranged so as to have limited movement, backed by spring pressure which keeps them securely against the rails.

Figs. 1 and 2 both show a ball governor *E* located overhead. The rope operating this governor passes around a tension sheave *N* at the bottom of the hoistway, Fig. 2, and is connected to a device *J* on the car that actuates the safety. If the car overspeeds when moving in a downward direction, as would occur if the

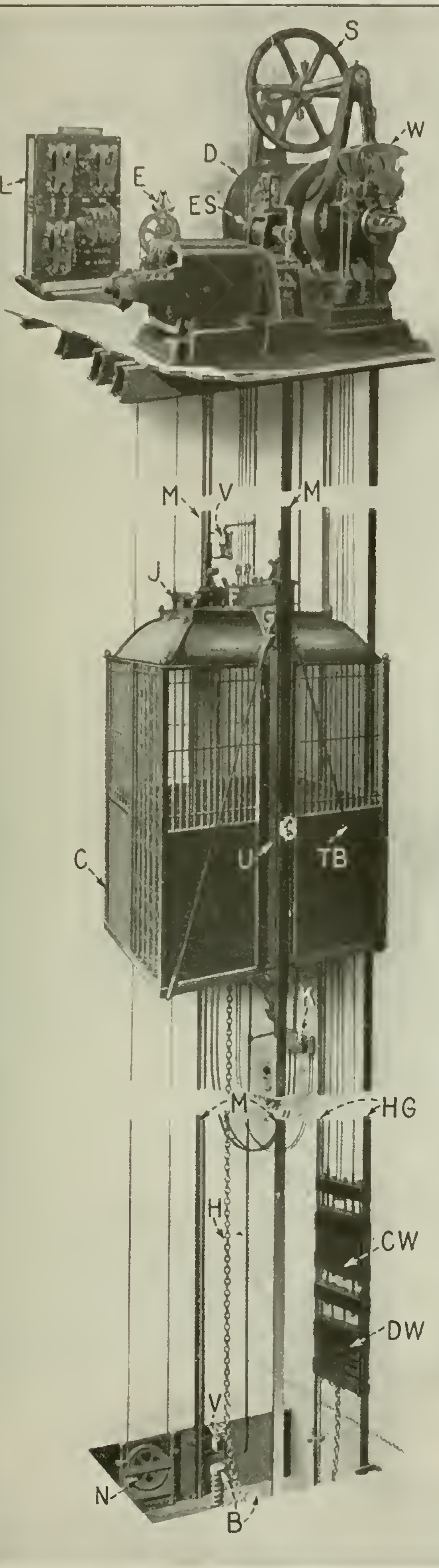


FIG. 1. WINDING-DRUM-TYPE ELEVATOR MACHINE; OVERHEAD INSTALLATION

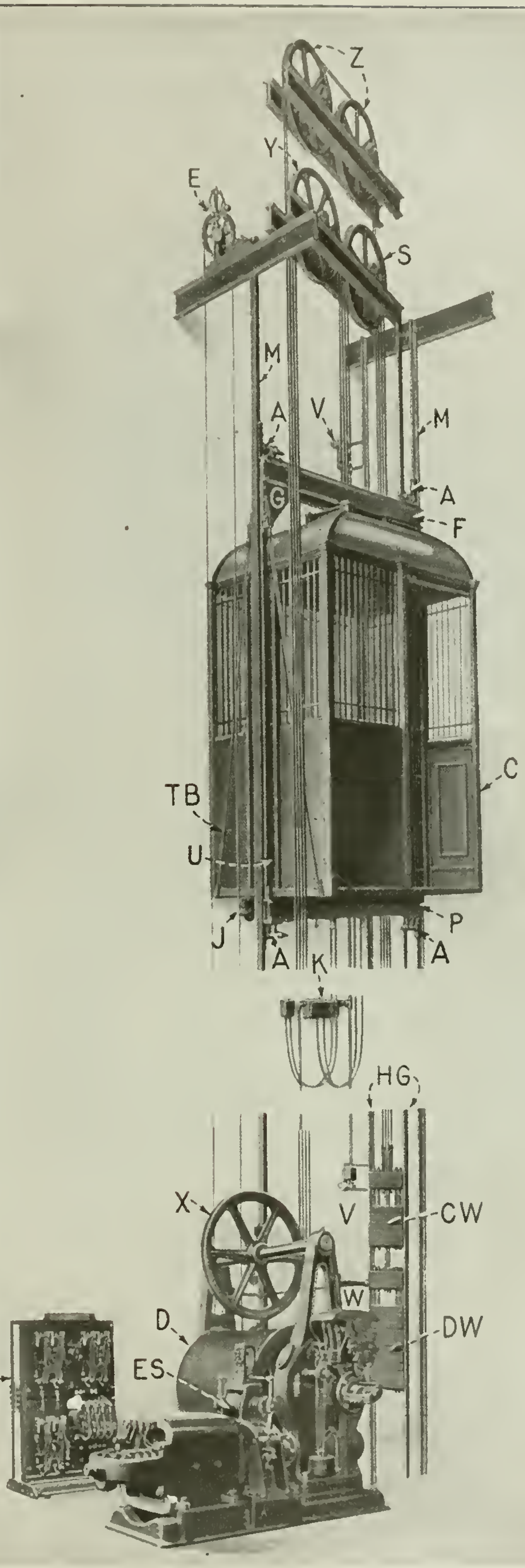


FIG. 2. WINDING-DRUM-TYPE ELEVATOR MACHINE; BASEMENT INSTALLATION

car ropes parted, the balls on the governor spread sufficiently to throw the governor jaws and hold the governor rope fast. This operation sets the car safety gripping device against the main guide rails and stops the car. A later article will describe in detail the various types of safeties and their operation.

Each of the installations shown in Figs. 1 and 2 is of the car-switch-control, single-speed type. The flexible cables containing the wires of the control circuits lead from the bottom of the car to the junction boxes *K* in the hoistway and are used for the operation of the controller by the car switch, for the light in the car and for the floor-signal system. The controllers *L* shown are arranged for direct current. Later articles will deal with various types of both alternating- and direct-current elevator controllers. In the present case each controller has a main-line or potential switch, "up" and "down" direction switches and an accelerating switch which brings the motor automatically up to full speed at a rate depending upon the load. A movement of the car-controlling switch toward the car-door opening energizes the magnet of the down-direction switch. This magnet closes the switch, which simultaneously lifts the brake shoes and connects the motor to the line so that it rotates in the proper direction to lower the car. Similarly, a movement of the car switch away from the door opening energizes the magnet of the up-direction switch. In the car a safety switch is provided which, when opened in case of emergency, interrupts the circuit of the potential-switch magnet, and this in turn interrupts the current to the direction switches and stops the car.

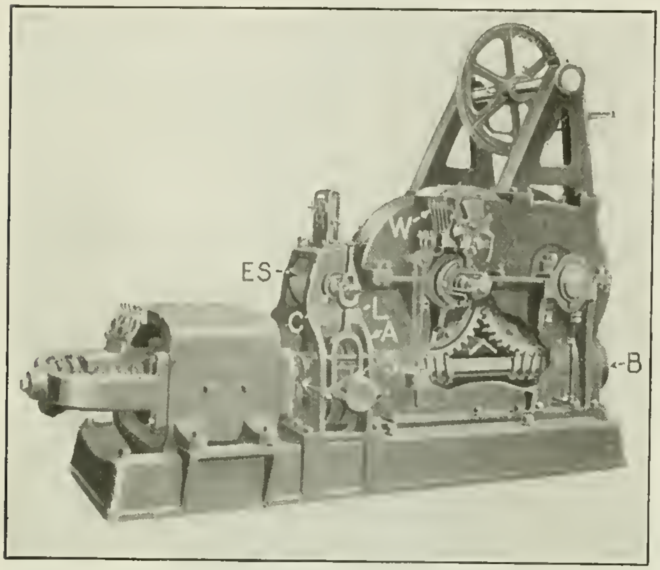


FIG. 3. DOUBLE-SCREW ELEVATOR MACHINE

Hoistway limit switches *V* are provided at the top and bottom of the hoistway. A cam mounted on the side of the car engages these limit switches after the car overruns the top- or bottom-terminal landing. This also causes the potential switch on the controller to open. A slack-rope switch is provided which opens the potential switch when the hoisting ropes become slack for any reason. In the case of an overhead machine this switch is mounted on the car crosshead and connected to the car ropes. For a machine in the basement or on the lower floor, the slack-rope switch is located on the bedplate under the hoisting drum. In either case, when the ropes become slack, as they would when the car safety operates or when the car runs down onto the bumpers in the pit, the amount of slack is prevented from increasing by stopping the motor. The slack must be removed and the ropes properly placed on the drum before the car is again started.

The hoisting machines are provided with an automatic switch *W*, shown in the figures on the right-hand side of each machine. This switch is adjustable and is set so that the car will run only a short distance past the top and bottom landings, if the elevator operator neglects to center the car-controlling switch. The automatic switch first causes the direction switch on the controller to open, corresponding to the direction of car travel, and the brake to set; a further movement of the car opens the hoistway limit switch *V*, and a still further movement causes the automatic switch *W* to open the main-line circuit to the motor.

It will be noticed that each machine has attached a sheave, *S* Fig. 1 and *X* Fig. 2, arranged to move along a shaft parallel with the drum. This sheave is known as an "attached vibrator," the sheave moving or vibrating back and forth along the shaft so as to maintain a proper lead on the ropes as they wind or unwind on the drum. Frequently, vibrator sheaves and shafts are detached from the machines and they are then termed "detached vibrators." In the case of a machine located in the basement or lower floors, as in Fig. 2, the attached vibrator is used for the drum-counterweight ropes and the vibrator sheave must move along the shaft as the ropes wind and unwind on the drum. For machines located overhead, as in Fig. 1, the attached vibrator is used for the car-counterweight ropes and does not move along the shaft although it is still called an "attached vibrator." Frequently two or three vibrator sheaves rotate on the same shaft, depending on the particular characteristics of the layout.

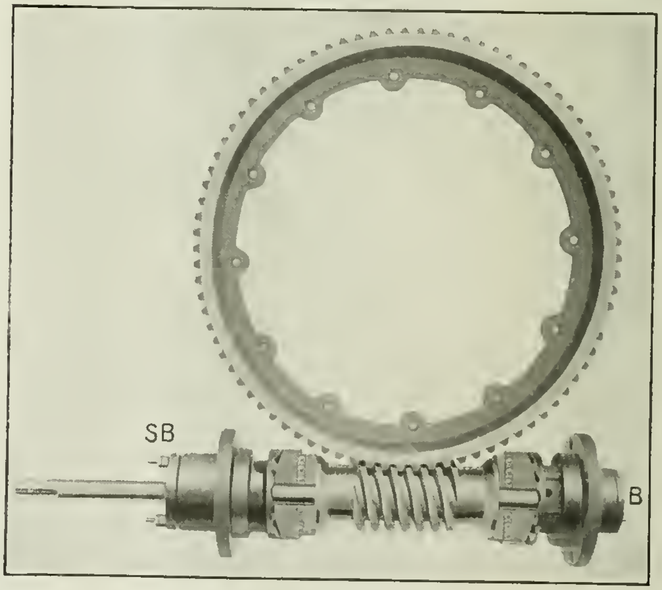


FIG. 4. SINGLE WORM AND GEAR, SHOWING BALL-THRUST BEARINGS

The sheaves shown overhead in Fig. 2 are termed the "overhead sheaves." Where there are two in the same horizontal plane for one set of ropes, as shown at *Z*, they are called "tandem sheaves." Sheaves *Z*, Fig. 2.

are used for the drum-counterweight ropes and sheave *Y* for the car-hoisting ropes.

The drum and worm-wheel spiders of the machine are keyed to the drum shaft. This shaft is provided with marine or collared bearings mounted in the outboard-end stand and in the wormwheel casing. This type of bearing is required so as to resist the side thrust of the wormwheel. The worm shaft is provided with an outboard bearing *B* in the gear case and passes through a stuffing-box *SB* on the inboard bearing of the case, Figs. 3 and 4. The motor shaft and worm shaft are connected with a coupling which is also used for the brake drum. The brake *A*, Fig. 3, is operated with an electric solenoid *ES* which, when energized, pulls the solenoid cores together. The cores *C* are attached to a link motion *L*, which lifts the brake shoes off the brake drum, the lifting being opposed by springs at *S*. When the circuit of the solenoid is open, these springs apply the shoes to the brake drum, and if properly adjusted, the car is smoothly brought to rest at all loads. This stopping distance is called the slide and varies with the car speed and load.

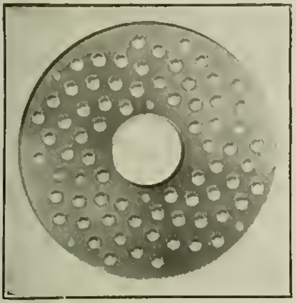


FIG. 5. THRUST-BEARING BALL PLATE

The outboard drum-bearing stand, gear case, brake stand and motor are all bolted to a cast-iron bedplate. This bedplate must be rigidly supported in place and the alignment of the motor shaft and worm shaft carefully checked after the load of the car and counterweight are on the drum before coupling them together.

Drum-winding machines are either of the single-screw type, shown in Figs. 1 and 2, or the double-screw type, as shown in Fig. 3. In the single-screw type, the thrust between the worm and wheel is taken on a ball thrust bearing. The details of the worm and wheel, thrust and worm shaft bearings are clearly shown in Fig. 4. Fig. 5 shows a thrust-bearing ball plate; note the spiral arrangement of the balls to evenly distribute the wear. In the double-screw type of machine, Fig. 3, no thrust bearings for the worm shaft are required as a right and a left worm on the same shaft as part of the same forging engage a right and a left wormwheel, which in turn are also cut to mesh together as spiral gears, thus giving a three-point drive. The outboard wormwheel is attached to the drum shaft. The worms may be single, double or triple threaded in either single- or double-screw machines, depending on the car speed desired.

Ventilated Side Walls

By William R. Caton

One source of annoyance to all stoker operators is the tendency of clinkers to stick to the side-walls, cutting down the available grate area and badly injuring the brick when cleaning fires. By the constant breaking away of brick that are melted into clinkers, the side-walls need frequent repairs. After a number of years of repairing brickwork in furnaces, Ernest Bernitz tried the method of ventilating the side- and bridge-walls shown in the accompanying illustrations.

Fig. 1 shows the furnace walls with Riley stoker. A hole five or six inches square is built in the wall below the grate and connecting air chamber under the grate with the 1½- or 2-in. pocket built in the side-wall. Above the grates for three, four or five courses, depending on what capacity boiler is to be worked, headers are laid without fireclay between side joints, which allows air from the air chamber to go to the side-wall pocket, then through the narrow apertures between the brick, keeping the brick cool and preventing clinker sticking to them. Fig. 2 shows the side-wall built with Taylor stokers. The brickwork or setting with Taylor stoker is similar to that with the Riley, but to connect it for ventilation necessitates cutting a V-shaped hole through the cast-iron wind-box under the tuyere irons.

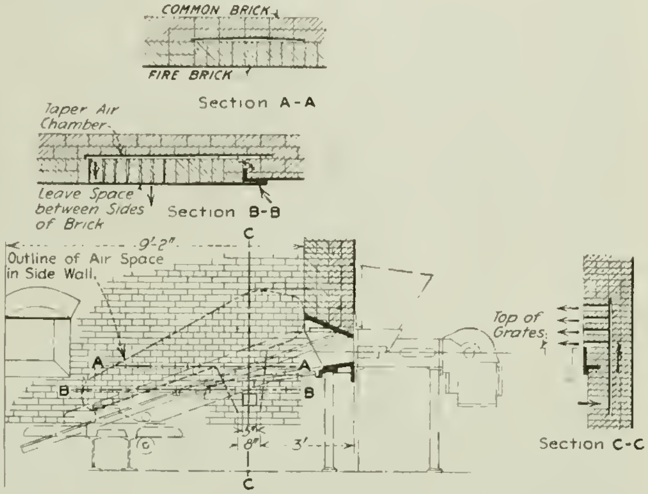


FIG. 1. SIDE-WALL AIR OPENINGS, RILEY STOKERS

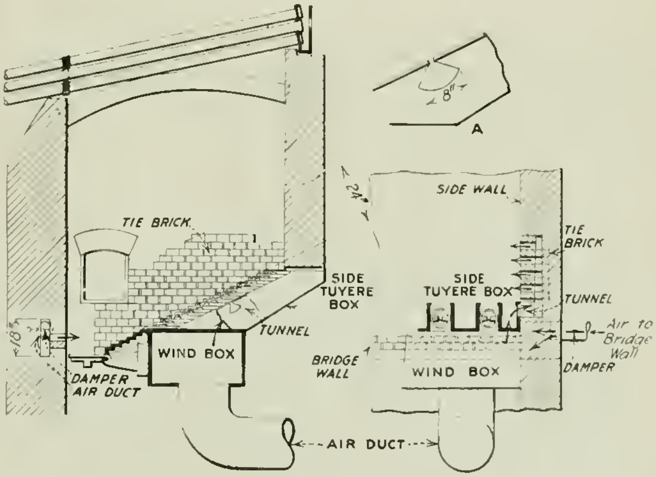


FIG. 2. SIDE-WALL AIR OPENINGS AS APPLIED TO TAYLOR STOKER

This scheme of ventilating was tried with hand fires and natural draft many years ago, but never proved successful enough to warrant a patent on it. With forced draft it is a success, either with stokers or hand fires.

Delivery of equipment these days is as slow as that lack of speed expressed by the English cabby to his American charge who protested at the cockney's delay. "'S all right; you kept us waitin' three years."

Camp Dix Military Cantonment

THE photographs reproduced show in a general way the progress made in preparation for the mobilization of the new American Army at Camp Dix during the period from July 17, when the picture at the top of the page was taken, to Oct. 13, when the one next below was taken. The artillery section may be seen in the distance in the upper left-hand corner of this picture. The picture at the bottom of the opposite page gives a better view of some of the officers' quarters and a part of one of the drill grounds.

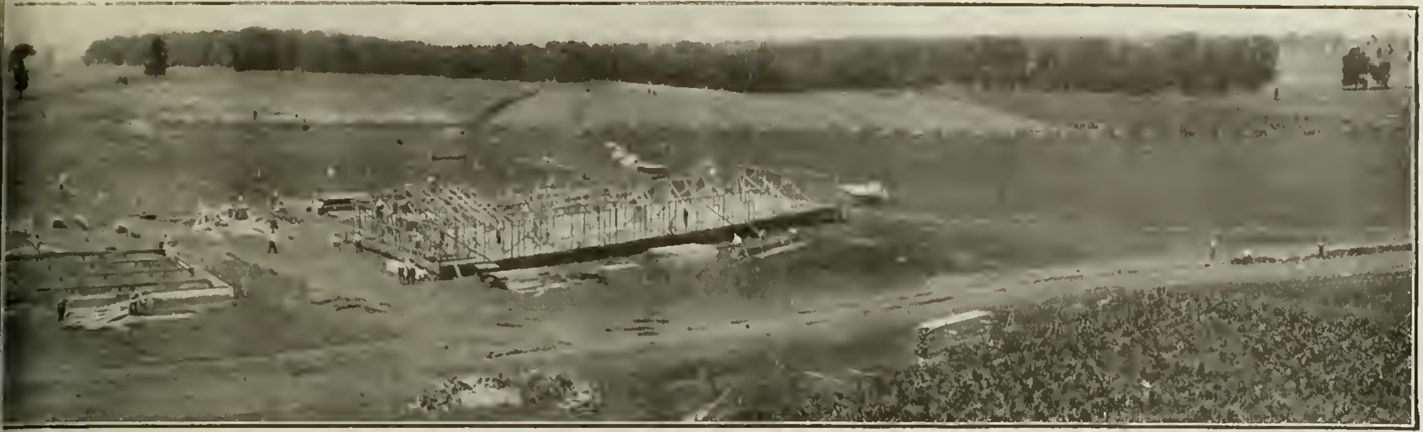
The building construction almost throughout is of the double-siding and double-floor type, with felt or tar paper between and tar-felt roofing, making at once inexpensive, easily built and warm buildings. Hand labor in all operations was reduced to a minimum. Semi-portable sawtables, driven by small gasoline engines mounted beneath, were much in evidence.

Road building constitutes an important element in all military operations and is one of the first engineering enterprises of any camp. Clamshell buckets were used for unloading road-making and like material from the railway cars wherever possible, and self-dumping motor trucks were used for distribution within the grounds.

The barracks generally are two-story frame buildings 43 ft. wide by 140 ft. long, with a one-story "cook shop" at one end, and each is designed as sleeping quarters and mess for about 175 men. They are heated by two large heaters on each floor. The officers' quarters are small one-story buildings, 20 ft. wide with an average length of 112 ft. divided into living quarters, offices and kitchen, so that heating by stoves is not practicable.

A small cast-iron sectional steam boiler is located in a pit at the rear of the building, and a loop of piping runs under the floor with short risers through the floor to the radiators—an arrangement at once as simple and "foolproof" as seems possible to design. The camp is provided with a complete system of roads, sewerage, water supply and fire protection, telephone communication and electric service. Standardization in design is thoroughly carried out.

The base hospital group of buildings is located at a considerable distance from the barracks. This is the only group supplied by a central heating plant. The boiler plant consists of a battery of eight boilers rated at 150 hp. each, seven of which are to operate at low pressure for heating direct and one at high pressure for the kitchen and other uses where a continuous high-pressure steam service is needed. Hot water is supplied through a 2½-in. flow and return line from a large storage tank containing a steam coil. The low-pressure boilers are fed by the "service main" pressure and the high-pressure by means of a feed pump. The boilers are hand-fired and each has an independent stack 33 in. diameter. The piping system is divided into two sections, but cross connections are provided at several points for use in case of emergency, expansion bends and loops are used on the 10- and 8-in. lines and slip expansion joints on all smaller sizes. The wards are piped independently with the "drainage slope" toward the extreme end where the condensate is discharged through a trap. The total radiation in the hospital group is upward of 90,000 sq.ft. The main distributing



Near Wrightstown, New Jersey

lines are of approximately the following size and lengths: 1150 ft. of 10-in., 1300 ft. 8-in., 1600 ft. 6-in., 1800 ft. 4-in. and 2200 ft. of 3-in. pipe.

The camp is supplied with ice from an electrically driven ice plant in a section of the grounds convenient to the railway, where meats and other perishable commissary supplies are received and distributed. By courtesy of Capt. H. A. Gilbert access to all proper data was given to a representative of *Power*. The photographs were supplied by W. N. Jennings, 1305 Arch St., Philadelphia, Penn., the official photographer for the contractors, Irwin & Leighton.

OFFICERS' QUARTERS AND PART OF ONE OF THE DRILL GROUNDS

Methods of Drying Out Flooded Power Plant Equipment

By NORMAN L. REA
Construction Engineer, General Electric Co.

Various schemes that may be employed for drying out electrical equipment after a power plant has been flooded are discussed. The advantages and disadvantages of the various methods are pointed out.

FLOODS are no respecters of power houses, and the majority of troublemen have to clean up the mess left by one of them sooner or later. Of course the old adage, "Many men of many minds," applies in this work as in everything else, and countless schemes have been tried with all degrees of success. In fact, some of the schemes have made matters worse instead of better. Possibly a brief outline of a few good ways and a caution regarding some of the bad ones may be of assistance to some brother in distress.

A power house after a flood is a sorry sight—oil and river silt smeared over everything and unlimited driftwood and sand everywhere. The first thing of course, is a thorough cleaning, and this should be started immediately and carried on while stock is being taken of the local facilities and a plan of campaign laid out. The machines should be thoroughly washed with water under pressure (a fire hose works very nicely), and all bright parts dried and oiled to prevent rusting. The bearings should also have immediate attention to prevent rusting. They should be thoroughly cleaned of all dirt and grit, dried and oiled before rust gets a foothold.

Run Machine To Assist in the Drying

Just as soon as the machines can be turned over, they should be brought up to speed and run without field as the windage will assist materially in the drying. The building should also be cleaned and heated to drive out the dampness. This heating will also assist considerably in drying the machines. Special care should be taken to ventilate the power station so that the damp warm air may be replaced by dry air.

In an alternating-current station the exciters should, of course, have the first attention, although the alternators should be run on windage while the exciters are drying. Small exciters have been dried out by windage and a plumber's furnace under the commutator. Care should be taken not to get the commutator too hot.

The machines may also be baked in a temporary oven or hot air blown through them. One must remember, however, that heat alone will not do the trick. The moisture must be removed, and nothing else will carry away moisture like hot, dry air.

In many cases machines have been surrounded with steam radiators and carefully covered with several thicknesses of tarpaulins. After several days of this "drying," those in charge of the job were greatly surprised to find the insulation resistance considerably lower than when the work was started. Steaming is all right for clams, but is poor treatment for water-soaked insulation. A little planning and a few bafflers will usually cause the hot air from the radiators to flow through the machine by its natural draft. Hot air may be forced through the machine by a blower when power is available. The foregoing methods are good when it is impossible to run the machines owing to lack of mechanical power, or in the case of synchronous motors. It is especially applicable to exciters. Of course the machine should be run if at all possible, and the heating arranged so that the natural windage will assist the hot-air circulation. The heat may be supplied by steam radiators, hot-air furnaces, stoves, electric heaters or lamp banks.

No two jobs are alike, and there is an excellent chance for a man to show his ingenuity and skill in the best use of local resources. An open flame should not be used. In one case where coke fires were used with a blower, the coke dust, ashes and fumes were blown into the windings. After several days' treatment, the windings showed a lower insulation resistance than when the drying was started. This was apparently due to the dust lodging in the windings, and the fumes may have caused copper corrosion.

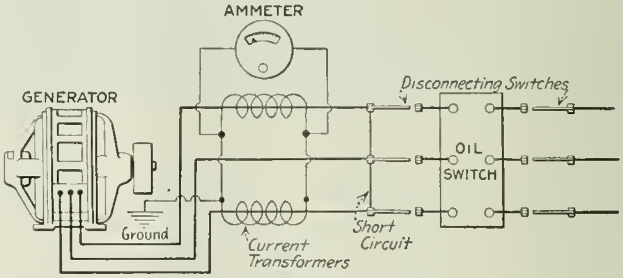


FIG. 1. CONNECTIONS FOR SHORT-CIRCUIT HEAT RUN ON ALTERNATING-CURRENT GENERATORS

The temperature of the hot air with any arrangement should not be higher than 100 deg. C., and 80 deg. C. is a safer temperature, because some insulating compounds change at fairly low temperatures. The fire risk must always be kept in mind and excessive temperatures avoided.

As soon as an exciter is dry enough or direct current is available from any source, all the alternating-current generators should be put on a short-circuit heat run. This is done by short-circuiting all phases through the proper size current transformers and ammeter, as shown in Fig. 1, and applying a weak field, which is increased slowly until the armature winding is carrying full-load current. Generators with an overload rating may be run with this overload current. However, many machines are now given a maximum rating, and any current in excess of this rating may damage the windings. The short-circuit of the generators should be made between the generator and the oil switch as in the figure, or the oil switch blocked in the closed position and the load handled by the field current exclusively, because opening the armature circuit during the short-circuit run is quite likely to puncture the wet insulation.

The short-circuit heat run should be continued until the insulation resistance reaches a proper value. This resistance will, of course, vary with the size of the machine, kind of insulation, voltage, etc. In general the insulation resistance indicates little more than the condition of the insulation as regards moisture. The rate of change of the resistance as the heat run progresses is, perhaps, the best indication as to when the drying has been carried far enough. The drier the insulation becomes the slower the insulation resistance will increase. Judgment must be used in deciding when it is safe to stop the short-circuit run.

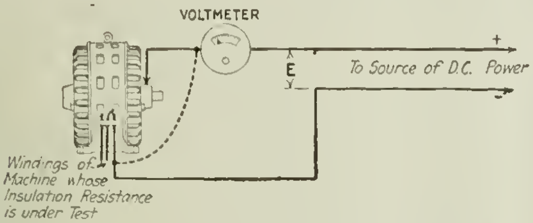


FIG. 2. INSULATION-TEST CONNECTIONS

In many cases a Wheatstone bridge or megger is not available for measuring the insulation resistance. The following method will give results accurate enough for general use: Connect one side of a direct-current circuit to the windings to be tested, connect the other side of this circuit to a portable voltmeter, and then read the voltage when the free side of the voltmeter is connected to the circuit where it is attached to the windings, as indicated by the dotted line, Fig. 2. Call this reading E. Then connect the free side of the voltmeter to to the frame of the machine, as shown in full lines in the figure, being careful to get a good contact, and call this reading E_1. Then the insulation resistance $R = \frac{R_1(E - E_1)}{E_1}$, where R equals the insulation resistance and R_1 the resistance of the voltmeter; the latter value is usually given inside the meter cover.

Before using any commercial circuit for insulation testing, voltmeter tests must be made to determine if the circuit is grounded. One side of the circuit must be free from grounds, and the ungrounded side used in series with the voltmeter when testing. Failure to test for grounds has led to short-circuits and personal injuries.

After the short-circuit test is ended, the machines should be brought up to normal voltage slowly and should be inspected very carefully while the voltage is building up. Incipient breakdowns can usually be seen, heard or smelled and the field circuit opened before the windings or punchings are materially damaged. One man should stand by the field switch to open it instantly on signal from the men watching the machines.

The machine should be run several hours at normal voltage or 10 per cent. above normal to heat the iron thoroughly before going into regular service. It is advisable to continue the drying of very large generators 24 hours longer as follows: Two hours at full-load current on short-circuit, then two hours 10 per cent. above normal voltage open-circuit. These alternating runs heat both the iron and the windings thoroughly and drive out any remaining moisture.

There is always a tendency to hurry the machines into service, and great pressure is usually brought to bear on the man in charge of the drying. It is imperative to "make haste slowly," as a day or two longer drying is a lot better than a burned-out machine with the consequent delay and expense.

Large direct-current machines that have been submerged usually give the most trouble in the commutator, especially if the machines are flooded when hot. Apparently the sudden cooling causes a partial vacuum under the commutator bars and some water is drawn into this space. The heating of the commutator causes expansion which traps this water. Consequently, the machine responds very slowly to direct heat on the commutator or short-circuit heat runs, unless some exit is provided for the moisture. The following scheme has produced excellent results on several occasions.

Every other bolt is removed from the outside clamping flange of the commutator. Then some small bent funnels were made, shaped like a ship's ventilator hood, as shown in Fig. 3 at *A*. One of these air scoops was fastened in every other hole and faced in the direction of rotation as in the figure. The ventilating funnels were made up by a local tinsmith and twisted into the holes, after which no trouble was experienced by their coming out. Of course all of them were used on fairly slow-speed machines, and as the funnels were down near the shaft, they did not move very fast. The machine must be run at reduced speed, to prevent injury to the commutator. The scoops force air through the space under the commutator bars and out the other holes, materially hastening the drying. In some cases one can actually see the vapor coming from the open holes.

There are several ways of heating direct-current machines. The various methods of drying with hot air, previously outlined, can, of course, be applied when the machine cannot be run or there is no outside power available. The simplest, when the machine can be run and direct current is available, is a short-circuited heat run. The series field should be reversed to buck the shunt coils and the armature short-circuited through an ammeter and a circuit-breaker or fuse.

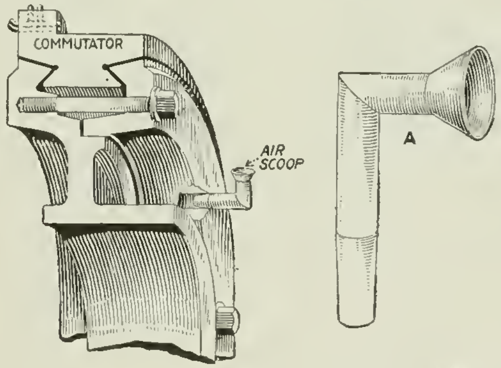


FIG. 3. AIR SCOOPS FOR VENTILATING COMMUTATOR

Then a very small current is sent through the shunt field and gradually increased until full-load current flows through the short-circuit. Extreme care must be used in first throwing on the short-circuit, for unless the series-field windings are bucking the shunt, the machine will pick up as a series generator on short-circuit, with surprising and sometimes disastrous results. Unless the circuit-breaker can be set very low, it is advisable to connect a small fuse in the circuit for the first trial.

In some cases the brushes may need shifting forward from the regular running positions so that the resulting sparking will increase the heating of the commutator.

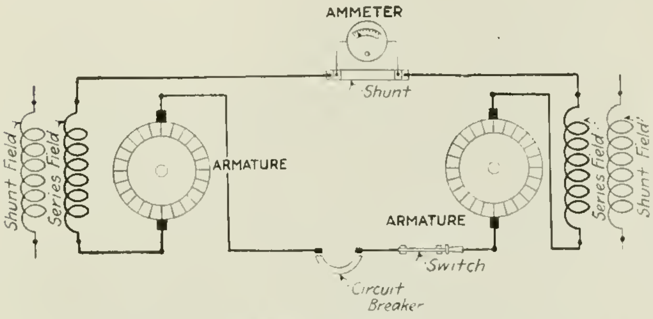


FIG. 4. CONNECTIONS FOR HEAT RUN ON TWO COMPOUND-WOUND DIRECT-CURRENT GENERATORS

This should not be carried far enough to spoil the commutator's surface and make turning or grinding necessary.

Where no exciting current was available on a job involving two large engine-driven machines—after considerable study the following scheme was used with excellent results: The series field of one machine was bucked so that it opposed the tendency to pick up as a series generator, then the two machines were connected in series through an ammeter shunt and circuit-breaker. Both machines were equipped with air scoops on the commutator end flange. The machine with the bucked field was brought up to half-speed. Then the other machine was turned over slowly and the speed gradually increased until full-load current was flowing through the combination. This required about 20 per cent. of normal speed for the generator. Fig. 4 shows the scheme of connections used. Both shunt-field windings were left open, as there was no way of exciting them.

Sometimes the commutator heating can be materially assisted by one or two plumber's furnaces turned low and placed with their tops a foot or two below the commutator. Care should be taken not to heat the commutator too quickly or too hot. Most commutators are pressed on an extension of the armature spider hub, and the pressing fit allowance is usually small. Too rapid heating may, therefore, expand the commutator enough to loosen it on the shaft. In fact, this was first discovered by a commutator starting to walk off its seat. Fortunately, this was noticed before any damage resulted, and the heat run was discontinued while it was jacked back to its proper place. The windings should not be heated over 100 deg. C., although the commutator will safely stand temperatures above 100 deg. C. "It is better, however, to be safe than sorry," therefore, use 80 deg. C. as a maximum on the windings and 100 deg. on the commutator. These values are actual temperatures and not a rise above the room temperature.

The drying should be continued until the insulation resistance reaches a safe value and the machine then brought up to normal voltage very slowly. The remarks under alternating-current generator drying apply equally well to direct-current machines, except that it is unnecessary to alternate the open and short-circuit runs.

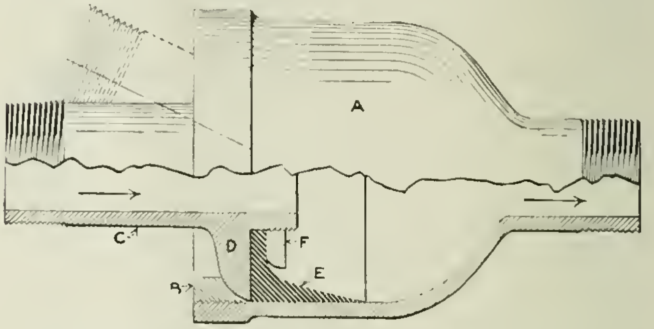
The insulation resistance is usually considerably lower than the alternators, but the drying takes about the same length of time, especially if water gets into the commutator.

Berry Flexible Joint

Various arrangements are used in pipe-line construction to provide for expansion and contraction and to release the pipes from strain, jarring and vibration. Expansion bends, swing joints, unions and sundry types of flexible joints are used for this purpose. Included in the line of flexible connections is the new Berry flexible joint, manufactured by the Iron Clad Joint Co., 400 Godchaux Building, New Orleans, La. It is arranged for use with steam, air or water, and is illustrated herewith.

This is not a metal-ball joint, but it has the action of one, and it is designed to take care of vibration, expansion and contraction. It is so flexible that it can be swung automatically in any direction and always leave a full and unobstructed area to the flow of liquid or gas.

The device consists of six parts, as shown. The shell, or bell end, *A* is threaded on the inside for a bearing ring. The pipe *C*, forming the other pipe connection, is made with a flange *D* with a machined curved surface on the side that has a bearing with the ring *B*. The flange is made flat on the opposite side, so that the cup-shaped flexible member *E* has a flat surface against which it is firmly pressed by the ring *F* when screwed up on the thread on the inner end of the connection *C*.



SEMI-SECTIONAL VIEW OF THE FLEXIBLE JOINT

With the pressure entering the joint in the direction of the arrows, the flexible member *E* is forced out against the inside surface of the body *A*, making a steam-tight joint regardless of the angle in which the connection *C* may be.

The Salt Lake *Tribune* recently published the following:

> Consent was voted yesterday morning by the City Commission for the Utah Power and Light Co. to drain condensed water from its heating system into the sewer. It was explained to the commission that distilled water that returns from the steam pipes is injurious to the boilers if returned to them because of its activity as a solvent.

Nothing like reading the newspapers for getting valuable engineering information—some engineers don't know about this.—*W. E. Jacob.*

Relief for New England Coal Situation

By CHARLES H. BROMLEY

Governor McCall of Massachusetts, together with Fuel Administrator Storrow and other governors and senators from New England, visit Washington to force relief for coal situation. Railroads and trolley-car service reduced to avoid immediate depletion of supply. Navy responsible for serious withdrawal of large-towing capacity. New England short nearly 8,000,000 tons of bituminous coal on January First.

NEW England's coal situation was never more acute. And there is the devil to pay about it, as Washington learned last week. Fuel Administrator Storrow and Governor McCall of Massachusetts, accompanied by other governors and senators from New England, visited the capital to force immediate action to relieve the grave fuel condition of the six Northeastern States. The outlook therefore is brighter, though it should be understood by fuel users that a shortage of the most severe kind cannot now be avoided; nevertheless it will be of shorter duration than it would have been but for the impressive visit of the New England delegation to Mr. Garfield at Washington. Governor McCall was not sparing in his condemnation of those responsible for New England's plight. The Navy Department particularly was censured by the Governor for its too wholesale commandeering of ocean tugs, leaving a shortage of power craft to tow loaded coal barges from Hampton Roads to New England ports. This is what the Governor had to say: "The Secretary of the Navy is said to have proudly declared before a committee of Congress the other day that we have a thousand ships in the Navy; but if those ships, according to tonnage, could begin to inflict the damage on the Germans that the withdrawal of coal tugs, according to their tonnage, has inflicted on the northeastern part of our own country, it is doubtful if the Germans would last a week."

One effect of the Governor's visit will, it is promised, be the stopping of cross-hauling; that is, no coal trains shall pass each other running in opposite directions. The Chesapeake & Ohio R.R. is to haul coal from the mines to Hampton Roads for New England delivery.

It is charged that while coal shortage is due to rail-transportation difficulties chiefly, the roads would have three-thousand locomotives for coal hauling if the locomotive shops had not been commandeered for the building of locomotives for Russia and France.

Capt. Arthur Crowley, who is the marine representative of the New England Fuel Administration, is confident of improvement in towing capacity for barges to New England ports. The Navy took one-fourth of the towing capacity of the Reading road used in the New England trade, and the ten tugs taken from the towing service between Hampton Roads and New England have left a shortage of such capacity amounting to many hundreds of thousands of tons per year. Much of this will likely be restored as the result of the efforts of Fuel Administrator Storrow.

There is serious congestion at Hampton Roads. The Boston Elevated Railroad Co.'s chartered steamer "Everett" has been, at this writing, riding at anchor for eight days awaiting opportunity to load, which she can do in eight hours. Her capacity is 7200 tons. To facilitate coal leaving Hampton Roads, ships may now pass in and out of the harbor at any time, day or night. The Boston & Maine R.R., according to President Hustis, requires 5000 tons of coal per day for its locomotives; but for the last thirty days only 2000 tons per day was received. The Boston Elevated system and the Bay State railways also must greatly decrease service to make the coal supply go far enough to meet the urgent transportation demands. Service on many of the suburban lines will be stopped except for a few hours morning and evening. The illustration shows the coal storage plant of the Boston Elevated Railway Co.'s South Boston station.

Though Thursday and Sunday nights are the "lightless" ones in Boston, there is a very noticeable absence of non-essential illumination every night of the week. Boston certainly responds much better to the pleas of the Fuel Administrator than does New York and Chicago, particularly.

The following data, chiefly from the office of the New England Fuel Administrator, show the coal situation as it is:

RECEIPTS OF BITUMINOUS COAL FIRST TEN MONTHS, 1917

	Net Tons
All rail (for commercial and railroad use)	9,267,925
Tidewater (for commercial and railroad use)	11,376,519
Total	20,644,444
Requirements for 1917	32,574.902
If receipts for remainder of the year continued at same rate as given above for first ten months, the total receipts for New England for year 1918 will be	24,773,332
On Jan. 1, 1918, the New England shortage of bituminous will thus be.	7,801,570

NEW ENGLAND RECEIPTS OF BITUMINOUS COAL, NET TONS, FOR THE FIRST TEN MONTHS, 1917

Company Coal:		
First 10 months actual, three big roads	3,168,124	
First 10 months actual, Central Vermont	5,629	
First 10 months actual, Rutland	60,447	
Total company	3,234,200	3,234,200
Commercial coal:		
First 10 months actual, three big roads	6,011,748	
First 10 months actual, Central Vermont	54,715	
First 10 months actual, Rutland	203,262	
Total commercial	6,269,725	6,269,725
Total company and commercial		9,503,925
Less exports to Canada (Sept. and Oct. est.)		236,000
Net total		9,267,925
Tidewater receipts 10 months		11,376,519
Grand total, 10 months		20,644,444
Requirements for 1917 as previously estimated		32,574,902
If receipts for last two months should equal 1/5 of first 10 months they would equal	4,128,888	
Plus 10 months' receipts	20,644.444	
Total	24,773,332	24,773,332
Shortage Jan. 1, 1918, would thus be.		7,801,570

NEW ENGLAND BITUMINOUS COAL CONSUMPTION IN 1916, NET TONS*

Tidewater coal	15,665,499
All-rail coal	10,230,253
	25,895,752
Depletion of reserves	1,250,000
	27,145,752

* These tidewater figures were obtained from statistics gathered with great care at each New England port by the Boston Chamber of Commerce. The all-rail figures were reported directly to the New England Coal Committee by the New England railroads. The coal used by the New England railroads was 5,916,789, and is included in all-rail and tidewater figures.

REQUIREMENTS FOR 1917

Consumption, 1916	27,145,752	
Add 20 per cent	5,429,150	
		32,574,902

Twenty per cent. increase for 1917 over 1916 is probably low for soft coal, as the New England industries are working this year under the most intensive pressure ever known and probably to a greater extent than any other section of the country, except perhaps the steel-making districts.

New England normally carries two-thirds of its soft coal by water and one-third by rail. Owing to war conditions many of the New England coal-carrying bottoms have gone off the coast and these cannot be replaced. The already overloaded railroads of New England cannot assume added burdens. Indeed, owing to lack of motive power the capacity of these railroads will soon be cut down at least 25 per cent. by winter storms and cold weather. The capacity of the coal-carrying fleet will likewise be cut down at least 25 per cent. by winter weather. New England's coal problem is quite as much one of transportation as of securing the coal. If New England goes into January 7,500,000 tons of coal short, as the figures given indicate, this not only cannot possibly be made up, but will inevitably rapidly grow worse owing to lack of transportation facilities.

The following is from the report of the Federal Trade Commission, June 20, 1917, Senate Document No. 50: "The situation in New England is made acute because of the disruption and disorganization of barge transportation. The cost of the water haul from New York to Boston has been increased from 50c. a ton to as high as $3 a ton. From Newport News bituminous coal is paying $3.50 to $4 per net ton instead of the normal of 70 to 90c. to New England."

NEW ENGLAND A SPOT SOFT-COAL MARKET

By long custom of the trade, New England has been preëminently a spot-coal market. The mines have been glad to sell their coal for cash to New England consumers during the summer months while other localities were less ready to buy. New England manufacturers and householders have learned the necessity of accumulating a supply of coal during the summer months owing to the inability of the rail- and water-transportation facilities to carry coal as fast as it must be burned during the winter months. Owing to its greater distance from the mines, New England is considered a less desirable market, and at times consumers have been obliged, in order to divert coal in their direction, to bid higher prices than other localities.

The situation in New England in regard to spot coal became acute as soon as the $3 tentative maximum price was put into effect by the Coal Production Committee, because consumers were prevented from bidding higher than other localities for the coal they needed, and the mines and originating railroads at the same price preferred to improve their inadequate car supply by selling coal nearer the mines and so getting their cars back sooner.

Now that the $2 price has gone into effect, the situation has grown, if possible, worse. A very large number of the New England manufacturers who are depending upon buying spot coal for their own use have been completely shut off. Most of the coal is going to fill contracts at higher prices, and if there is any balance of free coal it is being sold nearer the mines and New England today cannot buy a car of spot coal. This is the situation that needs immediate attention.

SHORTAGE OF ANTHRACITE COAL

On the first of May shipments of anthracite were 300,000 tons short of a year ago. By the first of July shipments had increased so that the total for the six months was nearly equal to a year ago. This had not wholly relieved the situation because no coal was provided for the normal growth of 5 or 6 per cent., and moreover, the percentage of domestic or household sizes had dropped substantially so that household coal was shorter than the gross figures would indicate; but during July and August shipments of anthracite continued to show gains over last year.

It does not appear that the anthracite situation in New England needs immediate attention, or at least that it is as grave as the soft-coal situation. Anthracite shipments to New England for the first ten months of 1917 were 10,227,010 tons; for the first ten months of 1916, 9,220,760 tons.

The industrial centers of New England are being assisted in fuel conservation as related to boiler rooms, by inspectors from the offices of the fuel administrations and by the coöperation of the local associations and sections of the engineering societies. These representatives are versed in firing methods and go into the boiler rooms to assist, if possible, in teaching firemen how to get the most out of the coal.

The President has now taken over the railroads and the steamship lines operated by the roads. The Fuel Administrator seriously contemplates "complete control of coal if the war lasts for a long while." The pity is that men in such high office do not see that it will. Likely Dr. Garfield will assume complete control, and along lines suggested in *Power* for Dec. 18, 1917, page 832, sooner than he at this writing seems to contemplate. With the roads now fully under Government control and with the more complete supervision of the coal industry by the Fuel Administrator, New England should get relief as soon as it is physically possible to do so; that is, there do not now exist any real reasons for Government failure—except the uncertain link, labor, which everyone hopes, will hold.

NEW ENGLAND HURT BY LONG HAULS

It seems certain that before relief can come to many producers of steam and power now crying for coal, the Fuel Administration must abrogate all contracts now existing between dealers, consumers and coal-mine operators. The present panicky situation is conducive to hoarding, and operators will not, of course, put out any free coal while there is opportunity for it to bring higher than Government prescribed prices. The New England Fuel Administrator truly tells how price fixing by the Government has operated to the serious disadvantage of the Northeastern States. New England, by reason of its geographical position, necessitates comparatively longer hauls at a time of extreme car shortage, which has made coal operators reluctant to accept New England's trade. But these are propitious times, and therefore this disadvantageous period is likely to be of short duration. Its very severity compels immediate alleviation to the limit of physical possibilities.

With industries vital to the war subject to interruptions on account of lack of fuel, with the railroads compelled to withdraw train after train from service for the same cause, with scores of ships, ships so very vital to the success of our arms and those of our Allies, detained for days at their ports because of empty bunkers, to say nothing of domestic suffering, who now dares to belittle the fuel shortage as did the exploiters such a short time ago who at the time knew full well the gravity of the impending crisis?

The severe effect of car shortage on loss of coal output at the mines is shown by the Geological Survey report for Dec. 29, from which the following table, condensed, is taken:

	Week Ended	Percentage of Full-Time Output Lost On Account of Car Shortage
Illinois	Dec. 8	9.1
	Dec. 15	17.0
Indiana	Dec. 8	5.4
	Dec. 15	18.4
Ohio	Dec. 8	31.7
	Dec. 15	57.1
Pennsylvania:		
Western Pennsylvania	Dec. 8	12.6
	Dec. 15	33.6
Irwin Gas	Dec. 8	14.3
	Dec. 15	28.3
Central Pennsylvania	Dec. 8	14.1
	Dec. 15	28.3
Somerset Co	Dec. 8	36.2
	Dec. 15	52.5
West Virginia:		
Winding Gulf	Dec. 8	25.8
	Dec. 15	41.9
Panhandle	Dec. 8	20.0
	Dec. 15	24.2
Pocahontas and New River	Dec. 8	34.0
	Dec. 15	46.4
High Volatile of S. W. Va	Dec. 8	56.9
	Dec. 15	59.9
Junior—Philippi	Dec. 8	35.6
	Dec. 15	35.7
Fairmont	Dec. 8	31.6
	Dec. 15	40.8
Cumberland—Piedmont	Dec. 8	13.7
	Dec. 15	34.9
Kentucky:		
Hazard Field	Dec. 8	35.4
	Dec. 15	65.5
Northeastern Kentucky	Dec. 8	38.4
	Dec. 15	60.9
Western Kentucky	Dec. 8	31.4
	Dec. 15	40.2
Southern Appalachian	Dec. 8	12.0
	Dec. 15	18.8
Southwestern Virginia	Dec. 8	3.0
	Dec. 15	8.2

Notice that Ohio lost 57 per cent. of its full-time output due to car shortage; Somerset County, Penn., 52.5 per cent.; Western Pennsylvania, 33 per cent.; the important fields of West Virginia 42, 24, 46, 60, 35 and 40 per cent., respectively, while the Cumberland and Kentucky fields suffered similarly.

—By Morris, in the New York "Evening Mail"

TAKING OUT THE CLINKERS

Determining Boiler Efficiency by Co₂ Analyses and Flue Temperatures

By HAYLETT O'NEILL

The author gives several charts with the aid of which the boiler efficiency may be closely approximated when the CO_2 and flue temperatures are known. The purpose of the article is to enable the engineer to obtain valuable operating data for practical use by means of simple and cheap instruments.

TO INVESTIGATE the cost of its product, a certain power company spends thousands of dollars a year experimenting in boiler-furnace operation. Some tests cost over a hundred dollars each. The resulting profits are manyfold to a large company because the expense of experimenting is shared by a hundred large units, and the gross returns are multiplied accordingly. But the average industrial plant cannot afford special coal and water scales, special measuring instruments and piping and the technical help for complete plant tests. The large power producers must do most of the pioneer work in boiler-plant design and operation. Easy experimental methods would undoubtedly lead to radical developments in industrial power-plant methods.

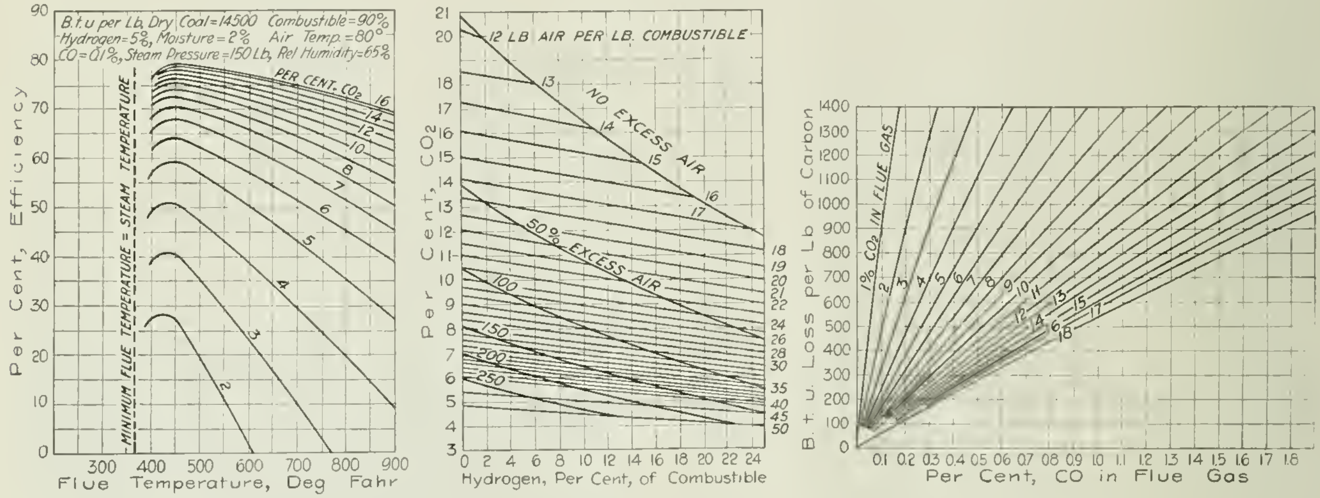


FIG. 1 FIG. 2 FIG. 3

FIGS. 1 TO 3. CHARTS SHOWING VARIOUS LOSSES IN STEAM-BOILER FURNACES

Fig. 1—Combined boiler efficiency indicated by CO_2 and flue temperature. Fig. 2—Effect of excess air on CO_2 in gas varying amounts of hydrogen in fuel. Fig. 3—Furnace loss on account of incomplete combustion of carbon

The object of this writing is to point out the significance of a simple and cheap method for determining evaporative boiler efficiency. This method is to measure the average temperature of the flue gas where the gas leaves the boiler-heating surface, to analyze for CO_2 content an average sample of flue gas from the same source, and to apply these two determinations to the efficiency chart, Fig. 1. Thus, flue-gas temperature and CO_2 percentage are assumed to be the only variable factors of boiler efficiency. This is computed by dividing the difference between the heating value of the coal and the calculated losses by the heating value of the coal.

In calculating the total losses, certain operating conditions and accompanying losses actually variable, are assumed constant and there is necessarily an error in the computed efficiency. However, where Eastern coals are burned, such error is usually less than 2.5 per cent., sufficiently precise for comparative results. It is well to note conditions under which such assumed losses may vary. For example, the refuse loss here is assumed constant, while it actually varies according to the coal and the design and the operation of the grates. The radiation loss is assumed equal to 4 per cent. of the boiler output at builder's rating. In very large units, the loss is probably nearer 2 per cent. A boiler in a cold climate, other things being equal, cannot be so commercially efficient as one surrounded by air averaging 90 deg. But the error from the foregoing assumption will, upon close analyses of the charts, be negligible compared to the losses accurately measured by the flue-gas temperature and the percentage of CO_2.

Heat losses may be divided into two classes: Those measured by CO_2 and flue temperature, and those measured by flue temperature only.

Loss in Dry Flue Gas—By itself, the percentage of CO_2 does not even measure boiler efficiency. In simple language it indicates the weight ratio of air to fuel when the proximate analysis of the coal is known. A CO_2 content in flue gas, formed from pure carbon burned in air, indicates one proportion of air to fuel, the same percentage CO_2 from the combustion of natural gas or soft coal indicates another. This difference is due largely to the varied proportions of hydrogen in the fuel hydrocarbons or the volatile combustible matter. Thus 8 per cent. CO_2 from a natural-gas burner may mean just as good an air ratio as 12 per cent from a soft-coal furnace. Hydrogen burns to water vapor, condenses in the gas-analyzing apparatus and thus the percentage of nitrogen and gases insoluble in the Orsat chemicals is increased. The greater the percentage of hydrogen the less will be the possible CO_2 percentage. Fig. 2 indicates a possibility of 20.9 per cent. CO_2 from the burning of pure carbon and an impossibility of greater than 18.5 to 19 per cent. CO_2 for soft coal containing 4 or 5 per cent. hydrogen.

In hand firing, where heaps of green coal are generally quickly thrown upon the grates, volatile matter therein is distilled and burned first in greater proportions than the fixed carbon. Low CO_2 at first results, incorrectly indicating an excessive air supply. After most of the volatile matter is distilled, the higher CO_2 follows, indicating a lower than actual air ratio. A stoker feeding coal at a uniform rate produces CO_2 more nearly indicative of the actual air mixture.

In any event, snap analyses of flue gas are worthless as clues to the problem of producing the lower fuel cost per unit of manufactured product. A recording analyzer helps in the study of transient furnace conditions, but records of individual analyses are open, in some degree, to the foregoing objection. Then too, the boiler must be large to acquire a profit from an instrument costing $250 to $300.

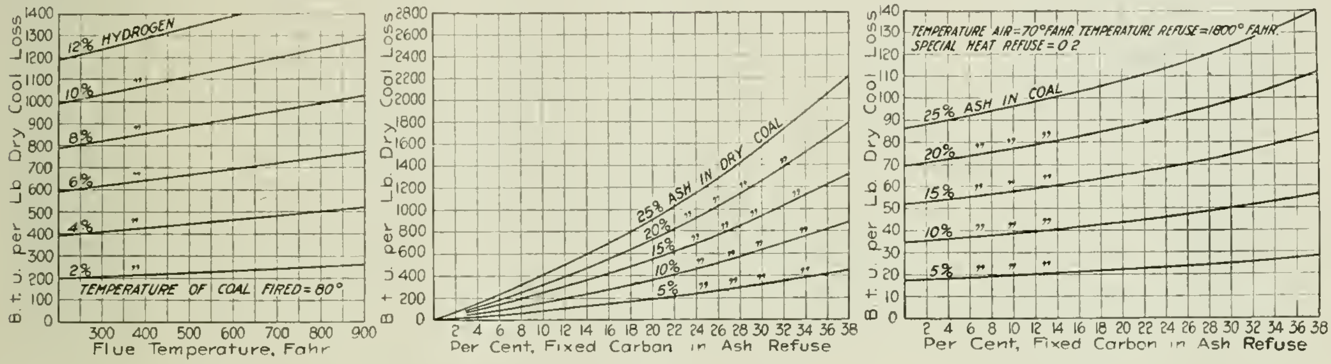


FIG. 4 FIG. 5 FIG. 6

FIGS. 4 TO 6. CHARTS SHOWING VARIOUS LOSSES IN STEAM-BOILER FURNACES

Fig. 4—Loss on account of hydrogen in coal. Fig. 5—Heat loss to ashpit from unburned carbon. Fig. 6—Sensible heat loss to ashpit

A plain Orsat CO_2 analysis of an average tank sample of gas collected over a given period shows all the flue gas analytical data of interest to the average plant superintendent. A sampling tank costs about one-tenth the price of a recorder.

The heat loss in dry gas at flue temperature is calculated as follows:

$$\textit{Heat Loss (B.t.u. per lb. of dry coal)} = WS(Tf - Ta)$$

where

W = Pounds of flue gas per pound of coal determined from proximate analysis of coal and Fig. 1;

S = Specific heat of flue gas, assumed constant for all temperatures;

Ta = Temperature of the air assumed at 80 deg. F.;

Tf = Temperature of flue gas.

Loss Indicated by Presence of CO in Flue Gas—Carbon monoxide (CO) is a result of the incomplete combustion of carbon and oxygen, and while the loss from it is not strictly measured by the percentage of CO_2, it is affected thereby. For example, from Fig. 3, 0.1 per cent. CO shows a loss of 320 heat units per pound of carbon when the flue gas is 3 per cent. CO_2, but a loss of only 70 units when the CO_2 is 14 per cent.; that is, the less the excess air the less the proportionate loss from incomplete combustion of coal. CO indicates a shortage of air required for complete combustion either locally or generally, and usually results from too heavy a fire for a given draft, stratification of gas on account of an uneven fire, or from the passage of hot CO_2 over soot-laden tubes where it combines with enough carbon to form CO. Thus, CO_2 plus CO = 2CO. Most furnaces get too much air rather than too little, and generally CO is absent. In the calculated efficiency chart, CO is assumed at 0.1 per cent.

Loss on Account of Moisture in the Air Supplied for Combustion—All air contains moisture indicated in definite proportions by the wet- and dry-bulb temperatures as illustrated in Fig. 4. These temperatures, together with the percentage of CO_2, measure the ratio of moisture in air per pound of fuel. The loss from superheating this moisture to flue temperature is usually inconsiderable. In the efficiency chart it is calculated at about 12 B.t.u. per pound of coal burned.

Loss on Account of Refuse—Soft-coal refuse usually contains both volatile and fixed carbon; but generally the volatile is negligible. Fig. 5 shows the loss from unburned combustible calculated on the fixed-carbon basis. This loss depends not only upon the percentage of combustible in the refuse, but also upon the percentage of ash in the coal. The poorer the coal with respect to ash the higher will be the refuse loss. The quality of the coal and the design and operation of the furnace are factors in boiler efficiency. The loss due to sensible heat of the refuse shown in Fig. 6 is small.

Loss on Account of Moisture in the Fuel—Moisture fed to the furnace with the coal, evaporated and superheated to the flue temperature, carries heat up the chimney. Ordinarily, as shown in Fig. 7, this is a minute loss.

Loss on Account of Hydrogen in the Fuel—When 1 lb. of hydrogen is burned, 9 lb. of water vapor is formed. Consequently, when a pound of coal containing 5 per cent. hydrogen is burned, 0.45 lb. water vapor is formed and this as superheated steam carries about 550 heat units to the chimney. It will appear from Fig. 7 that this loss, in the case of fuel oils and natural gas high in hydrogen, may be very high.

Since the bomb calorimeter, measuring the heat value of coal, is jacketed by cold water, to absorb the latent heat in the water vapor burned hydrogen, the coal is credited with the 550 heat units which must be lost in the flue. That is, water vapor under atmospheric pressure will not condense at temperatures above 212 deg. F.; and since the flue temperature is always higher than this, the latent heat in the flue-gas vapor cannot be reclaimed to produce steam.

TABLE I TEST ON SPECIAL 2365-HP. STIRLING BOILER AT DELRAY STATION, DETROIT, MICH., BY D. S. JACOBS, 1910, JOURNAL A.S.M.E.

Flue Temperature, Deg. F. Observed	CO_2 per Cent. Observed	Efficiency by Regular Method	Efficiency by Chart	Efficiency per Cent Error of Chart
480	14 33	79 88	79 0	—0 88
483	14 40	81 15	79 0	—2 15
576	11 95	77 84	74 0	—3 84
670	14 74	75 78	75 0	—0 78
636	14 69	76 73	75 5	—1 23
487	11 86	77 90	75 5	—2 45
493	13 69	80 29	77 5	—2 78
575	14 00	77 07	76 0	—1 07
647	14 20	76 42	75 0	—1 42
651	15 45	75 84	75 5	—0 34

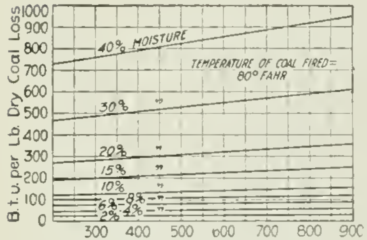


FIG. 7

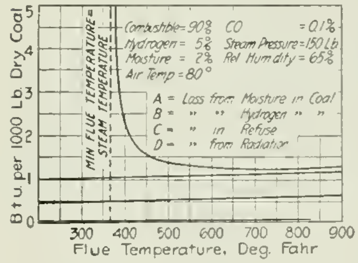


FIG. 8

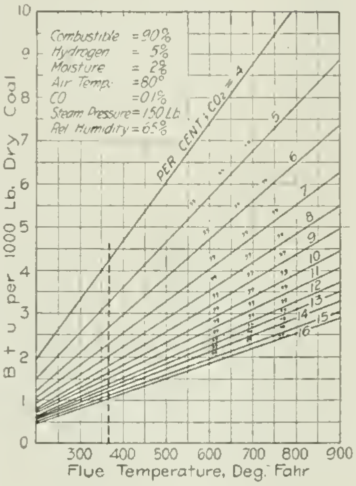


FIG. 9

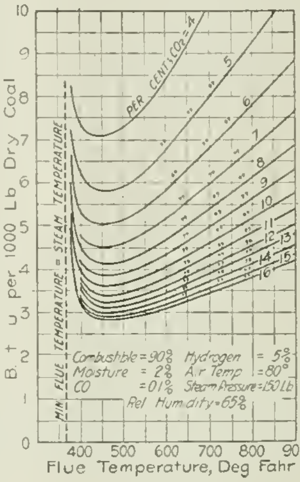


FIG 10

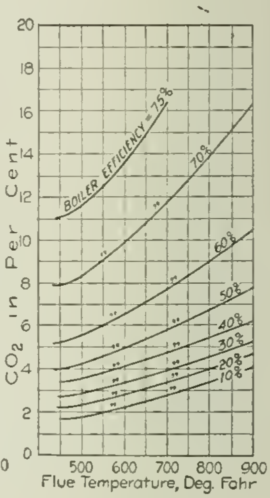


FIG. 11

FIGS. 7 TO 11. CHARTS SHOWING VARIOUS LOSSES IN STEAM-BOILER FURNACES

Fig. 7—Heat loss due to moisture in coal. Fig. 8—Furnace losses measured by flue temperatures independent of CO_2. Fig. 9—Furnace losses measured by CO_2 and flue temperature. Fig 10—Furnace losses measured by flue temperature, with and independent of CO_2. Fig. 11—Relation between CO_2 and flue temperatures for constant boiler efficiency.

Loss on Account of Boiler Radiation—Depending upon the design of the setting, the radiation loss is about 4 per cent. of the rated boiler output. That is, from a 500-hp. boiler, the radiation loss is about $0.04 \times 500 \times 33{,}479 = 669{,}580$ B.t.u. per hour. The loss per unit of output will vary inversely as the output; that is, it may be infinity at zero output, and it approaches zero as the output indefinitely increases. The maximum flue-gas temperature at zero is that of boiler water. Its rise above boiler-water temperature varies almost directly with the load. Consequently, the radiation loss per unit of output and per pound of coal fired varies inversely as the rise in flue temperature above the steam temperature. This is illustrated by the hyperbolic curve of radiation loss per pound of fuel in Fig. 8.

Total Heat Losses—The general conditions assumed constant to calculate the efficiency and heat-loss curves are as follows: Combustible in coal, 90 per cent.; hydrogen in coal, 5 per cent.; moisture in coal, 2 per cent.; air temperature, 80° F.; CO, 0.1 per cent.; steam pressure, 150 lb. gage; relative humidity, 65 per cent.; combustible in refuse, 20 per cent. With these assumptions Figs. 8 and 9 respectively show heat losses measured by CO_2 percentage and flue-gas temperature and those measured only by flue-gas temperature. The combined losses are shown in Fig. 10.

Except for the radiation losses, the total heat losses are accurately determined and the error in radiation loss is practically negligible at flue temperatures above 475 deg. F. Little interest is attached to points of lower temperatures.

It appears that for any percentage of CO_2 there is a certain flue temperature at which the total heat losses per pound of fuel is a minimum, and this is the point of maximum efficiency.

To compute the efficiencies in Fig. 12, 200 B.t.u. were added to the losses to account for undetermined losses. Tables I and II illustrate the close practical accuracy of the curves.

More clearly in Fig. 11 are shown the relative values of CO_2 percentage and flue temperatures in the determination of boiler efficiency. Suppose a boiler at 70 per cent. efficiency shows 10 per cent. CO_2 and 610 deg. F. flue temperature. Let the air leakage of the boiler setting be eliminated and the firing be improved so that the CO_2 is raised to 12 per cent., but at the same time let the baffles deteriorate and allow the soot to build

TABLE II. TEST ON 650-H P. BABCOCK & WILCOX BOILER AT WATERSIDE STATION, NEW YORK CITY, BY THE NEW YORK EDISON CO., 1911

Flue Temperature, Deg. F. Observed	CO_2 per Cent. Observed	Efficiency by Regular method	Efficiency by Chart	Efficiency per Cent. Error of Chart
523	12 4	74 3	75 4	+1 1
533	11 7	75 9	74 7	—1 2
541	11 4	75 2	74 1	—1 1
497	13 7	75 5	77 2	+1 7
505	11 8	77 0	75 4	—1 6
509	11 1	76 5	74 6	—1 9
491	11 2	75 1	74 8	—0 3
512	12 2	76 9	75 5	—1 4
574	11 2	73 9	72 8	—1 1
571	16 5	73.2	77 5	+4 3
665				
695				
505	10 5	75 1	73 8	—1 3
595	14 3	73 4	76 0	+2 6
555	13 0	76 8	75 4	—1 4
571	11 9	74 5	73 8	—0 7
507	13.4	80.1	76 8	—3 3

on the tubes until the flue temperature rises to 710 deg. F. Then the efficiency will still be about 70 per cent., and all the good operating work will be nullified by the slovenly maintenance. It is a great thing to key up the firemen, but it is just as important to key up the repair gang and have proper machinery. Notwithstanding the vast amount of literature showing the value of flue-gas analysis in boiler operation, good soot blowers and a good repair boss are the most certain elements in producing boiler-room results with given apparatus.

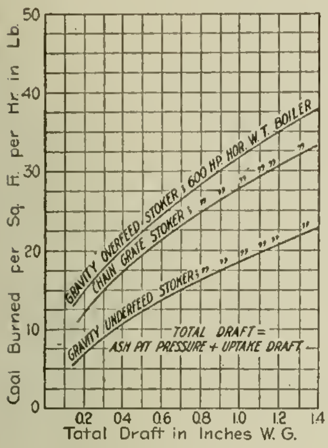


FIG. 12. EASTERN SOFT COAL COMBUSTION RATES ON DIFFERENT STOKERS

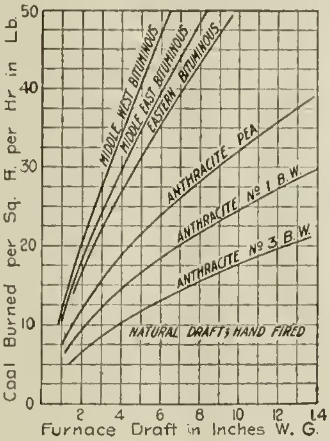


FIG. 13. COMBUSTION RATES WITH NATURAL DRAFT, HAND FIRING

A draft gage used in connection with Figs. 12 and 13 shows data necessary to determine approximately the rate of combustion, and from this and the efficiency determination the boiler output may be closely estimated.

Thus, valuable boiler-operating data can be obtained for practical use, through simple and cheap instruments, and except where extreme accuracy is essential, elaborate boiler tests are neither necessary nor advisable.

Some Pipe-Threading Hints

Did you ever hear of W. J. Willis? Probably not, because he was only an engineer in a small New England manufacturing city and the worst that could be said about him was that his wife never knew when to have his evening meal prepared, because she never knew when he would be home to eat it.

The real trouble was that Willis liked to talk shop, and he probably knew more engineers in the town than there were dead cats to the credit of his pet bulldog, which was going some. Because of his wide acquaintance it was as difficult for him to pass an engine room without stopping as it would be for a fully developed souse to pass a barroom without wanting a drink.

One evening on his way home he stepped into the engine room of a small plant, where he found young Stetson busily engaged in cutting threads on a length of pipe.

"Caught you right in the act, didn't I?" was Willis' greeting. "What are you doing? Making a lot of poor threads on that pipe end?"

"Yep," answered young Stetson, "but I guess they will answer so long as I can get the joint tight when it's made up. The threads are pretty ragged, but I'll put a lot of dope on them when they are screwed into the fitting."

"You have the same false notion that so many engineers and some pipefitters have; that is, that any kind of a thread will answer so long as it can be made tight at the first go-off. You ought to know, and you probably do know, that there is a standard thread embracing pitch, depth and length of cut, when it comes to cutting a thread, and at a steam plant almost any departure from the standard can be expected. Some of the threads are cut small and do not fit in the fittings, some are stripped and others do not have the proper taper. Often it will be found that purchased pipes have threaded ends that do not conform to the standard."

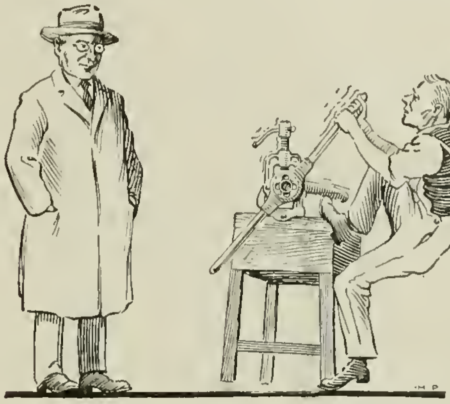


FIG. 1. "WHAT ARE YOU DOING? MAKING A LOT OF POOR THREADS?"

"Well, what's the odds so long as a fellow can make a tight joint? Let the other fellow worry after the job is up."

"Young feller," replied Willis, as he examined the stripped threads Stetson had just cut, "when making a pipe connection that is to be under steam pressure, one should remember that with the failure of such a joint there is the possibility of injuring or killing one or more workmen. There is no excuse for making a faulty joint as one can easily determine when screwing up the joint whether it is going together properly or not. Now there ain't any sense in making up a joint with the threads stripped like these are." See Fig. 2.

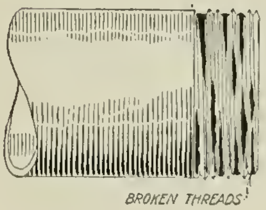


FIG. 2. STRIPPED THREADS

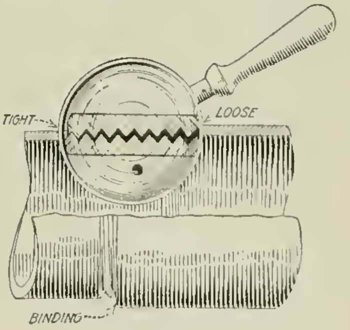


FIG. 3. A POOR PIPE JOINT

"Say, Willis, what makes these threads strip so? Of course, I don't pretend to know much about pipe work, and if you can give me a pointer it will be all to the good, and perhaps it will save a little extra work on my part; this die does go hard."

"The reason your threads are stripped in the cutting is because you did not use enough oil on the dies, or because the die is so dull it wouldn't cut musty cheese. Under such conditions when you begin to cut a thread, the chips pack in the die and the threads are stripped just as you have them here. A little care on your part will prevent that kind of work.

"Now just you take this hint, Stetson. After you have the die started, don't think that the diestock has got to be revolved like a windmill. Instead of making a complete turn and bracing your foot against the bench in order to turn the die as you were doing when I came in, just try turning it a partial revolution, then back the die off and go ahead again, using plenty of lard oil. If you will try that way of cutting a thread, you won't have any trouble even with a dull die. Oil and backing the die are what count. Furthermore, don't be afraid of making the threaded end of the pipe long enough to screw well into the fitting."

"What's the difference?" asked Stetson, as he carelessly wiped his hands on a dirty piece of waste. "What's the difference so long as you get enough threads in the fitting to hold? Cutting threads is no cinch."

"For one thing, cutting a short thread is inexcusable and represents carelessness on your part, a trait that is dangerous for anyone to develop, especially an engineer. For another thing, it is almost criminal to make up a joint with but two or three threads engaging in the fittings. You can't make a joint that is to withstand steam pressure any too strong for safety, and there is the danger of a faulty joint pulling apart."

"Gee! I hadn't thought of that. One thing you said when you first came in I can't quite get through my noodle. How are you going to get a pipe thread so small that it won't fit tightly in a fitting?"

"That is the easiest thing in the world with certain kinds of thread dies. With the solid dies there is not the danger of making small threaded ends, but with the adjustable type of dies they can be so set that the pipe end is cut small, although the threads may appear to be perfect. Such a thread will not fit snugly in the fitting, and the joint is made tight only by screwing the pipe into it so far that the butt end of the thread is forced in against the outer end of the fitting." See Fig. 3.

"Such a joint, although it may hold for a time, will eventually begin to leak. This action is hastened where water is used that is of a character to rapidly corrode wrought iron or steel piping, because it has a chance to get in between the threads and act upon them. As the pipe is comparatively thin at the bottom of the threads, it does not take long for the metal to waste to a thin skin. Of course, the corroding action will be slower when the pipe carries steam, but the pipe joint will fail much sooner than if it were properly made.

"Now take my advice, cut the end off that piece of pipe and then use plenty of lard oil; and don't neglect to back off that die in making a new thread. While you are doing that, I'll toddle along home where I belong."

In cutting pipe it frequently happens that the cutters depress the pipe, reduce the area and leave ragged edges on which foreign substances gather. Do not use a nipple or piece of pipe without looking through it for blisters and obstructions, as this may save trouble later.

Turbine Speed Decreased

By E. C. Parham

A characteristic feature of all automatic governing devices is that a change must take place in the quantity governed before the governor can act to check the change and restore the governed quantity approximately to its original value. If speed is the quantity that is being governed, the speed actually must change a little in order to start the governor on its cycle of constant-speed maintenance. The governing device that most promptly responds to slight variations and prevents them from becoming heavy variations, either temporary or permanent, is the device to be desired.

The connections were checked, and found to be all right, of two 50-kw. 250-volt compound-wound direct-current generators, driven directly from two water-wheels, preparatory to paralleling them for the first time. The machines were brought up to speed and voltage, and as a final check on the polarities, the switch and breaker of one machine and the breaker of the other machine were closed, then the voltages above and below and across the remaining switch were measured with a voltmeter. As the voltages above and below the switch were equal and the voltage across the switch was zero, the proper condition for paralleling was insured. A moderate load then was put on one machine and the switch of the other machine closed, thereby placing the machines in parallel. They divided the load fairly well at first, but there soon appeared a tendency of first one machine and then the other to take most of the load. Speed variations of the turbines was evident, and on throwing on a much heavier load, the speeds dropped way down and the governors tripped out the turbines.

Investigation disclosed that the oil system of the governors was full of bits of thin paper that clogged the governor parts so that they could not function properly. Before satisfactory operation could be secured, the whole oil-piping system had to be disconnected and cleared of the paper that came from no one knew where.

Some Tall Chimneys

What is claimed to be the tallest chimney in the world, at Sagonoseki, Japan, is made of concrete and is 570 ft. tall and is on a hill 430 ft. high. It is 26¼ ft. inside diameter at the top and 42 ft. at the base. The foundation is 95 ft. in diameter and contains 2700 cu.yd. of concrete. For 150 ft. the chimney is reinforced by a concrete lining, separated from the outer concrete shell by a 5-ft. air space. In the construction of the chimney 400 tons of steel was used. The one next highest is in Montana, 506 ft. Others are as follows: At Port Dundee, Scotland, 488 ft.; Townsend, Glasgow, Scotland, 454 ft.; Freiburg, Saxony, 453 ft., on hill 259 ft.; Mechernich Lead Mining Co., 440½ ft.; Tennant & Co., Glasgow, Scotland, 434 ft.; Crossley's, Halifax, England, 381 ft.; Metropolitan Street Ry. Co., New York City, 353 ft.; Omaha & Grand Smelting Works, Denver, Colo., 350 ft.; Fall River Iron Co., 350 ft. The American Smelting and Refining Co. is constructing a chimney at Tacoma, Wash., that will be 420 ft. high.

Editorials

Exhaust Steam Waste

CONSERVATION, the keynote these days, looms up morning, noon and night. It is conserve this, that and the other thing, all of which is the proper procedure in every field of labor and endeavor. No doubt about it.

This war will do for the American people what nothing else would have accomplished, and that is, they will be brought to the realization that they can easily do without many things that have been deemed actual necessities. It will also bring out the fact that they have left undone many things that they could have done and that they have allowed waste to go on unchecked just because no one took the initiative.

For weeks past the newspapers have published articles dealing with the coal shortage and the necessity of saving fuel. Other items have urged the immediate development of water power, to be under Government control, in order to reduce consumption of coal for industrial and commercial purposes. Although more coal was mined in 1917 than in 1916, there is not enough to meet the demand, because of car shortage and other reasons. To overcome this shortage, manufacturers and householders have been and are being urged to economize in fuel in every way.

Has it ever occurred to the Fuel Conservation Commission that the coal consumption of the country could be cut down thousands of tons each year by simply employing a little engineering ability, whereby the steam-plant owner and the householder could be of mutual benefit to one another, and at the same time make a saving in fuel that would be astonishing?

About eighty per cent. of the heat value in every pound of coal consumed in a power-boiler furnace is allowed to go to waste through the engine exhaust to the atmosphere. In all cities there are hundreds of these exhaust pipes discharging to the air, after passing through a steam engine, steam which could be used to advantage in the adjoining buildings that are equipped only with a heating boiler. It would require but slight pipe extensions in most cases to connect these hundreds and thousands of noncondensing engines to the heating systems of adjoining properties, thus supplying their heat requirements with steam that is now going to waste. This would enable thousands of heating boilers to be shut down, and the coal that they burned would be saved and could be delivered to such plants as are in urgent need of it for power purposes.

This journal has and does favor what is termed the isolated-block central station for just the very reasons that now confront this country as a whole—the cheaper production of power, light and heat. This idea has been developed to a limited extent in the larger cities, but not by any means on such an extended line as conditions warrant and the present time demands.

In support of this contention there are steam plants that generate steam for no other purpose than to supply heat to properties not as a byproduct, but as a commercial business pure and simple. With the outlay for underground piping and upkeep there is a good profit in carrying on the business, notwithstanding the fact that the demand for steam heat during the summer months is practically cut out, the requirement being mostly for units using steam for power purposes only. We have in mind one large central station in which the reciprocating and turbine units were operated noncondensing and exhaust steam sold to customers who did away with or had not put in heating boilers.

These instances go to emphasize the fact that exhaust steam is valuable as a heating medium, and there is no dodging the fact that the lack of action to prevent the continued waste of steam is responsible for the unnecessary burning of thousands of tons of coal.

Not only would there be a saving of fuel by the steam consumer and producer getting together on the heating question, but both could make money by so doing. The steam producer would by such an arrangement get his power for practically nothing, and the consumer would obtain his heat cheaper than he could produce it himself. More than that, there would be men released from these isolated heating plants who are needed in other channels of labor.

Why not work along more practical lines, and if there are any regulations that stand in the way of utilizing waste steam, as should be done, the Government surely has the power, as a war measure, to set these regulations aside for the common good of all.

What Do I Get Out of My Society?

THIS is a question which is often asked, especially by the isolated member. He sees others rise to positions of preferment and distinction in the society and the vocation or profession which it serves and is prone to conclude that he is contributing to the emolument of a few, favored by location or influence.

It may seem to be an irritant to his discontent to tell him that the most valuable privilege that his membership in a vocational or professional society offers him is an opportunity to give, but it is a thought the consideration of which may lead to a solution of his dissatisfaction.

Such a society is, in effect, a massing of the means and endeavors of its members for the uplift of the group, for the doing of those things which can better be done collectively than individually. If the society is truly representative, if it includes the best and accepts only reputable and recognized practitioners, his acceptance into it is in itself a mark of standing and of recognition not without value. The greater the society becomes in influence, in achievement, in usefulness to the members and service to the public, in the professional and general estimation, the greater the value of his membership in it from this point of view; and it is as much his duty and privilege to aid in making it great as it is that of any other member. If everybody's interest and effort ended with the payment of his dues, the society would die from inertia.

But to the man whose professional interest is not bounded by his individual practice, membership in a live society offers the avenue for participation in the wider activities and identification with the achievements of the profession; and he will find that the dividends that he receives upon his membership will increase in proportion with his own share in the common effort. Attendance at the meetings, joining in the discussions, by correspondence if presence is impossible, the presentation of papers, correspondence with their authors, exchange of views and information with fellow-members, willingness to do committee work, activity in enlisting desirable new members will lead to an extension of one's acquaintanceship, to a recognition of his attainments, to a knowledge of his specialties, and to a standing in the society and profession commensurate with his true worth. A society that is seeking to do things is always scanning its membership list for those who can be made use of in accomplishing its purposes; and those who come forward, not in a spirit of self-seeking but of sincere interest, and take an intelligent part in the work are the ones to whom the opportunities come for greater usefulness and through it to preference and emolument.

Determination of Boiler Efficiency by CO_2 Analyses and Flue Temperatures

ELSEWHERE in this issue appears an article showing many curves, by the aid of which the boiler efficiency may be closely approximated without the use of the usual large number of instruments and without lengthy calculations. The method is to measure the average temperature of the flue gas where the gas leaves the boiler-heating surface, to analyze for CO_2 content an average sample of gas from the same source, and apply these two determinations to a chart. The flue-gas temperature and the CO_2 percentage are assumed to be the only two variable factors of boiler efficiency.

Mr. O'Neill, the author of the article, is well known to the readers of *Power*. It is hoped that the curves presented by him will be of especial value at this time, when fuel economy in the boiler room is so important to the national welfare.

The New Military Cantonments

THE magnitude of the task of building and equipping sixteen cities, each to house from thirty-five to forty-five thousand men, is not fully realized by many, and the panoramic views on another page cannot even show the entire extent of one of them, but are intended to give a general idea of the appearance of an army cantonment. Criticism of the speed and execution of the work seems entirely out of place when one of the finished cities is viewed. One camp, for example, has about eighteen hundred Government buildings, which required for their construction some fifty million feet of lumber. The military reservation is nineteen thousand acres in extent, with ten miles of crushed-stone road, thirty miles of earth road and ten miles of railroad, thirty-five miles of water mains and thirty miles of sewerage system discharging two miles from camp. Material was unloaded at the rate of one carload every six minutes, day and night, for several weeks. At one time the contractors had a force of over fourteen thousand men employed, and the weekly payroll was approximately four hundred and fifty thousand dollars.

In view of the staggering undertaking of converting a peace-loving country and people into a huge military camp and machine, the showing made in the short period of time is truly marvelous and utterly discredits the rabid croakers whose chief business seems to be giving comfort to the enemy by charging inefficiency and lack of speed in the execution of the work. The only error appears to have been in the estimated time of completion. In other words, the work has been done as rapidly as was humanly possible, all things considered; therefore there can be no criticism of efficiency in doing, but simply that insufficient allowance was made in the estimate for inevitable delays and shortage of man-power, which could not possibly have been estimated with any degree of accuracy.

It takes a pound of coal to keep about twenty-five of the small ten-watt lamps that are used in electric-sign work running for an hour. It would run only ten of the ordinary twenty-five-watt tungstens, or seven of the forty-watt lights often used in residences. Of the best of the sixteen-candle carbon lamps it would supply only about five. The two hundred to seven hundred and fifty-watt incandescent street lamps take from eight-tenths to three pounds of coal per hour each. Count up the lamps that you see burning needlessly in lighting up streets before sunset, in running Great White Ways, in decorating store windows, or carelessly left burning in your own home, and see if a substantial saving could not be made by suppression and repression, which would cause no suffering and little, if any, inconvenience.

"The doors of the Edison Company in Detroit are wide open to anybody coming with a legitimate inquiry. Come and see us. We will tell you all we know and show you anything we have," said President Dow, of the Detroit Edison Company, to the Electro-Chemical Society at its recent meeting. This is the spirit that has wiped plagues from the earth, educated the lowly, built the United States and which gets the world nearer that material and spiritual ideal that big men know must come.

Savings-bank deposits pay four per cent. interest or less and are subject to taxation. Banks sometimes suspend payment and fail. War Savings Certificates pay four per cent. and are not subject to United States, state or local taxation, netting therefore more than the usual savings-bank interest. They are the safest investment in the world and the best paying for anything like the same degree of security. Subscribe today.

The Alcohol Fuel Committee of Australia, St. James Street, London, Eng., is looking for a good motor that will use that combustible. Got one? And this follows on the heels of the Prohibition movement!

Correspondence

Saving Coal in the Home

The editorial appearing in the Jan. 1 issue of *Power* is of interest to every reader, not because he uses coal in one way or another in producing power, but because it applies to the management of his home furnace. The idea expressed is commendable, but many of us would like to know how the one shovelful is to be saved each day with the grade of coal that is being sold at a higher price than one could buy good coal for one or two years ago.

Take my own case, for instance. Before the heating season began, the steam-heating boiler in my house was thoroughly cleaned, all leaks were stopped up, and everything was put in first-class order for heating the lower floors and the bathroom on the second floor of the house. Excepting in very cold weather, one radiator and a kitchen hot-water tank, the water in which is heated by running a circulating pipe through the boiler furnace, will comfortably heat four downstairs rooms.

There is no use in carrying a fire so low that steam will not be generated; if so, the fire is practically banked and the fuel is being burned without heating the house. Therefore it is necessary to carry a fuel bed thick enough to maintain a steam pressure, and with automatically controlled dampers the steam pressure is kept practically constant. Coal is put on the fire morning and night and at no other time, excepting in very cold weather.

Shaking down is stopped as soon as a spark of live coal drops into the ashpit, so very little coal gets into the ashes. However, it is taking more coal to heat the house this winter than it has before, and there is a reason. Judging from the coal that I have been able to get, the slate pickers at the mines have either struck, gone to war or are asleep on the job. Nobody but a blind man would allow the amount of slate to get by that I have bought, unless it was purposely done. More than that, the coal contains an excessive amount of ash, which, together with its slate content, reduces its heating value to a low standard.

If manufacturing and power plants are getting as low a grade of coal at a price equal to or higher than they have been paying, and if it contains an increase of ash and slate over former coals in proporton to the increased refuse in the coal I am burning in my house boiler, it is no wonder that there is a shortage of cars for its transportation from the mines. In my own case it will probably require between one and two tons more coal to heat the house this year than it has previously, and if this holds good in every case, of house heating, then there will be required (using the figures in the editorial) between 15,000,000 and 30,000,000 tons more of coal to do the same heating of homes than it did in former years with good coal.

I wonder if it is not a fact that the mine operators are mining coal this year that they could not find a market for in other years when there was not such a lack of transportation and a demand for coal of any kind. There is not much economy in any direction in transporting coal to market containing from 30 to 40 per cent. ash when the same cars could be used to carry coal low in ash, not any harder to mine and costing the same to buy as the trash that is now being sold as coal.

F. G. HIGGINS.

New York City.

Meeting the Emergency

I have read with interest the article by E. W. Miller on page 764 of the Dec. 4 issue, entitled "Meeting the Emergency," and give herewith my experiences while in central-station work, where the planning in detail what to do in case of an emergency came in good service.

The station is of about 45,000-kw. capacity and supplied all of the electrical power in one of the large cities in the East. As is usual, three classes of service were carried: The alternating-current incandescent and power circuits, direct-current incandescent and power circuits through motor-generator sets, and the city street-arc lighting.

Some time ago one of my articles was published (page 739, Nov. 19, 1912), outlining in detail a method of cleaning vertical turbine blades of boiler scale by pumping kerosene oil into the throttle while the machine was being run noncondensing. In order to save this oil instead of letting it go to waste through the hotwell, the exhaust was turned into an old feed-water heater to try to recover the oil. On the first trial this worked all right, the turbine being washed for about an hour and a quarter, using nearly seven barrels of kerosene. The machine had been shut down, when there was an explosion in the feed-water heater, due no doubt to the ignition of kerosene from spontaneous combustion, the force blowing one of the cast-iron heads off. In flying across the room, this hit the gravity lubricating-oil feed from the storage tanks, on the third floor, to the accumulator pumps. This line was located in the boiler-feed room under the boilers. The oil thus liberated spurted up under the 30- or 40-lb. pressure to the under side of the mechanical stokers, igniting and starting a blaze that soon got beyond control and drove the stoker attendants—in fact, all the help—from the boiler rooms.

The engine room was separated from the boiler rooms by a fire-wall, and at the time of the explosion we were operating a machine in the middle of the engine room. I was on the switchboard in charge of the load and was notified by the floor engineers at 4:20 a.m. that the engine room was on fire and it would be necessary to change the load from No. 3 turbine to No. 1 engine, as No. 3 was dangerously close to the seat of the fire, and a reciprocating engine would have to be put on the line because the accumulator was rapidly going to the length of its stroke and there was danger of burning the step of the turbine. The reciprocating alternator was immediately brought up to speed, thrown on the line and a load of about 5000 kw. transferred to the reciprocating engine at 4:46.

In the meantime two of our substations which carried auxiliary steam units had been notified to bring their machines to full speed and be prepared to take the maximum load that their units could carry. By this time the oil supply had been entirely lost and we were operating the reciprocating units simply with splash oil, endeavoring to keep them cool with increased water circulation on the bearing jackets.

We immediately split up the remaining load, cutting over all the direct-current district onto one of the substations, thus reducing the load on the main station. This was accomplished without a hitch at 4:50. At 5:17 a.m. the engineer on the floor notified me that the reciprocating alternator must come off the line as the oil on the governor had been lost and the bearings were heating up. This necessitated cutting out all the street-lighting load and transferring the remaining alternating-current incandescent load to another substation. The reciprocating alternator was pulled off the line immediately, thus shutting down the station.

In the meantime the engine room had become so clouded with smoke that all the oilers and engine tenders were compelled to go outside the building. The switchboard-operating room was inclosed in a glass cage, which proved to be smoke-proof, and I with my assistant was able to stick on the job, we having ready a rope as a means of sliding down to the street level from the window should the operating room become untenable.

At 5:28 all the load had been safely transferred, with the exception of the street arc lighting, to the substation, and things were running along smoothly. By 6 o'clock the direct-current load began to pick up and the current began to rise to a dangerous point on our machine, which we took care of by raising the voltage four volts on the substation steam sets, thus reducing the current, and in this way we were able to carry the entire direct-current load without interruption.

When the alternating-current load began to pick up, it was simply a question of dumping one circuit after another, thus keeping down the load to a safe limit, we having arranged, months before, just which circuits were to be pulled first should such an emergency arise.

In the meantime a fire alarm had been sounded and the engines from the city fire department responding had been able to finally extinguish a rather stubborn blaze, which lasted until about 8:30. The oil lost was replaced by an emergency call sent to a large local oil retailer, who loaded up several thousand gallons of engine and cylinder oils and sent them around on trucks. These were pumped off into the storage tanks, and at 8:55 the reciprocating alternator had been put on the line, and all the load was back on the station in normal running condition at 9:33, just five hours and 13 minutes from the time the alarm of fire was first given.

An idea of the intensity of the heat can be gained from the condition of the concrete floor slab of the boiler room directly over the spot where the fire occurred. This was warped up and cracked to such an extent that it was unsafe to walk across it until sufficient reinforcing planks had been laid to insure absolute safety.

Altogether there was a loss of 5000 gal. of lubricating oil, both cylinder and engine, besides a temporary shutdown on part of the system of five hours or less.

Needless to say, the practice of recovering kerosene by this method was abandoned from that time on, as we preferred to let it go to waste rather than run the chance of a second similar experience.

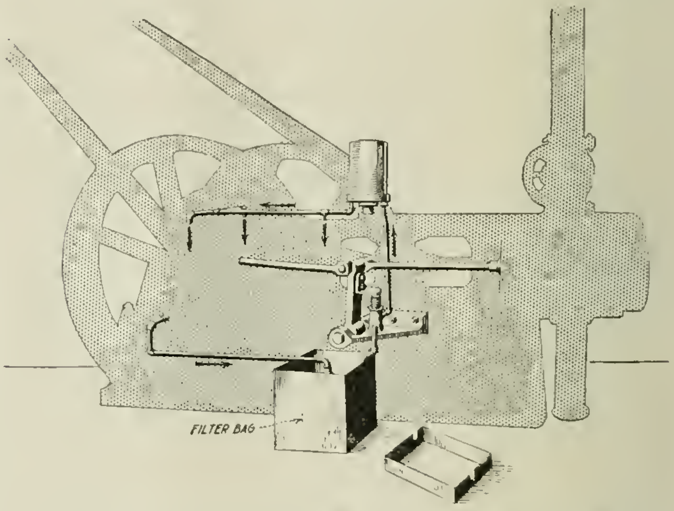
Philadelphia, Penn. MORGAN G. JOHNS.

Engine Oiling System

Engineers sometimes fail to take advantage of the opportunities they have and complain that the management is unwilling to purchase needed apparatus. Yet they could, if they would, do much to make up for the lack of equipment.

In a certain plant where the engineer is a "live wire," even though operating a plant of less than a hundred horsepower, the engine is not of the best, having given a lot of trouble because of hot bearings, etc.; but it is now doing first-rate, since the engineer rigged up a home-made oiling system for it.

The owner refused to purchase any new oiling devices, as in his estimation the power plant was only a necessary evil, so the engineer set about contriving a system of stream lubrication from odds and ends about the plant.



CONTINUOUS OILING SYSTEM APPLIED TO OLD ENGINE

For an oil reservoir he used a ten-gallon can, with a cloth bag in it, tied to the end of the return pipe to filter the return oil. By removing this bag and substituting a clean one occasionally, the circulating oil is kept reasonably clean. For a pump he used the gasoline pump taken from an old gasoline engine. This pump was driven by a bracket bolted to the rocker-arm as shown.

The elevated tank is made of 8-in. pipe and a reducer and is fastened to the engine frame with a 2-in. nipple and flange.

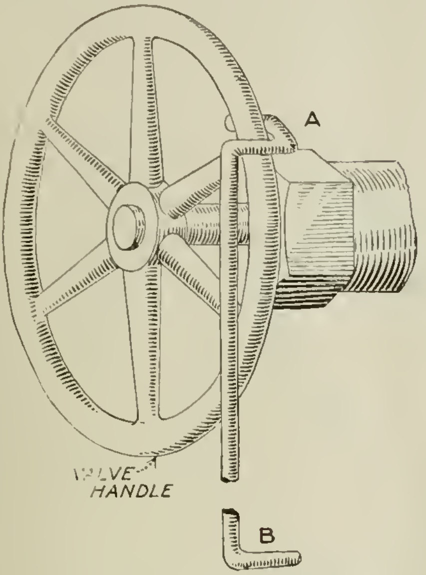
The pressure-feed lines are ¼-in. iron pipe, and worn-out valves that would not hold steam pressure are good enough to regulate the flow of oil with. A neat guard was fitted over the engine crank and did not allow the oil to splash over the floor.

It is an excellent example of what can be done with little to do with. E. S. MORRISON.

Dallas, Tex.

Operating Overhead Valves

A simple and easily made device for operating valves that are out of reach is shown in the illustration, and no other explanation seems necessary. If the valve is somewhat "stuck" or is to be closed "tight," the end *A* is used but in many cases the simple hook on end *B* will do the work. **James E. Noble.**



HOOK FOR OPERATING VALVES

Portsmouth, Ont., Canada.

Remembering Which Terminal of a Device is the Cathode

It is somewhat difficult to remember which is the cathode or anode of an electrochemical device or rectifier; that is, where the current enters or where it leaves the device. A professor, in a talk sometime ago, gave an example that is very easy to remember.

He had a cat that could open a screen door and go out, but could not open it to enter. By thinking of "cat-hole," the cat going out, it was easy to remember "cathode," the terminal at which the current left the device. Of course, if this is the cathode, the other terminal must be the anode. I have found it very easy to remember the difference between the cathode and anode since hearing this illustration.

Philadelphia, Penn. **W. H. Nostan.**

Engineers and Their Wages

I must say "A Union Engineer, Somewhere in Connecticut" on page 638 in the issue of Nov. 6, has learned the same lesson that I have; namely, that while the union scale is not fair to all, it is a good thing for the large majority. We cannot all get chiefs' jobs and their pay, but we can get lots of jobs requiring intelligent operators and through the union can get good pay. In the plant where I am we get $4.75 per day of eight hours and the firemen get $4.25 for eight hours. In the other plants outside of the union they work ten hours for $3.50 and $2.75 respectively.

Somewhere in Washington. **A Union Engineer.**

Lubricating Corliss Valves

A Corliss engine "groaned" and the valves would stick so badly at times that the dashpots could not pull them shut, although the amount of oil that was fed was "outrageous."

The oil pump was piped to feed over the ends of the valves in the usual way, but after changing the piping to feed into the steam pipe just above the throttle, there was no further trouble and the amount of oil required was greatly reduced. **N. C. Gleason.**

Northport, Wash.

The Use of Electric Hoists at Coal Mines

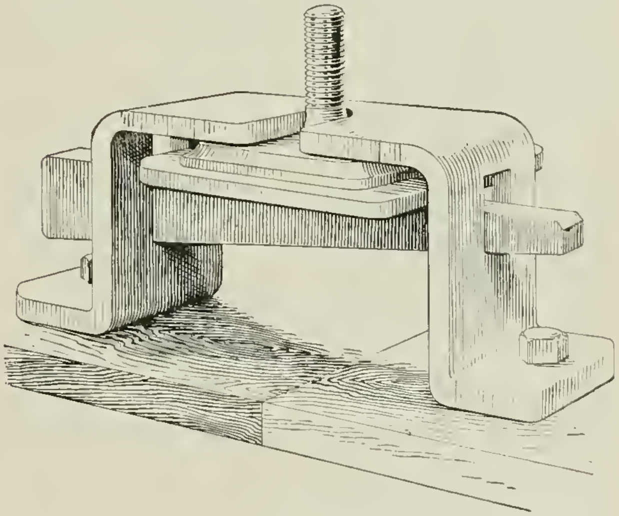
I would like to hear from readers of *Power* who have had experience with electric hoists at coal mines in Illinois, as to their reliability and economy over steam hoists, and under what conditions it is better to install an electric hoist in preference to a steam hoist.

It would also be of interest to know why one type of hoist is preferred over another, from the operating engineer's standpoint. **W. F. Decker.**

La Salle, Ind.

Bench Clamp for Handhole Plates

It has been customary when cleaning our B. & W. boilers to have a couple of men run dies over the studs of the handhole plates, because when replacing the plates, if a nut is not easily screwed home, the plate will be thrown out of position and the gasket misplaced; so it is desirable that the nuts work freely. Ordinarily, two bench vises were kept busy for this work, and often someone wanted to use one of the vises, and the work was temporarily stopped. The illustration shows a special vise, the use of which has reduced the time on the 2000 plates for two boilers from twelve hours to nine hours.



BENCH CLAMP FOR HANDHOLE PLATES

Perhaps this kink may be of assistance to some other fellow who has a lot of handhole plates to take care of. **Charles H. Willey.**

Concord, N. H.

Necessity of Air-Gap Gaging in Induction Motors

Most of the troubles arising in the use of induction motors are caused primarily by the failure of the operator to keep the air gap between the rotor and stator uniform. Consequently, if this point is carefully attended to, many delays and considerable rewinding expense will be avoided.

At the time an induction motor is placed in operation there is usually furnished a thin steel gage which should pass freely between the rotor and stator at any point. The gage is used during the installation and then probably lost or thrown away. After months or even years of operation the motor begins to heat; later, if not given proper attention, it may begin to smoke and if not attended to promptly will burn out the windings or otherwise be seriously injured.

When the air gap becomes uneven, owing to the bearings wearing down in an induction motor, the current consumption increases, the starting torque is decreased and the machine begins to heat. If these conditions are noted and properly diagnosed, the bearings will be replaced or adjusted and the motor becomes as good as ever; but if not, the condition grows worse until a shutdown results.

It is obvious that all repairs should be made before they are absolutely necessary; in other words, when they can be made at the convenience of the operator. Therefore it is good practice to use an air-gap gage periodically to determine the clearance between the rotor and stator. If this is done, the necessity of new bearings or adjustments becomes apparent before the motor efficiency is seriously impaired or abnormal current flow has injured the windings. By following this method the gain in efficiency of operation and in economy of repairs will much more than offset the cost of the additional bearings that may be necessary.

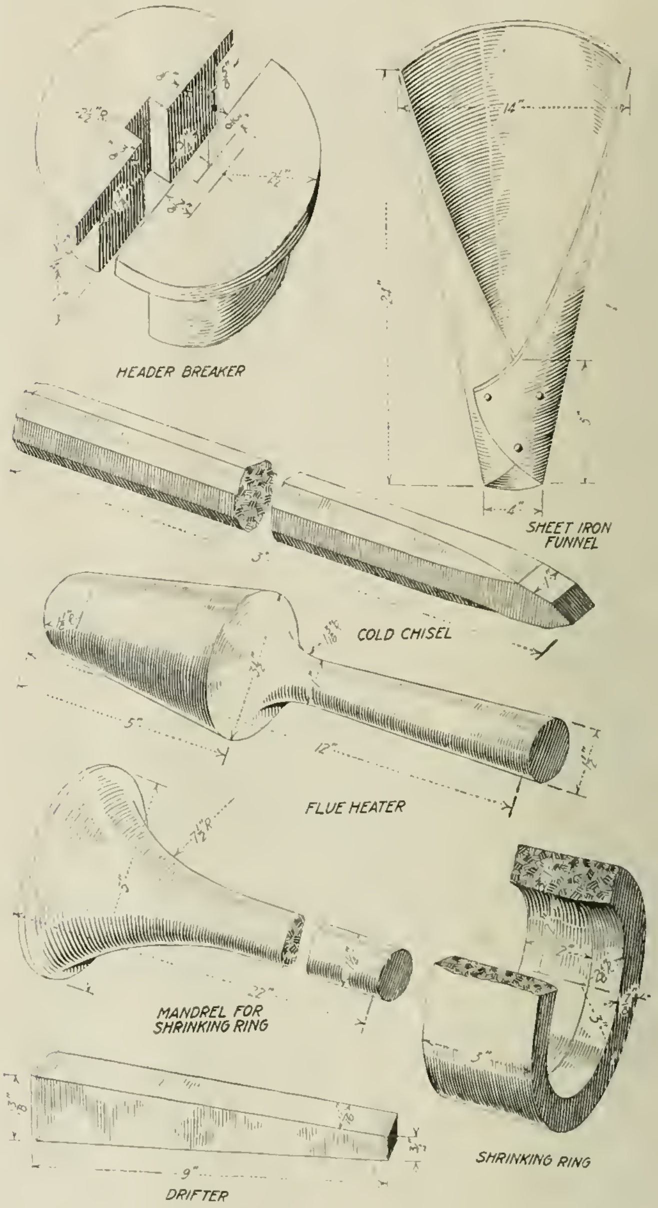
Johnson City, Tenn. D. R. SHEARER.

Replacing Boiler-Tube Headers

We have at our mine several B. & W. boilers with cast-iron headers, and after a boiler has been shut down for cleaning, on starting it up again we sometimes find a cracked header. This we think is due to unequal contraction or possibly expansion, as we have never had a header fail while under pressure. In the iron mines, as a rule, the boiler plant is worked to its full capacity with no spare boilers, every one being in use; so when a cracked header is found, it means a "hurry-up job" to get it back in service.

After making a great many different kinds of tools to remove a broken header without removing the tubes, we have adopted the set shown in the illustration and proceed as follows:

All the caps are removed from the header, then the header breaker is put in and the tapered drifter pin driven in the square hole in its center until the header breaks, the operation being repeated at each handhole. Then with the long chisel any pieces that cannot be drawn over the end of the tube are broken up. The next operation is swaging the flared end of the tube back to its original size, which is done in the following manner: The flue heater is heated in a portable blacksmith's forge, or it may be heated in the furnace of another boiler. When hot, it is placed on the inside of the tube end and to increase the heating effect the sheet-iron funnel filled with burning oil-saturated waste is hung on it, and the tube will soon be brought to a red heat. The tube-shrinking ring is then placed over the tube and the mandrel used to force the ring on by striking it lightly with a hammer; this quickly reduces the tube to its original size. Then wood blocks are placed between the tubes to keep them the right distance apart, and all is ready to put in the new header. If the job is done in this way, no new tubes are required.



TOOLS FOR REMOVING BROKEN TUBE HEADER

THOMAS J. PASCOE.

Norway, Mich.

It would help the fuel situation a bit if the street lamps in American cities were turned on when it grows dark enough to need them and not three-quarters of an hour before that time each day.

Inquiries of General Interest

Steam Required for Atomization of Fuel Oil—For atomization of fuel oil, what quantity of steam is required per pound of oil atomized? B. H. D.

The steam required to atomize the oil varies from 0.3 to 0.7 lb. per pound of oil. The average consumption is about 0.5 pound.

Overheating of Clean Water Tubes—What causes burning, bagging or blistering of tubes of water-tube boilers below the water line when the tubes are made of good material and clean of oil and scale? J. T. M.

A water tube may become burnt, bagged or blistered when, from forced firing or poor circulation, the water of the boiler is driven or held away from the tube surface by the steam that is generated, thus permitting the tube to become overheated.

Setting Steam Valves of Duplex Pump—What is the simplest method of setting the steam valves on a duplex pump? W. N.

Place both pistons in the center of their travel; the rocker arms will then be plumb. Remove the steam-chest cover and place each steam valve centrally over the ports, and adjust lost motion equally on each side of the collars or nuts that move the valves. Before replacing the steam-chest cover, move one of the valves so as to open a steam port and thus enable the pump to start up when steam is admitted to the steam chest.

Holding Safety Valves During Hydrostatic Test of Boiler—The pop safety valve of a boiler is set to blow off at 100 lb. pressure. What should be done to the valve so as to obtain a test pressure on the boiler of 150 lb. per square inch? B. B. T.

During a hydrostatic test the safety valve or valves of a boiler should be removed with the connection temporarily blanked off, or each valve disk should be held to its seat by means of a testing clamp. Most manufacturers of spring pop safety valves furnish a special testing clamp, or "gag," for the purpose. The valve should not be held closed by screwing down the compression screw upon the spring, as that would be likely to injure the spring.

Kilowatt Output of Alternator—What is the actual kilowatt output on an alternator when the ammeter reads 300; power-factor meter, 0.82; and the indicating kilowatt meter, 1360? W. C. C.

The ammeter reading and the power factor are not necessary to be taken into account, as the kilowatt output of the machine is that registered by the kilowatt meter; namely, 1360. If the number of phases and voltage were given, it would be possible to check the correctness of the meter readings. For a two-phase machine the kilowatt output is equal to volts per phase × amperes per terminal × 2 × power factor ÷ 1000; and for a three-phase machine the output would be volts per phase × amperes per terminal × 1.732 × power factor ÷ 1000.

Size of Conductors for Two-Phase Motor—How is the size of the conductors, 200 ft. long, determined for a two-phase four-wire 50-hp. 220-volt motor? I. C. B.

The full-load current required per terminal by the motor is generally given on the name-plate, but can be determined approximately by the expression, hp. × 1000 ÷ volts × 2, in this case amperes = 50 × 1000 ÷ 220 × 2 = 114. The National Board of Fire Underwriters' Code states that the carrying capacity of conductors for alternating-current motors requiring over 100 amp. per terminal must be 150 per cent. of the normal full-load current rating of the motor; in this problem, 114 × 1.50 = 171 amp. For a rubber-covered conductor the wire table gives a No. 000 B. & S. as the correct size. This size conductor for alternating-current motors can be fused up to the rating for other insulations or 275 amp. The resistance of 400 ft. of No. 000 copper wire is 0.025 ohms, and the volts drop in the line at 50 per cent. overload is, current × resistance = 171 × 0.025 = 4.3 volts, which is well within good operating practice.

Short-Circuit Secondary of Current Transformer—Why is it necessary to short-circuit the secondary terminals of a current transformer when they are disconnected from the device the transformer is serving? E. K. P.

The iron core of a current transformer under normal conditions is worked at a very low magnetic density, consequently the flux will build up very rapidly as the ampere turns increase, if their effect is not neutralized in some way. When a current transformer is under normal load, the ampere turns in the secondary are almost equal to those of the primary, therefore the effective ampere turns, and likewise the flux and voltage, are at a low value. However, if the secondary circuit is opened, when the transformer is loaded, the total primary ampere turns are effective in setting up a flux, which reaches a high value, likewise the voltage in the winding. The latter in many cases become of a value that will break down the insulation and destroy the transformer. A current transformer operating with its secondary open-circuited also acts as a choke coil in the line. By short-circuiting the secondary terminals, when they are disconnected normal conditions are maintained in the transformer.

Heating Feed-Water at Expense of Back Pressure—In a steam plant operated at 100 lb. boiler pressure, a closed type of exhaust-steam feed-water heater delivers the boiler-feed water at 205 deg. F. with 2 lb. back pressure on the exhaust of the engine. Would it not be more economical to raise the temperature of the feed water to 212 deg. F. by increasing the back pressure on the engine? W. C. C.

If the only heat recovered out of the exhaust is that utilized by the heater in raising the temperature of water required for generation of steam supplied to the engine, then it would be detrimental to economy to increase the temperature of the feed water at the expense of increasing the back pressure. The temperature of the exhaust at 2 lb. back pressure above the atmosphere is about 219 deg. F., and to increase the feed-water temperature to 212 deg. F. or 7 deg. higher would require the exhaust to be at a temperature of about 226 deg. F. corresponding with about 4.5 lb. per sq.in. above the atmosphere, or an increase of 2.5 lb. back pressure; and with the same load the consumption of steam by the engine will be increased practically as though the load had been increased to require 2.5 lb. additional m.e.p. Allowing the required m.e.p. to be 50 lb. per sq.in., the increased steam consumption would be about 5 per cent. A pound of steam at 100 lb. gage, or 115 lb. absolute, contains 1188.8 B.t.u. above 32 deg. F. and generated from feed water at 200 deg. F. requires 1188.8 + 32 — 200 = 1020.8 B.t.u. With the feed water at a temperature of 212 deg. F. obtained with 4.5 lb. back pressure, each pound of steam generated would require 1188.8 + 32 — 212 = 1008.8 B.t.u.; but 1.05 times, or 1008.8 × 1.05 = 1059.2 B.t.u. would be required for performance of the same work as obtained from a pound of steam with only 2 lb. back pressure, so that increasing the back pressure to raise the feed-water temperature from 200 to 212 deg. F. would be attended by requirement of (1059.2 — 1008.8) × 100 ÷ 1008.8 = 4.9, or practically 5 per cent. more fuel for developing the same power.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Preventable Waste of Coal in the United States*

BY DAVID MOFFAT MYERS†

By employing proper operating methods in boiler plants it is easily possible, according to the author, to save at least 10 per cent. of the coal now burned for steam-making purposes. Such a saving would release cars for other service equivalent, say, to the coal-carrying capacity of the Pennsylvania Railroad lines east of Pittsburgh, equal to 1,000,000 fifty-ton carloads per year, and the direct money saving to the industries would be around a quarter of a billion dollars, figuring the coal at $5 a ton. Discussion on the paper appears in this article.

As a means of far-reaching economy the Government of the United States should at this time apply intelligent and direct-acting efforts to the conservation of fuel at the industrial plants which are responsible for its greatest consumption.

The mining and distribution of the coal have been placed under the supervision of the War Coal Board in order more nearly to meet the crying needs in these directions, to use the railroad facilities more efficiently so that the present car shortage may be minimized and to apportion the coal in quantity and to uses deemed most expedient.

While this organized effort to bring about efficiency in the production and distribution of coal is being made, no parallel measures have been adopted to bring about a normal and practicable efficiency in its use. The hundreds of large plants which are consuming fuel wastefully, in many cases more wastefully and carelessly than ever before, are directly and needlessly causing a large fraction of the existing car shortage.

PREVENTABLE WASTE OF FUEL

The preventable waste of fuel in the boiler furnace of one steel mill which I investigated amounted to 40,000 tons per year, which at $5 a ton would cost $200,000. This was a comparatively modern plant. The efficiency of boilers and furnaces in a 14-day test was 55 per cent. The load factor was unusually favorable to high efficiency and could readily be raised to 70 per cent. or over. This is only one example, and there are many more extreme cases. In one hand-fired plant the evaporation was raised from 6 to 9 lb. in a few days of instruction and continuously kept close to this higher mark with the help of coal and water measurements which were inaugurated. The saving was due exclusively to instruction and consequent better operation.

The saving or wasting of one-fourth of the coal consumption of any industrial plant depends entirely upon the efficiency of its operating management. Let me emphasize that this fraction of the consumption relates exclusively to the *boiler* plants, that is, the production of steam, and does not include the large economies possible in connection with its distribution and use.

For well-known reasons the boiler plant offers the more lucrative field for producing economies, and these with a minimum of alteration in physical equipment.

Under present conditions a plant which carelessly operates at an efficiency of 40 to 50 per cent. receives from the Government the same consideration in the delivery of coal as the one whose efficiency is 70 to 75 per cent. This obviously is unfair and wasteful.

The Government hands over, say, 200,000 tons of coal a year to a plant owner, but asks for no accounting as regards its consumption, nor any questions as to the amount of steam it is made to produce.

There is no doubt that very important economies in the use of food have already been effected by educational campaigns. These economies are largely the result of educating the ultimate consumer. The requisite propaganda does not attempt to teach the intricacies of food chemistry or the complex action of the gastric juices.

The object of this paper is to open a discussion which, it is hoped, will ultimately lead to the formulation of definite fuel conservation recommendations, to forward these recommendations to the proper governmental authorities as an official communication of this society, and to offer to the Government the services of the society for the organization, furthering and, as far as possible, the execution of the plan which may as a consequence be adopted.

There are, I think, two plans of operation worthy of consideration. The one might be termed the autocratic method. This would involve the use of authority to compel coal consumers to execute such measures of economy as the proper authorities might prescribe for any given case, limits to be set as to expense to the user. Such limits might be in terms of a percentage of his present yearly coal bill. Alterations should be directed chiefly, as previously implied, to purely operating improvements. Many objections would probably be made by consumers against this plan, but once in effect the majority would no doubt realize its pecuniary advantage to themselves. But its tendency may be too strongly opposed to democratic principles.

The other plan would be largely an educational one, in which patriotism and efficiency would furnish the motive forces required. The teaching must be accomplished with the utmost simplicity and directness. Above all it must be in such form as to be readily comprehended and applied.

The requisite information must reach the owners and managers of industries, and there must be simple instruction sheets for the engineers and firemen. The vital importance of daily accurate records of coal and water must be taught and information given regarding practical appliances for automatic measurements of both.

Blank forms might be sent in advance to plant owners in order to be advised by them, first, whether they would be willing to coöperate with a governmental organization offering to assist them in reducing their coal consumption, and second, to obtain such data as to size, type, equipment, operation and fuel consumption of the plants as would enable a classification that would permit a government board of experts to send such instructions as would include the information needed for any one class of plants.

This work would be very greatly aided by a staff of experts ready to visit plants when so requested by owners, and make investigations and recommendations and keep in touch with the progress of economies. Included in such a staff must be men intimately familiar with practical operating economies, whose duties would be the delivering of lectures or talks which should be planned so as to reach directly not only managers and owners of the industries, but also the chief engineers and firemen of the boiler plants.

TABLE I. TOTAL COAL PRODUCTION, BITUMINOUS, LIGNITE AND ANTHRACITE, YEAR 1915

		Net Tons	Per Cent.
1.	Bituminous and lignite	443,462,509	85.2
2.	Anthracite	76,906,431	14.8
3.	Total	520,368,940	100.0

The United States Bureau of Mines has for a number of years engaged in obtaining and disseminating scientific information regarding the mining and consumption of coal, and the results of the work have been of great value to technical engineers who are able to use and apply it.

Six hundred million tons of coal was mined in the United States last year. It is predicted that 700,000,000 tons will be mined this year, and next year's production will likely be still greater. Of this quantity approximately 67 per cent., or 469,000,000 tons, will be burned for steam-making

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*Presented at the annual meeting, December, 1917, of the American Society of Mechanical Engineers, New York.

†Consulting engineer, New York City.

purposes on land, assuming the same percentage consumption for steam production as existed in the year 1915.

The saving or wasting of one-quarter of this coal, that is, over 117,000,000 tons, depends on the efficiency with which we operate our boiler furnaces. If we actually saved by proper methods only 50,000,000 tons per year, this economy would result in freeing for other important service the use of 1,000,000 fifty-ton freight cars per year. The significance of such an economy may be realized when it is stated that the number of cars thus released for other service would be equivalent to 15 per cent. more than the combined yearly coal-carrying capacity of the Baltimore & Ohio and Southern Railway systems; approximately equal to that of the Pennsylvania R.R. system on lines east of Pittsburgh, or 1⅝ times the number of coal cars hauled by the Norfolk & Western. The direct saving to our industries would be $250,000,000 worth of coal per year, if figured at $5 per ton.

TABLE II. PERCENTAGE DISTRIBUTION OF BITUMINOUS COAL AND LIGNITE PRODUCED IN THE UNITED STATES AND IMPORTED IN 1915, BY USES

		Per Cent
1.	Railroad fuel	28.0
2.	Steamship bunker fuel—tidewater	2.0
3.	Steamship bunker fuel—Great Lakes	0.3
4.	Manufacture of beehive coke	9.3
5.	Manufacture of byproduct coke	4.3
6.	Manufacture of coal gas	1.0
7.	Domestic and small steam trade	16.0
8.	Industrial steam trade	33.0
9.	Exported	4.0
10.	Steam and heat at mines	2.0
11.	Special uses	0.1
12.	Total bituminous and lignite	100.0

NOTE.—Imports were only a little over one-tenth of one per cent. and are therefore neglected.

No information is available for complete classification of the distribution of the anthracite, but it is estimated in report on "Coal in 1915"* from which Tables I and II are made, that 50,000,000 net tons of anthracite were used in 1915 for "heating households, apartment houses, hotels, and office, school and other buildings." This leaves about 27,000,000 net tons or 35 per cent. for industrial uses, principally steam making. If we eliminate households we may assume that 25,000,000 tons of the 50,000,000 tons are used for making steam, so that of the total 77,000,000 tons of anthracite we may say that 52,000,000 tons, or 67.5 per cent. are used for steam production.

* "Coal in 1915," by C. E. Lesher, published by the U. S. Geological Survey; Part A on production, Part B on distribution.

This saving would be $\frac{50,000,000}{469,000,000} = 10.65$ per cent. of the coal now burned for steam production. It is impossible to state the present average efficiency of boilers and furnaces, but I have personally spent sixteen years of concentrated study in the investigation and improvement of steam and fuel conditions in factory power plants, and I have never visited a plant of this class where a saving in coal of at least 10 to 12 per cent. could not easily be made. The poorer the conditions found the easier it is to make an attractive saving in fuel.

Table IV shows to what point the efficiency of a plant must be raised to obtain the saving of 10.65 per cent. upon which these economies are based. The poorly run boilers would of course be susceptible to the greatest improvements. Hundreds of boiler plants operate at no greater than 58.07 per cent. efficiency, and it is a comparatively simple matter to bring them up to an efficiency of 70 per cent. or higher. The latter would result in a saving of over 17 per cent. of the coal.

TABLE III. COAL USED ON LAND FOR STEAM PRODUCTION IN PERCENTAGE OF TOTAL PRODUCTION

		Per Cent
	Bituminous:	
1.	Railroads, item 1, Table II	28.0
2.	Domestic and steam trade, assume only one-quarter of item 7, Table II	4.0
3.	Industrial steam trade, item 8, Table II	33.0
4.	Steam and heat at mines, item 10, Table II	2.0
5.	Total bituminous	67.0
	Anthracite:	
6.	To steam making	67.5

Hence it may be assumed that 67 per cent. of all the coal produced is used for making steam on land.

To save 10.7 per cent. of the coal consumption necessitates the raising of any combined efficiency of boiler and furnace from that shown under Old Efficiency in Table IV to the corresponding value under New Efficiency in the same table.

If we do not limit our action to coal used for steam generation, but extend it to include economy with which the steam itself is utilized and applied, the predicted saving could be doubled, so that we might save 2,000,000 fifty-ton carloads of coal per year. There is, for instance, widespread ignorance to a surprising degree in regard to the value of exhaust steam in heating and process work. The coal-consuming public should be taught that a heating system which requires 100 boiler horsepower may insert a steam engine between boiler and heating main and obtain nearly 100 mechanical or electrical horsepower in addition to the required heating for about the same consumption of fuel.

TABLE IV. INCREASES IN COMBINED EFFICIENCIES OF BOILER AND FURNACE NECESSARY TO EFFECT A 10.7 PER CENT. SAVING IN COAL

Old Efficiency, Per Cent.	New Efficiency, Per Cent.	Old Efficiency, Per Cent.	New Efficiency, Per Cent.
44.67	50	62.54	70
49.14	55	67.00	75
53.60	60	71.47	80
58.07	65		

Saving of coal with same output of steam

$$= \frac{\text{New Efficiency} - \text{Old Efficiency}}{\text{New Efficiency}}$$

and

Increase of steam production for same coal

$$= \frac{\text{New Efficiency} - \text{Old Efficiency}}{\text{Old Efficiency}}$$

Steam plants are under the immediate management of chief operating engineers. The examination requirements for licenses in this profession call for practically no knowledge of steam and fuel economics. These examinations deal chiefly with matters of safety, repair and maintenance of equipment and neglect almost entirely the subject of coal economy. This is a very serious defect in our present system and is directly responsible for a large preventable waste of fuel.

The mining and distribution of our coal supply, the regulation of prices and the adjustment of financial and labor problems have already been placed under official administrative attention. But no parallel measures have been adopted looking toward reduction of waste in connection with the utilization of this coal.

DISCUSSION OF THE PAPER

Walter N. Polakov: The invitation to discuss the means and methods for reducing waste of coal is very welcome since all that has been said and done so far has failed to produce tangible results.

Last April I brought out the impending danger of a fuel famine and soon afterward the movement was on the way affecting at that stage only coal production, transportation and prices.

Being limited in its scope and nature, it did not embrace at that time the third group of my original recommendations concerning the use of fuel. My editorial in *Coal Age* of July 14 and articles in other magazines[1] emphasized this paramount task "to start at once the movement for the efficient utilization of every available supply of fuel."

A couple of months later Mr. Garfield publicly admitted that the principal hope for a solution of the coal problem lies with the people themselves: "They must save every possible bit of fuel."

Saving may be carried out along two lines—either on the principle of German "Spar Kasse," inevitably limiting the industrial productivity and impairing the health of the people, or on the principle of more efficient utilization of fuel, producing more power and heat with less coal. Only this latter means of saving is to be considered.

The inauguration of efficient management of power plants cannot be accomplished overnight. It requires study in each plant of its peculiar conditions. It requires careful training of firemen and other employees. It necessitates an adequate stimulation of employees to continually maintain the highest degree of efficiency. To do it no capital investment is needed. It is not a matter of better furnaces, of mechanical stokers, or other cures preached by salesmen. It is a matter of knowledge and method.

There are already many plants that have reduced their coal consumption from 20 to 40 per cent. for the same output, by better organization of power-plant work. There is no need to here describe these principles and their results. "Task Setting for Firemen," a paper presented before this

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[1] "Industrial Management," May, 1917, September, 1917; "Literary Digest," June 15, 1917; "Utilities Magazine," September, 1917.

society in 1913, "Planning the Power Plant Work," a paper delivered before the Taylor Society, and numerous other contributions describe the nature of my work and fundamental principles more or less at length. Van H. Manning, Director of the Bureau of Mines, recently took the view advocated by me for years. Said he: "The immediate problem is a difficult one. We cannot scrap all out-of-date power plants. We must start by doing the best with what we have. We must begin saving coal at once. The problem is a personal one. It deals with the human elements. We must reach the man with the shovel."

Mr. Myers presents for discussion two plans. The first one is unfortunately worded so as to create prejudice against it. It reads ". . . . the use of authority to compel coal consumers to execute such measures of economy as the proper authority might prescribe in any given case." It sounds Prussian. But is it? Does it mean imperialistic, arbitrary authority or an authority of an expert based on scientific knowledge of facts, similar to the authority of a doctor prescribing treatment?

The strength of England, France and even the Central Powers is due to the coöperation in industries. Those who fail to render the service to the common cause are denied the privilege to mismanage their plants. True enough, this coöperation is regulated by the state and at times compulsory as is conscription or commandeering of productive facilities or commodities. The voluntary coöperation for which we long will come only after the war as a result of new social readjustments. But we cannot wait. The problem is of today. Tomorrow may be too late.

In other words we must create conditions stimulating voluntary coöperation even under individualistic regime.

The plan therefore means the abolition of privilege to waste fuel in inefficiently conducted plants, by giving priority in coal deliveries to those who prove that they do not use it efficiently.

At present a wasteful plant gets an excessive amount of coal, while the highly economical one stands an equal risk of being shut down for the lack of coal. If the efficiency is protected by priority, it will work also as a stimulus for the wasteful ones to find means to improve their methods and then ask for a new rating.

Such encouragement of efficient plants, rendering good service to the country and stimulating the inefficient to seek their salvation through the means beneficial to the country can be accomplished along the following lines:

Rating by experts (nominated by the national engineering societies and supported by public opinion and Government) of plants in the indispensable industries who are entitled, because of coal-saving methods in use, to the priority in coal supply.

Receiving of applications by the special service bureau of American Society of Mechanical Engineers, from the low-rated plants for assigning the expert help.

Serving the needs of such inefficient plants by offering services of recognized experts in power-plant management for direction of the work.

Organizing a staff of steam, electrical and combustion engineers, whose members will be assigned to carry out the work in the plants of the applicants under the direction and supervision of experts.

Charging for such services an adequate compensation to cover the expenses involved (salaries, traveling and office) but no profit.

Mr. Myers' second plan, "an educational one, in which patriotism and efficiency would furnish the motive forces required," is in my opinion doomed to failure for the following reasons:

Teaching efficiency by a correspondence-school method will accomplish little good, is incompatible with the professional dignity of this society and lacks the personal touch.

Endless variety of equipment, grades of fuel available, personality of men, nature of load, climatic conditions, etc., make the preparation of "simple instruction sheets for engineers and firemen" impossible and if made they are so general as to be useless. Failure of the Massachusetts fuel board in such an attempt is a joke among power-plant men in that section.

No instructions of real value could be given unless examination of the plant was made. Selling patent medicines curing all diseases ranks with fake only too often not to make one careful.

Keeping records, logs, etc., necessitates instrument equipment and measuring devices; all of this is good only when the data are used and interpreted by a trained man and this is done continually. Too many plants have no instruments at all; most of those that have, keep them as ornaments owing to the lack of proper organization.

If the regular employees failed to secure high efficiency it is not because of the lack of "circularized education" but chiefly on account of lack of time to carry on investigations and tests all the time being absorbed by routine duties; absence of instruments, facilities or encouragement; lack of experience in this highly specialized line of research work.

The education must begin with owners and managers, not with the firemen.

The very principle of "teaching" and "instructions" given to manufacturers and plant owners by the society is undemocratic and unamerican. They do not want or need "to get something for nothing." Producing for the country but not without profit they can prefer to pay for what they get if the benefit is commensurate with the expenses.

"Educational" talks and circulars usually degenerate rapidly into debating societies, wasting time needed for deeds.

Any half-measures with good intentions falling short of accomplishing valuable results are dangerous as they chloroform the public conscience, creating a belief that something real is being done while there is little behind the words that make all content.

To sum up, the problem is to be solved by groups and individuals availing through this society to the services of those who know how more power can be gotten out of a pound of coal. There is no necessity to compel plant owners to improve their methods since in such a step lies their self-preservation. But there is an urgent necessity from the national viewpoint to conserve the fuel by preventing its waste by ignorance or indifference. The valuation of plant methods to establish ratings for priority in coal deliveries is therefore recommended.

Albert A. Cary: Mr. Myers endeavors to focus our minds upon this panacea in the statement that "the saving or wasting of one-fourth of the coal consumption of any industrial plant depends *entirely* upon the efficiency of its operating management," and this seems to be the text upon which the balance of his paper is founded.

To secure the desired conservation of fuels in such plants, Mr. Myers advises the services of the expert in operating management. Provided he understands his business, such an expert can undoubtedly secure desirable fuel savings; but results depend largely upon the coöperation he receives from the plant owners and their employees, as well as their willingness to equip plants with the needed apparatus and to use them continuously after the expert concludes his work.

To illustrate, I will refer to the plant of one of my clients, the Tennessee Copper Co. By redesigning the furnaces in this plant and adapting them to the fuel used and by substituting machine-fired grates, they have since succeeded in obtaining the same amount of steam with but 64 per cent. of the Jellico coal formerly used. This plant, when completed, was turned back to the same management that it had before with no further instructions. There were installed facilities for continuously determining the weight of the coal, ash and water used as well as the analysis of the furnace gases.

In another large industrial plant a similar saving in coal was effected. This plant has an aggregate capacity of over 7000 nominal boiler horsepower, divided into 22 units. It was formerly operated with hand-fired shaking grates for which machine-fired grates were substituted with properly designed furnaces. The plant is now being operated continuously at 150 per cent. rating and is using no more fuel than it formerly did when being operated at two-thirds of its present output. The boiler-room force required to operate this altered plant is less than half of the number of men formerly required. No change has been made in the management of this plant.

Proper furnace design and construction, flue and draft-producing equipment adapted to the use of the particular kind or quality of fuel used is the keynote of the question of fuel conservation.

Furnish the mason with complete instructions for "laying up" the brickwork and properly bonding the interior and exterior walls of the furnace so that the large difference in temperature between the two sides will not, by unequal expansion and contraction, rapidly destroy these furnace inclosures and so waste fuel by infiltration of air.

The selection of material used and its method of erection should never be left to the mason, as it is safe to say that fully 90 per cent. of the masons erecting furnace settings are hopelessly unqualified to produce a proper setting. After equipping the plant with proper furnace settings which are adapted to produce the highest possible efficiency with the particular fuel available, the expert in operating management can come into the plant to instruct the men.

To meet the present emergency, I propose that the War Coal Board bring all the firemen in this country under its control by requiring them to take out United States licenses. The various state, county or municipal governments can assist them in this work. The applicants for these licenses must show some qualifications that would entitle them to hold such privileges, but it is doubtful whether it would be possible, at the beginning, to have all these applicants examined before qualified examination boards.

Future applicants should be required to pass an examination before such boards and qualify in a satisfactory manner before receiving their licenses. Any operator of a coal-burning plant (domestic plants, of course, excepted) who operates his equipment without a licensed fireman should be liable, first to fines and finally to more severe penalties.

Each license should be issued for the applicant to operate in a definite, described plant and nowhere else. Should the fireman leave this plant for any good reason, rather than for incompetence, he can take his license to the proper authorities and have it transferred to another plant where he has found reëmployment.

Should the fireman be found to be incompetent, his license should be revoked and future applications be denied.

Inspectors appointed by the War Coal Board might visit from time to time the various coal-burning plants, and should they find any of them using fuel wastefully, a notice should be served upon the owner. If this is not followed by prompt action to reduce or stop the waste, the fireman's license should be revoked.

The foregoing is proposed as a war measure.

Professor L. P. Breckinridge told of the methods used in Connecticut to conserve coal, stating that meetings were held to which the public was invited, to be told how to burn coal economically in house and power-plant boilers. Norman Reinicker believed that fuel economy was much more a matter of design than education of firemen. E. N. Trump emphasized the value of bonuses to firemen to give incentive for economical use of coal.

Utilizing Surplus Electrical Energy for Generating Steam*

By F. Hoehn

An interesting test was conducted by the Swiss Society of Steam Boiler Owners to determine the commercial possibilities of generating steam for heating purposes by electricity. The plan proposes the heating and storing of the proper volume of water under pressure, from which the steam was to be generated by expansion to a lower pressure on the principle of the fireless locomotive.

A small model tubular boiler 24 in. in diameter and 50 in. long containing thirty-eight 1¼-in. steel tubes was used for the test. Glass-insulated microhm heating coils having a resistance of 1.1 ohms were inserted in 34 of the tubes and so connected that the latter were divided into three groups of 18, 9 and 7 respectively, any of which could be cut out of service. Direct current at 225 volts obtained from a hydro-electric plant on the premises was applied.

The following table gives the results of two tests:

	Test No. 1	Test No. 2
Duration, hours	7.6	7.0
D.C. voltage	225.8	225.6
Average amperes	142.4	148.8
Average kilowatts	32.2	33.6
Average pressure, lb. per sq.in. abs	25.0	29.4
Average temperature, deg. F	51.8	50.0
Total heat in one pound of steam, B.t.u.	1,160.0	1,163.4
Total evaporation, lb. per hour	85.5	89.7
Evaporation in pounds per square foot of heating surface at minimum demand	2.7	2.42
Evaporation in pounds per square foot of heating surface at maximum demand	2.85	2.68
Evaporation in pounds per square foot of heating surface at average demand	2.76	2.62
Total pounds steam generated per kw.-hr	2.65	2.67
Theoretical heat in B.t.u. per kw.-hr	3,415.0	3,415.0
Actual heat obtained in B.t.u. per kw.-hr	3,074.0	3,106.3
Efficiency, per cent.	90.0	90.9

The efficiency of 90 per cent. might have been improved by better lagging, as most of the losses were due to radiation.

It is interesting to note that the evaporation per square foot of heating surface was greatest at minimum demand, owing to the better heat transfer to the water when the latter was not filled with steam bubbles. For practical purposes it is fair to assume a mean evaporation of 2.46 lb. per sq.ft. of heating surface.

The first requisite for steam generation by electricity is a cheap source of power. In order that such a system may compete with a coal-fired plant, with coal selling at $8.75 per ton in Switzerland and an average evaporation of 7 to 8 lb., the author computes that the cost of current cannot exceed 0.16c. per kilowatt-hour.

Such low-cost current is rarely obtainable. However, cases may arise where an otherwise partly idle hydro-electric plant can be used to furnish the necessary current on nights, Sundays and holidays. If, then, sufficient heat can be stored in the water to furnish steam by regeneration for the entire week, the practical application of this method takes on an entirely different aspect.

The author derives a number of equations for computing the heating surface and the storage space required for furnishing the maximum amount of steam for heating purposes at a reduced pressure of 22 lb. absolute, with an available power supply of 883 kw. for 12 hours.

Given a feed temperature of 59 deg. F., the total steam obtained at a mean pressure of 99 lb. is shown to be 2244 lb., which would require about 80 sq.ft. of heating surface. The total amount of water necessary amounts to 20,661 lb. and would require a storage space, making due allowance for extra steam space of some 400 cubic feet.

Placing the radiation losses at 6 per cent., the total amount of steam reduces to 2109 pounds.

With an evaporation of 7.5 lb. and coal at $8.75 per ton, this represents an equivalent fuel cost of $1.23 per day, or $369 per year of 300 working days, an amount which the author believes sufficient to cover the interest and depreciation of the simple equipment required.

The system offers the advantage of high efficiency in transforming the surplus electrical energy into heat with only slight storage losses and to give up this heat at any rate desired while requiring only nominal attention. It may also become the means for improving the load factor of the plant by cutting in the heating coils as the load decreases.

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*Translated from "Schweizerische Bauzeitung."

Heating Houses with Gas

As a producer of heat units on the generous scale for such service as house heating, manufactured city gas has not been able to compete with coal, says E. D. Milener, in *American Gas Engineering Journal*. Even with gas at 35c. a thousand cubic feet and coal at $8.50 a ton, the average fuel cost of heating an entire house with gas will be at least 25 per cent. more than with coal, and to keep this difference from being greater it is necessary that the best equipment only be used and proper attention given to its operation. A three-story cottage equipped with a gas-fired steam-heating system consumed, during the eight months from October to May, 465,800 cu.ft. of gas. The lowest monthly consumption, during October, was 23,700 cu.ft., and the highest, during February, was 88,700 cubic feet.

Engine-Room Management in the Ice Plant*

By EDWARD N. FRIEDMAN†

The author does not condemn the high-speed ammonia compressor; but believes more accurate performance data and more knowledge of how these machines "stand up" under everyday service are needed to warrant their wide and rapid adoption. Several hints on engine-room management follow.

WE HAVE not exactly been told, but it has been intimated, that anybody not using the new high-speed compressors and electrical drive or uniflow engine is a back number; that this or that certain system of raw-water ice with or without core-suckers is the only system to use; that only synchronous motors with direct drive show that a plant is up to date; that this or that filtering system does away with water softening; that this or that water softener does away with filters, etc., etc.

There are scarcely any reliable test data available as to the actual performance, and particularly as to the lasting qualities, of the high-speed compressor under various conditions. They have not been in use long enough to judge whether the claims for them are justified. I am as much in favor of progress as anybody, but I feel that far more information about actual performances must be gathered. I know that a number of plants have been installed, but not enough data have been established yet to remove all doubt that the slow-speed compressor must go. Two reasons for favoring the high-speed compressors against the old-time slow-speed are usually given; namely, the smaller space required and the cheaper first cost. I find, however, that the second reason is not in accordance with the facts. Some of the new high-speed compressors cost more than the slow-speed of the same capacity, and I cannot see why.

SEPARATE COOLING OF LIQUID AMMONIA AND WATER

One thing, however, has been done lately to a greater extent than before, and that is the separating of the cooling of the liquid ammonia and the water from the general system, using a separate compressor running under higher back pressure, which means higher economy, as I shall try to explain later. This, of course, has nothing to do with the high-speed compressor or the uniflow engine, but is the outcome of the installation of the raw water system, since without that system the question of economy is mainly a question of the boiler-plant economy.

This also refers to the question of superheaters for the steam. Since, however, we all are not ready to put in new machinery and since we have to get along with what we have, let us see how we can arrange things to get the best results out of our present plants.

Any ordinary ice plant consists of boiler plant, engine-room equipment, condenser floor and ice-tank storage room. Each of these things is important and essential to the plant, but the main question is whether these different parts are built of sizes or capacities to work with the other parts to the greatest advantage for the final purpose. There must be a certain relationship as to the size of compressors, the number of cans and amount of piping in the tanks, the size and amount of piping in the water forecooling tank and the size of the ice-storage room. Any mistake in sizes and arrangement of any one of these items means a drawback and lack of economy.

If, for instance, the size of the distilled-water storage tank is too small, it means losses of water during lunch hours. If the amount of piping in tanks is too small, it means lower back pressures to obtain lower temperatures, a decidedly uneconomical feature; if there are not sufficient cans, the same argument holds good; if the condenser capacity is too small, it means higher condenser pressure and higher power consumption per unit of output, whether steam, electrical or any other kind.

If the storage room is too small, it means trouble during the hot season and the danger of being induced to draw ice ahead to meet the Saturday demand and then have no ice for Monday, which may be a hotter day than Saturday. It would take too much time to go into every detail of ice-plant construction. I must confine myself to the management of the plant, which may be assumed to be reasonably well constructed and proportioned, and here again I must confine myself to the engine room, in accordance with the wishes of the committee in charge of the program.

You will notice that when a test has to be made of the capacity and economy of the plant, the thing that invariably happens is the surprising number of data that have to be carefully recorded. Evidently, it is needed to establish the best way of running, and it is also remarkable that the employees, knowing that these data are being taken, suddenly seem to realize that they must try to be more regular, even pay more attention to oiling, pumps, etc., feeling that if something goes wrong, the professors making the test will find it out somehow and quickly, and there will be the deuce to pay.

TUNING UP THE MACHINES FOR THE TEST

Before the tests start, the machines are "tuned up," minor repairs are made and the condensers are cleaned; in other words, the plant is put in proper condition for the test, with the expectation that this will produce better results and save the men from being accused by the party making the test of being careless or incompetent. Since a test is made to prove the best results, it must logically be the aim of the owner to produce as nearly as possible the same results all the time. Therefore, if the keeping of data tends toward better results, why not keep the same data and records all the time? I do not mean that readings should be made and entered every half-hour, as during a test, but say every two hours, or even every four hours. The mere fact that such data as condenser pressure, back pressure, water and brine temperatures must be entered at certain hours makes it necessary to pay more attention to these matters, with consequent better handling. Furthermore, it shows the night man the condition the plant was in when turned over to him.

I have found that on the average log the only things recorded are the number of cans of ice pulled and the temperature of the brine in the freezing tanks. Since it is, as a rule, rather difficult to read thermometers correctly, considering that in many cases the instrument has to be pulled out of the brine to get sufficient light, I have always advocated the installation of recording thermometers. I cannot make the point too strong that I believe it is impossible to run a compressor in the best manner without the use of thermometers; that is, without having a thermometer in both the suction and the discharge line. One might as well tell the engineer to maintain 100 lb. steam pressure, yet give him no steam gage. The object of thermometers is particularly to prevent too much liquid entering the compressor, since that liquid has circulated without doing any useful work. I cannot go into further details, but would suggest giving the engineer a table such as the following to guide him in handling the gas:

Gage Pressure, Lb.	Boiling Point, Deg. F.	Temperature at Which Suction Gas Enters Compressor, Deg. F.
12 25	—3	+3
15 67	0	+7
19 46	+5	+11
23 64	10	+16
28 24	15	+20
33 25	20	+25
38 73	25	+28
44 72	30	+33

If, for instance, the gage shows 20 lb. back pressure, then the thermometer in the suction line should show about +11

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*From a paper before the Eastern Ice Association, Atlantic City, November, 1917.

†Consulting engineer, 90 West St., New York City.

deg. F. Then little or no liquid will go into the compressor. If the suction gas is handled rightly, the discharge gas will take care of itself. At the same time it might be well to give them also a short table as a hint how these temperatures usually run. This table is based on tests:

Back Pressure, Lb.	Single-Acting Compressor, Deg. F.	Double-Acting Compressor, Deg. F.
5	260	295
15	240	287
25	213	253

This is assuming cooling water of 60 deg. F. initial temperature. If temperature is higher, add the difference to figure given; for lower temperature deduct, etc. I have found, and quite naturally so, that the average engineer has not been told enough by the contractors furnishing the outfit, therefore even as small a table as the one given will help him.

It is also advisable to provide an indicator for the engineer and make sure that he uses it on the steam engines as well as on the compressors. Diagrams should be taken at regular intervals, say every two weeks, even if everything is apparently working all right.

I wish to call attention to the method, in many plants, of using the return gas from the freezing tanks to cool the water in the forecooler. This, in my opinion, is not economical, since it usually results in superheating the gas returning to the compressor, diminishing the capacity of the compressor by allowing less weight of gas to enter than would otherwise enter.

Keep in mind that refrigeration is based on the *weight* of ammonia evaporated—the lighter the gas returning to the compressor the more revolutions the machine has to make to handle the same weight of gas.

The use of thermometers will show at what temperature the gas returns, and any ammonia table will then show how many cubic feet of gas at that particular temperature are required to weigh a pound. If, for instance, the back pressure is 15.67 lb., the temperature of the ammonia would be 0 deg. F., and it would take 9 cu.ft. to make one pound. Now assuming that the thermometer shows 31 deg. F., or 31 deg. superheat, it would take 9.682 cu.ft. to make a pound, or about 8 per cent. loss. This also shows how important it is to have the ammonia return pipes covered. Many owners look on the pipe covering as an unnecessary expense; as a matter of fact, it is absolutely justified and pays for itself in a short time. This refers also to distilled or cooled-water lines to can fillers.

Loss of Ammonia a Source of Complaint

One of the usual complaints is the loss of ammonia, and this is always a serious matter. You can read any number of articles about the deterioration of ammonia, yet if you talk to an ammonia salesman representing a concern whose goods you are not using, he will tell you in a minute that all you have to do is to buy his ammonia and that will settle the whole question. I can truthfully say that I have never found any appreciable difference in the ammonias made by several reputable concerns. When there seem to be no leaks it is most perplexing to tell where the ammonia disappears to, and again, in other plants of similar construction, the leakage losses are really insignificant. The two places where the chances for losing the ammonia are the greatest are in the stuffing-boxes and the condensers. It is important not to allow the stuffing-boxes to leak, and to regulate the return gas so that it will have, if possible, the same temperature continuously to avoid heavy back frost, which invariably causes leaks around stuffing-boxes. If the engineer then tightens the stuffing-box to prevent this temporary leak, the chances are that later the piston rods will run hot or even cause the gland bolts to break, as I have seen happen several times.

As far as the condensers are concerned, it is natural that the danger of leaks is greater there on account of the high pressure as well as the fact that the water running over them will absorb the ammonia, so that numerous small leaks may exist for a long time without being found. When there is a perplexing loss of ammonia, I think it would be well to shut off the water over one or two condenser coils at a time, and go over them carefully. The possibility of leaks in the brine-tank coils makes it desirable to periodically examine the brine by means of Nessler's or any other suitable reagent. Peculiarly, leaks are often near the bottom of the tank and in an inaccessible place.

If the leak is not very strong, although it is a matter of fine judgment to determine that, it may be advisable to let it go until the cool season, since the operation of emptying the brine tanks, removing the ice cans, refilling, etc., is one of the worst things that can happen in an ice plant and emphasizes the importance of having only the best steel or malleable fittings and flanges and wrought-iron piping and thorough tests under pressure before the brine is put in. In many plants this is not done thoroughly enough for the simple reason that the contractor often is late with his work and does not take the proper time to test after the plant is installed. That is wrong, since it is better to finish the work a few days later than to have to interrupt the whole plant or at least one tank during the warm season for never less than a week and sometimes even more.

Leaks are started by the cans being dropped on the pipes, and sometimes on account of the brine being allowed to get weak, the cans freeze in the brine and the coils are bent by using crowbars to get the cans loose. Weak brine may freeze into the coils, forming an insulation, retarding the freezing action and cutting down the capacity. In addition, as previously stated, it may cause the more serious trouble of ammonia leaks. See to it that the brine agitators are run at the right speed. Unfortunately, the machines driving them are often of a cheap and poor make and require constant attention. Insufficient agitation means lower efficiency of tank.

One point that usually received very little attention is the water jacket of the compressors. I have inquired from several operating engineers what instructions they had received from the contractor's engineer. In no case had they received any direct instruction, and the handling of the water jacket was left to their own judgment. Generally, the water jacket should have as large and as cold a water-supply as one can manage to give it. Whatever heat is removed by the water in the jacket reduces the amount of power required to drive the compressor. I have seen the water in jackets frozen solid, caused by liquid being allowed to return to the compressor in sufficient quantity to freeze the water.

Tests of Welded Joints

A series of tests of the strength of oxyacetylene-welded joints in mild-steel plates has been completed by the Engineering Experiment Station of the University of Illinois under the direction of H. F. Moore, research professor of engineering materials. Specimens were supplied by the Oxweld Acetylene Co., of Chicago, and tests were made in the laboratories of the station at Urbana under three conditions of loading: (a) Static load in tension (in a testing machine), (b) repeated load (bending), and (c) impact in tension (in a drop testing machine).

For joints made with no subsequent treatment after welding, the joint efficiency for static tension was found to be about 100 per cent. for plates one-half inch in thickness or less, and to decrease for thicker plates. For static tension tests, the efficiency of the material in the joints welded with no subsequent treatment was found to be not greater than 75 per cent. The joints were strengthened by working the metal after welding and were weakened by annealing at 800 deg. C. (1472 deg. F.) For static tests and for repeated stress tests the joint efficiency sometimes reaches 100 per cent.; the efficiency of the material in the joint is always less. This indicates the necessity of building up the weld to a thickness greater than that of the plate. The impact tests show that oxacetylene-welded joints are decidedly weaker under shock than is the original material; for joints welded with no subsequent treatment the strength under impact seems to be about half that of the material.

In general the test results tend to increase confidence in the static strength and in the strength under repeated stress of carefully made oxyacetylene-welded joints in mild-steel plates. The results of these tests have been published as Bulletin No. 98 of the Engineering Experiment Station, copies of which may be obtained without cost by addressing C. R. Richards, Director, Urbana, Illinois.

North Jersey Severely Suffering from Coal Shortage

The industries and homes of Northern New Jersey are in the grip of a most severe coal shortage as this goes to press. The two large stations of the Public Service Electric Co., Marion and Essex, which supply much of North Jersey with electricity for industries, railways and homes, are hobbling along with but one turbo-generator running in each plant. These stations consume 1200 tons of coal per day of the pooled coal which they have been getting, but nowhere near this amount is coming in. All the company's coal reserve is used up, and though according to the Fuel Administrator's books the company still has 400 tons in the pooled coal pile, there is no pile. Some one has overdrawn his account, evidently.

The Public Service has reached the point where its officials have given up in despair. Seeing the shortage coming, it paid out a million dollars bonus to get coal; but before it reached the company's yards it was pooled or directed elsewhere. It has put the situation up to Fuel Administrator Jenkinson, who has one of his best men at work trying to keep the Public Service supplied with enough coal so that further curtailment of service will not be necessary. Many carloads of coal were on the way to the company's yards; but word came (Wednesday, Jan. 2) that these had been directed to other more urgent uses by the Government.

Wednesday, Jan. 2, the circuit-breakers were pulled and most of the industries using the company's service cut off. This came after urgent appeals to consumers to reduce consumption had failed to get results. Many of the engineering staff sat in the offices at the Terminal Building, Newark, Wednesday night and directed the load dispatcher in an effort to effect the most equitable distribution of current. The electric street lights were not turned on until 7: 30 p.m. to make available enough current to carry the trolley service over the rush-hour period.

Among the industries affected by the Public Service coal shortage are munition factories and others engaged in related work. Many of those consumers who have their own plants, but use in addition purchased current, are shut down only in those departments supplied with purchased current, though several factories are without coal for their own plants. What little coal there is at Perth Amboy, the distribution center for New York City and this section of New Jersey, is frozen into lumps, each lump filling a car.

This period of "short rations" will last at least a week, say the Public Service officials, and how much longer they do not know. Hoboken at this writing has no water, electricity, gas or coal. The locomotives in the Jersey City yards have no water and power plants are down. The great Edison plant at West Orange, the Westinghouse Lamp Works, Newark, part of the General Electric Co.'s Harrison plant, and the American Shell Co., Paterson, are closed.

The whole of North Jersey is not only hobbling along on a very greatly reduced electrical supply, but trolley service is seriously inadequate and the gas supply has been shut off from whole counties.

Heating Buildings With Sprinkler Systems

The increasing use of automatic sprinklers in modern commercial industrial buildings has led to the development of the sprinkler system for heating purposes, according to E. S. Densmore, in the *Quarterly* of the National Fire Protection Association. As is well known, the sprinkler system consists in general of a series of pipes which cover uniformly the ceilings. If the water which is maintained in the system can be heated and circulated, evidently the sprinkler piping can be used for heating. One fundamental objection is that the sprinkler head which is in ordinary use will melt at the temperature necessary for the water to be used for heating purposes. This melting of the sprinkler head is prevented by a U-connection through which the hot water cannot circulate. In practice it has been found that a bend in the horizontal nipple carrying at the end the upright sprinkler head will prevent the head from melting.

The connections of the hot-water heating system with the sprinkler piping are exceedingly simple and need not change the sprinkler piping in any way. The hot-water heater may be located in any convenient place. From the hot-water heater a hot-water supply pipe is run and connected to the foot of the sprinkler riser inside the sprinkler alarm valve. It is advisable to provide an ordinary stop valve at this point so that the hot-water supply may be entirely shut off from the sprinklers when necessary. Between the hot-water connection to the riser and the sprinkler heads no changes are made, the riser, laterals and distributing pipes being installed in the usual way. Many successful installations have been made, and apparently no fundamental difficulties have been encountered over a period of several years in operation.

Insolvency's Effect on Power Contracts

When a power company becomes insolvent and its affairs are entrusted to a receiver, who continues to operate the property for the benefit of the company's creditors, he is not bound to carry out a preëxisting contract of the company to furnish power to a particular customer. It is left to the receiver's judgment, acting under control of the court, whether he will adopt such a contract or repudiate it according to what is deemed to be for the best interests of the estate. In the absence of indication of his election to the contrary, the contract becomes automatically dissolved on the receiver's appointment. But in this case it is decided that the receiver of an electric-power company, who agreed to supply power to a manufacturer, under an independent contract entered into by him, should not be permitted to recover a fixed charge for keeping power in readiness for service whether needed or not, in the absence of proof that he had agreed to and did keep the amount of power supplied, whether used or not. (Iowa Supreme Court, Maxwell vs. Missouri Valley Ice and Cold Storage Co., 164 Northwestern Reporter, 329.)

Liability for Defective Condition

Since it is a general principle of law that one is not liable for injury sustained by another on account of a defective condition of premises, unless the defect had been previously known to the former, or had existed so long as to fairly charge him with constructive knowledge of the conditions, and ample time had elapsed in which the defect might have been repaired, the owner of a steam-power plant is not liable for injury to a pedestrian, caused by a break in a steam pipe line under a pathway used by the public where it appears that the break must have occurred between 4 o'clock in the afternoon and 11 o'clock that night, and that those in charge of the plant had no notice of the break before the accident to the pedestrian occurred. (Truschine vs. Fayette Manufacturing Co., 63 Pennsylvania Superior Court Reports, 124.)

"Coal Savers" in Great Britain

From the following it is evident that the United States is not the only territory that has been invaded by the so-called "Coal Saver." *Power* has published a number of articles dealing with compounds that are supposed to increase the heat value of coals if sprinkled upon them or when sprayed over ashes, and various preparations are extensively advertised in Great Britain at present which are presumed to contribute considerably to the heating power of coal when applied in the prescribed process.

The Director of Fuel Research, in answer to an inquiry as to the value of these preparations, states that these proprietary substances have been in the market a long time, but that there does not appear to be any genuine scientific evidence in support of the claim of their manufacturers. He concludes: "The nature of the substances makes it highly improbable that they have any effects whatever on the combustion of coal or other fuels when they are used in the quantities prescribed."

Personals

O. L. Ruley, formerly with the Union Traction Co., of Indiana, is now superintendent of the Portland Municipal plant, at Portland, Ind.

E. M. Walker, formerly manager of the Dubuque (Iowa) Electric Co., is now general manager of T. H. I. & E. Traction Co., at Terre Haute, Ind.

George W. Schmidt, formerly chief engineer of the Dubuque (Iowa) Electric Co., is now chief engineer at T. H. I. & E. Traction Co., Terre Haute, Ind.

M. H. Owens, formerly manager of Hobart City plant, Hobart, Ind., is now manager of the Inter-State Public Service Co., for Columbus and Seymour, Ind.

H. E. Smith, formerly chief engineer at T. H. I. & E. Traction Co., Terre Haute, Ind., is now chief engineer of the Indianapolis (Ind.) Light and Heat Co.'s Mill Street plant.

Charles H. Parker, who has been with the Edison Electric Illuminating Co., of Boston, for the last 22 years, has been appointed superintendent of the generating department, of which he has been assistant superintendent for 17 years.

Milton Kraemer, consulting engineer, of San Francisco, has undertaken an investigation into the utilization of coals, mined in California and neighboring states, for use as fuel in a pulverized form. This will be a continuation of a study made in 1916 and the early part of 1917, for some of the large California power companies.

Frank W. Hall has been appointed commercial manager of the Sprague Electric Works of General Electric Co. With the exception of a short period, Mr. Hall has been connected with the Sprague Works continuously for 22 years in various engineering and sales capacities, and for the three years prior to his present appointment occupied the position of sales manager. He succeeds D. C. Durland, former executive head of the Sprague Electric Works, who resigned to acecpt the presidency of the Mitchell Motors Company, Inc.

Business Items

Gannestad & Jacobsen, engineers, of Pittsburgh, Penn., have removed from the Benedum-Trees Building to Suite 1103-1106, B. F. Jones Building, where they have more spacious quarters to take care of increasing business.

Engineering Affairs

Fuel Conservation in Boiler Rooms is the subject of a meeting under the auspices of the Baltimore Section, American Society of Mechanical Engineers, the Engineers' Club of Baltimore and the City Club at the rooms of the last, Thursday evening, Jan. 10. Efforts are being made to have a large attendance of firemen, among others. Charles H. Bromley, associate editor of "Power," will give the main address of the evening, followed by W. L. DeBaufre, of the United States Naval Experiment Station, Annapolis, Md., and others. The meeting will be the first of a number to arouse more general interest in fuel economy in boiler plants.

Miscellaneous News

Public Hearing on New Jersey Boiler Code—Before the code formulated by the State Board of Boiler Rules is adopted finally, a public hearing will be held at which minor changes will be discussed. This was the decision of the board at a conference recently held, presided over by J. F. Scott, chief of the License Board of the Bureau of Engineers.

According to the November Bulletin of the New York State Department of Labor, the metals, machinery and conveyances group had an addition of more than 1 per cent. to the number of employees, and paid 3 per cent. more wages in November than in October. The water, light and power group in November had more than 1 per cent. additional employees, and a slightly greater payroll than in October. As compared with the corresponding month of last year, November reported gains of 4 per cent. in the number of employees and 19 per cent. in the wage volume.

New Power Site Reserve—The Secretary of the Interior recently recommended, and the President has approved, the inclusion within a power-site reserve of about 196 acres of public land in the Big Sandy River Basin, Oregon, in order that this land may be used in connection with the development of power, but not for other purposes. Big Sandy River has its source on the western slope of the Cascade Range, and its principal tributaries are fed by the glaciers of Mount Hood. The land recommended for withdrawal is located near or adjacent to Big Sandy River below the mouth of Salmon River.

The withdrawal for power-site purposes of a tract within the Eldorado National Forest, Cal., has also been recommended by the Secretary of the Interior and approved by the President.

Free Class for Radio Operators at Stevens Tech.—A free evening class to train men as radio operators for the Signal Corps will soon be started by the Stevens Institute of Technology at Hoboken. Those who actually expect to be called to the colors will be admitted into the class if prompt application is made to Prof. L. A. Hazeltine, head of the Department of Electrical Engineering, under whose supervision the course will be conducted. The definite object of the course which will require four evenings each week, is to develop radio or buzzer operators so as to be able to send a minimum of 20 words per minute. Upon finishing the course, which requires about 200 hours, less for some and more for others, a certificate of attainment will be given. The course is offered specifically for those who desire to enter a cantonment trained and ready to do a specific job. The authorities at Washington state "that drafted men who attain the required proficiency are practically certain of rapid promotion and increased pay in the Army. The rank of corporal and sergeant with a wage of from $36 to $51 a month awaits the majority of men thus trained, and in proportion as a man so instructed shows his ability and interest, promotion lies ahead of him to the position of Master Signal Electrician, with a wage of $81 a month.

The Army and Navy Staff Departments continue to demand men of engineering experience, especially in industrial lines. At present the outlook is that this demand will continue throughout the period of the war. In calling attention to this, the United States Public Service Reserve, Washington, D. C. (where records of men willing to serve when called will be kept on file), points out that a man of engineering experience has a rare combination of opportunities open to him, which are not open to the average patriotic American, as follows: (1) To serve the country in his most effective capacity; (2) to keep in touch with his own profession, with the result that his patriotic service will not have caused him to become rusty by the time peace returns; (3) to become a commissioned officer and receive much better pay than the average man who has wholly subordinated personal interests and now works for the national good; (4) to perform his service usually without leaving the United States

Technical Troops for France—Skilled engineers and "handy men" wanted, 18 to 21 or 31 to 40. Jerseymen, volunteer before these regiments are filled from other states. There are now being organized and enlistments are invited for (N. A.): 20th Engineers (Forestry), 23rd Engineers (Highway), 24th Engineers (Shop and Supply), 25th Engineers (Construction), 26th Engineers (Water Supply), 27th Engineers (Mining), 28th Engineers (Quarry), 30th Engineers (Gas and Flame), 37th Engineers, 38th Engineers (Crane Operators), Engineers Unassigned, Washington, D. C. All applicants are enlisted as privates; but may soon advance as corporals and sergeants when found qualified. Applicants must have the same physical examination as any other recruits. A technical worker or handy man in any of the mechanical industries will find in the above field of enlistment a rare opportunity. If of draft age no man can volunteer. Enlistment is for the period of the war only. No cards from Engineer Officers are required except for 37th and 38th Engineers (N. A.) The enlisted personnel of the Engineers N. A. (Crane Operators) will be approximately as follows: 200 locomotive crane operators (operation of railway constructing derricks, cargo-handling machinery on lake, ore and coal docks and first-class steam shovel runners), 32 Rotary Tenders, 16 Armature Winders, 16 Electrical Foremen, 16 Storage Battery Charging Men, 16 High Tension Wiremen, 144 Journeymen Electricians, 8 Cooks. It is proposed to limit enlistments in the 37th and 38th Engineers N. A., to those men whose vocational training has been examined and approved by officers representing the Engineer Department. Applications for enlistment in the 37th Engineers should be addressed to Chief of Engineers, Washington, D. C., and in the 38th Engineers to same or to the Director General of Railways, Washington, D. C. For the other Engineer Regiments (N. A.) apply direct to any recruiting office. The above regiments are National Army. In addition, men are accepted for the Engineers, regular army. Recruiting stations: Main office, 86 Park Place, Newark, N. J., near McAdoo Terminal; Paterson, 269 Main St.; Passaic, 215 Main Ave.; Elizabeth, 55 Broad St.; Trenton, 103 E. State St.; New Brunswick, Post Office Bldg.; Atlantic City, 1536 Atlantic Ave.; Perth Amboy, 130 Smith St.; Camden, 540 Federal St.

Volunteers Wanted in Ordnance Corps—For every man on the firing line there are skilled men back of the line upon whose help and coöperation he depends. The enlisted Ordnance Corps of the National Army, into which the Ordnance Enlisted Reserve Corps has been merged, is that army behind the army which the great war has made more important than ever before. Unless the fighting man in the front-line trenches has the help and skilled coöperation of specialists behind him, his work is seriously hampered This is a war of specialists, and a man can serve his country efficiently by applying the result of his civilian experience to the work of the army. In the Enlisted Ordnance Corps, the skilled man continues the same type of work he pursues in civil life. The acceptance or card from an ordnance officer is no longer needed. The chief of ordnance is charged with the supply, maintenance, and repair of all cannon and artillery vehicles and equipment; all machines for the service and maneuver of artillery; all small arms, ammunition, harness, motor trucks, motor cycles, railroad cars, and also every device for the mechanical service of the front-line army. There is a definite place in the ordnance corps for the skilled man in almost every line of trade: Machinists, mechanics, plumbers, painters, tinsmiths, carpenters, auto mechanics, saddlers, blacksmiths, and wheelwrights are especially needed at this time. Military training, while desirable, is not essential, as men will continue the type of work they pursue in civil life, thus saving the Government a long period of instruction, and also greatly improving their own chances for advancement. If you are a skilled artisan, join the army behind the army. If handy with tools, perfect yourself with these technical troops. If accepted for enlistment, men will ordinarily be sent to an arsenal for a short period of instruction, upon completion of which they will be assigned to detachments, units, or organizations, with ultimate service abroad. Applicants must be between 18 and 21 or 31 and 40 years, and must be able to pass a physical examination conforming to that prescribed for the regular army. Registrants are not eligible for voluntary enlistment. In view of the work of the Enlisted Ordnance Corps, National Army, and the fact that the men in the first-line trenches depend upon their help and coöperation, a large number of men will be promoted as noncommissioned officers. Pay ranges from $30 to $61.20 a month, depending upon demonstrated ability and place of service. Enlistment is for the duration of the war only. In addition to the regular pay, free quarters, rations, clothing, bedding, medical and dental attention are provided by the Government, and 20% increase while on foreign service. There are also vacancies in other branches of technical troops: Aviation; Quartermaster Corps; Engineers; Sanitation, Hospital Corps; Heavy Artillery, Field Artillery. Also in the line: Infantry, Cavalry, U. S. Guard, etc.

How to enlist: If you are a mechanic or have a trade, call either at the Main Army Recruiting Station for New Jersey, at 86 Park Place, Newark, N. J. (near the McAdoo Tube Terminal), or at any of the following branches: 540 Federal St., Camden; 130 Smith St., Perth Amboy; 103 E. State St., Trenton; 55 Broad St., Elizabeth; 269 Main St., Paterson; 215 Main Ave., Passaic; Post Office Bldg., New Brunswick; 1536 Atlantic Ave., Atlantic City.

If working during the day, call until 9 P.M. for information.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$6.00—7.00
Buckwheat ..	4.30—5.00	2.75	5.05—5.75	5.50—6.00
Rice	3.75—3.95	2.20	4.50—4.75	5.00—5.50
Barley	3.25—3.50	1.95	4.00—4.25	3.75—4.00
Boiler	3.50—3.75	2.20	4.00—4.50	....

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).................	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Jan. 3, 1918	1 Yr. Ago	Jan. 3, 1918	1 Yr. Ago	One Year Ago
Buckwheat ...	$3.15–3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65–3.65	1.25	3.65	2.15	3.35
Boiler	2.45–2.85	1.10	3.55	2.00	....
Barley	2.15–2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago
6-in. lump..	$2.65–2.80	$3.50	$2.65–2.80	$3.50	$2.65–2.80	$3.50
2-in. lump..	2.65–2.80	....	2.65–2.80	....	2.65–2.80	3.50
Steam egg..	2.65–2.80	3.50	2.65–2.80	3.50	2.65–2.80	3.50
Mine-run ..	2.40–2.55	3.50	2.40–2.55	3.50	2.40–2.55	3.50
No. 1 nut..	2.65–2.80	3.50	2.65–2.80	3.50	2.65–2.80	3.50
2-in. screen.	2.15–2.30	3.50	2.15–2.30	3.50	2.15–2.30	3.50
No. 5 washed	2.15–2.30	3.25	2.15–2.30	....	2.15–2.30	....

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

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[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Mobile—The Mobile Electric Co. plans to build a 5-mi. transmission line to the Chickasaw Shipbuilding plant now under constructon. T. K. Jackson, Mgr.

Ark., Stuttgart—S. R. Morgan & Co., Little Rock, has been granted a franchise to build and operate an electric-lighting and power plant. Estimated cost, $100,000.

Calif., Palo Alto—The City Council plans an election soon to vote on $6600 bonds for the installation of a Diesel engine and an electric generator for the power plant.

Colo., Salida—The Colorado Power Co. plans to double the capacity of its local steam plant in order to supply the Rawley mine with electricity. W. E. Robertson, Mgr.

Ga., Atlanta—City plans to install an electric generating plant at the city incinerating station. A. Turner, City Electrician.

Idaho, Shelley—City plans to install an electric-lighting system.

Ill., Joliet—The Chicago & Joliet Electric Ry. Co. plans to build 2 substations, 1 at Osgood and St. Louis Sts. and the other at Delwood Park. Estimated cost, $50,000. J. R. Blackhall, Gen. Mgr.

Iowa, Marshalltown—The City Council plans to build a new electric-lighting plant and install new machinery and equipment. W. H. Steiner, Engr.

Kan., Burns—City plans to install an electric-lighting plant. Estimated cost, $10,000. C. A. Beebe, City Clk.

Md., Mt. Savage—The United Big Vein Coal Co. plans to install electrical mining machinery and completely electrify its plant.

N. J., Hightstown—Grover Bros., Broad St., plans to install an electric-lighting plant in connection with its works.

N. Y., New York—(Borough of Brooklyn)—The Transit Development Co., subsidiary of the Brooklyn Rapid Transit Co., has had plans prepared for the erection of an addition to its generating power station on Kent and Division Ave. Estimated cost, $500,000. H. A. Robbins, 85 Clinton St., Supt. of Power.

Ohio, Cleveland—City is having plans prepared by F. H. Betz, Arch., City Hall, for the erection of a 4-story, 80 x 250-ft. addition to its electric-lighting plant on 53rd St. Estimated cost, $1,750,000. Noted Sept. 25.

Ohio, Cleveland—The New York Central R.R. plans to build a 40 x 79-ft. power house and install new electrical equipment, generators, motors, etc., here. J. W. Kittredge, New York City, Ch. Engr.

Okla., Durant—The Consumers' Light and Power Co. plans to rebuild and equip its electric-lighting plant which was damaged by fire. W. H. Williams, Engr.

Okla., Miami—The Bilharz Mining Co. plans to build a central electric generating plant to supply power for plants 1, 2 and 3.

Ont., Perth—The Hydro-Electric Commission plans to build a 26,400-volt transmission line between Perth and Smith's Falls.

Ont., Wiarton—The Hydro-Electric Power Co., Ontario, is having plans prepared for an electric-light and power plant to be erected here.

Ont., Windsor—The City Commissioners plan to install 2 new electrically driven pumps in its pumping plant.

Penn., Coaldale—The Panther Creek Valley Hospital is having plans prepared by L. Stockton, Arch., 35 West 39th St., New York City, for the erection of a 1-story power house. Estimated cost, $8000.

Que., Valleyfield—The Montreal Cotton Co. plans to rebuild its power plant which was recently destroyed by fire. Loss, $100,000.

S. D., Preshn—O. E. Helgerson has been granted a franchise for the installation of an electric-lighting system.

Tex., Marfa—The Marfa Electric and Ice Co. plans to install additional machinery in its electric-lighting and power plant.

Wash., Glacier—The Lone Jack Mining Co. plans to install a power plant at its works on Silesia Creek. Estimated cost, $20,000.

Wash., Seattle—The Puget Sound Machinery Depot is having plans prepared for the erection of a 160 x 240-ft. boiler shop and will install new machinery and equipment in same.

W. Va., Ansted—The Mill Creek Colliery Co. plans to rebuild its power plant which was recently destroyed by fire. Loss, $40,000.

Wis., Kaukauna—The Kaukauna Electric Light Co. plans to extend its transmission line to Fairview Heights. W. B. Montgomery, Mgr.

POWER

Vol. 47 NEW YORK, JANUARY 15, 1918 No. 3

THE BOYS WHO SWING the SHOVELS DOWN BELOW

BY W. A. DUNKLEY

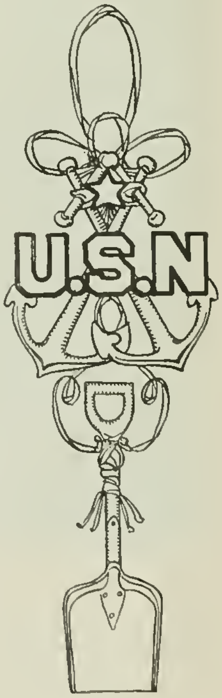
IN THESE DAYS of high excitement, when all eyes are on our fleet,
And much homage on our sailors we bestow,
Let us not forget to honor and to give due share of praise
To the boys who swing the shovels down below.

THEIR DEEDS may lack the glitter of the men above the deck,
As they toil and sweat deep down within the hold,
But their courage is as noble and their service is as great,
Though the valor which they show is seldom told.

THEY DO NOT SHOOT torpedoes and they do not work the guns,
But they fit as much into the general scheme,
For you cannot fight a battle and you cannot chase the foe
Unless you have a good supply of steam.

WHILE, ABOVE, the battle rages, you will find them on the job,
Sweating blood and grimly hanging to their task;
And if the good ship founders, then their hope of life is small,
But the chance to serve their country's all they ask.

SO IN VICTORY or disaster give these boys their honor due,
Count them heroes in a land where heroes grow;
And remember that our Navy has no braver names enrolled
Than the boys who swing the shovels down below.



Multi-Stage Compression Plant of Central Cold Storage Co.

Modern two-unit ammonia plant of 500 tons refrigerating capacity employs new D. I. Davis system of multi-stage compression with cooling of vapor between stages. It is expected to save in power 25 per cent. over the standard simple compressor and to develop one ton of refrigeration on less than 25 lb. of steam per hour.

FOR low-temperature work where brine temperatures running below zero are required, the standard compression plant has not been looked upon with favor. Boosters have been employed to increase the capacity of the compressor, but more often this class of work has been regarded as belonging to the absorption plant. The poor economy of the compression system in this work is due to several factors, developing as a direct result of the low suction pressures corresponding to the low temperatures in the refrigerator. As the suction pressure is reduced, there is a rapid falling off in the capacity of the compressor without a corresponding reduction in the power required. At lower suction pressures the ammonia vapor occupies more space and the volumetric efficiency is reduced. For example, with a suction pressure of zero, one pound of ammonia would occupy about 17.6 cu.ft.; with a 30-lb. suction pressure, only 4.5 cu.ft. For these reasons the standard single-cylinder compressor was both uneconomical and expensive for low temperatures.

In the development of the compression system[1] devised by D. I. Davis, of Chicago, and perfected commercially by the Vilter Manufacturing Co., the above objections have been eliminated and extremely low temperatures can be economically produced. The outstanding features of the new system are multi-stage compressors and the cooling of the vapor between stages by the refrigerant to a temperature corresponding to the saturation point for the intermediate pressure. The use of two cylinders decreases the temperature range per cylinder with the attending advantages, and reduces the heat of compression. The cooling between stages permits of making the high-pressure cylinder smaller and keeps down the temperature of the discharge to the condenser.

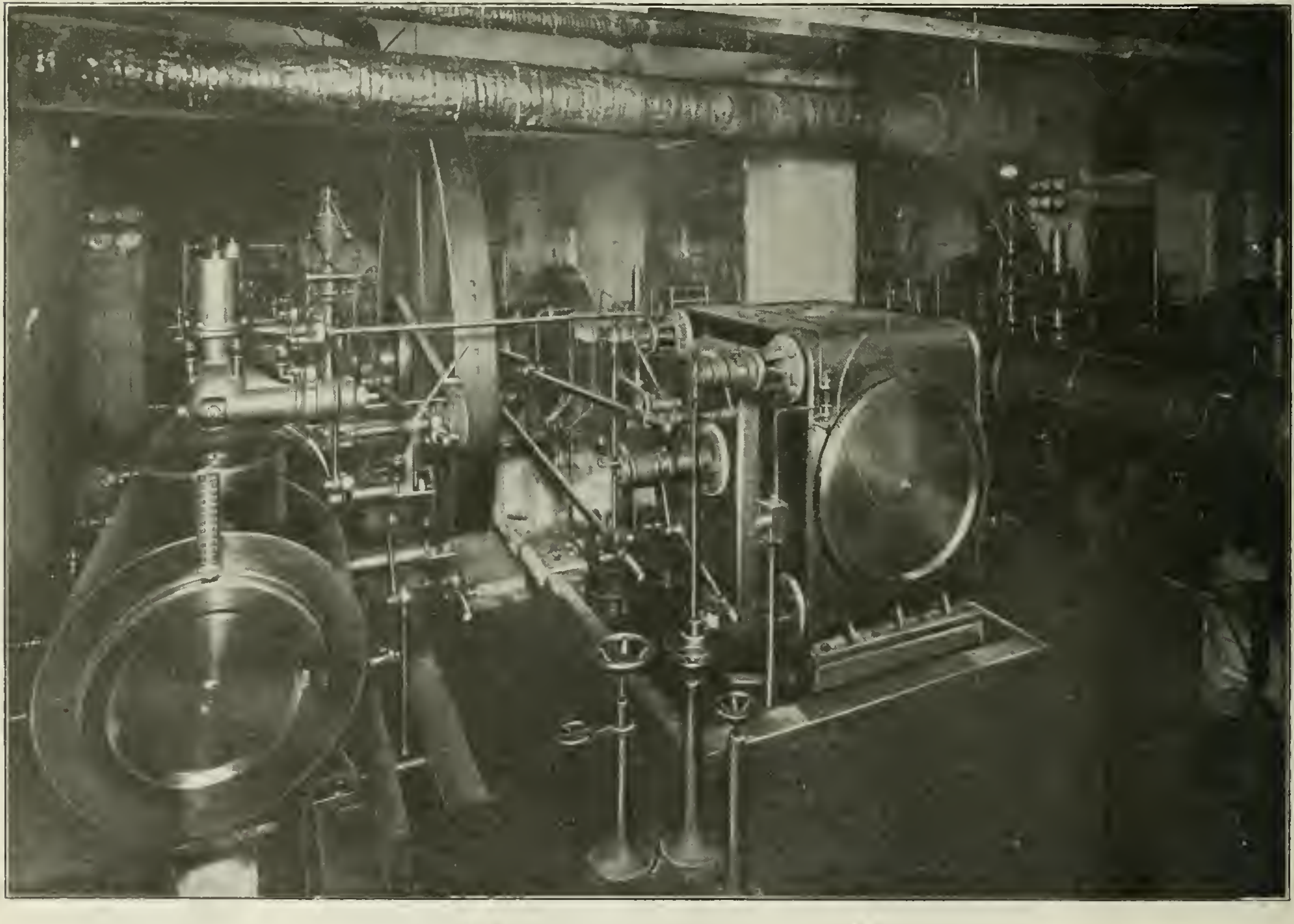


FIG. 1. STEAM END OF ONE OF THE 250-TON COMPRESSORS

A two-unit 500-ton plant of this type has been installed recently by the Central Cold Storage Co., Dearborn and Kinzie Sts., Chicago. The building is a 14-story structure of steel and reinforced concrete faced with brick. It is adjacent to the Chicago & North

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[1] See "Power," Dec. 19, 1916, p. 844.

Western R.R. tracks, has excellent facilities for teaming and is a short distance from the Chicago River, from which feed water for the boilers and condenser cooling water is obtained. The building contains over 9 acres of floor area and 3,500,000 cu.ft. of cold storage.

The first floor is given over to receiving and shipping. Cooling rooms in which the temperature ranges from 30 to 40 deg., depending upon the product stored, occupy the second to the eighth floors inclusive, and from the ninth to the fourteenth floors are freezers with temperatures of 10 deg. below zero maintained by brine circulated at temperatures ranging from 18 to 22 deg. below zero.

The building has a total of 39 refrigerated rooms. It is divided into six independent sections and is equipped with 60 miles of 2-in. piping for circulating the brine. In each room the coils are divided into sections, and only as many sections as are needed to give the desired temperature are used. Temperature regulation is effected in this way rather than by varying the temperature or circulation of the brine.

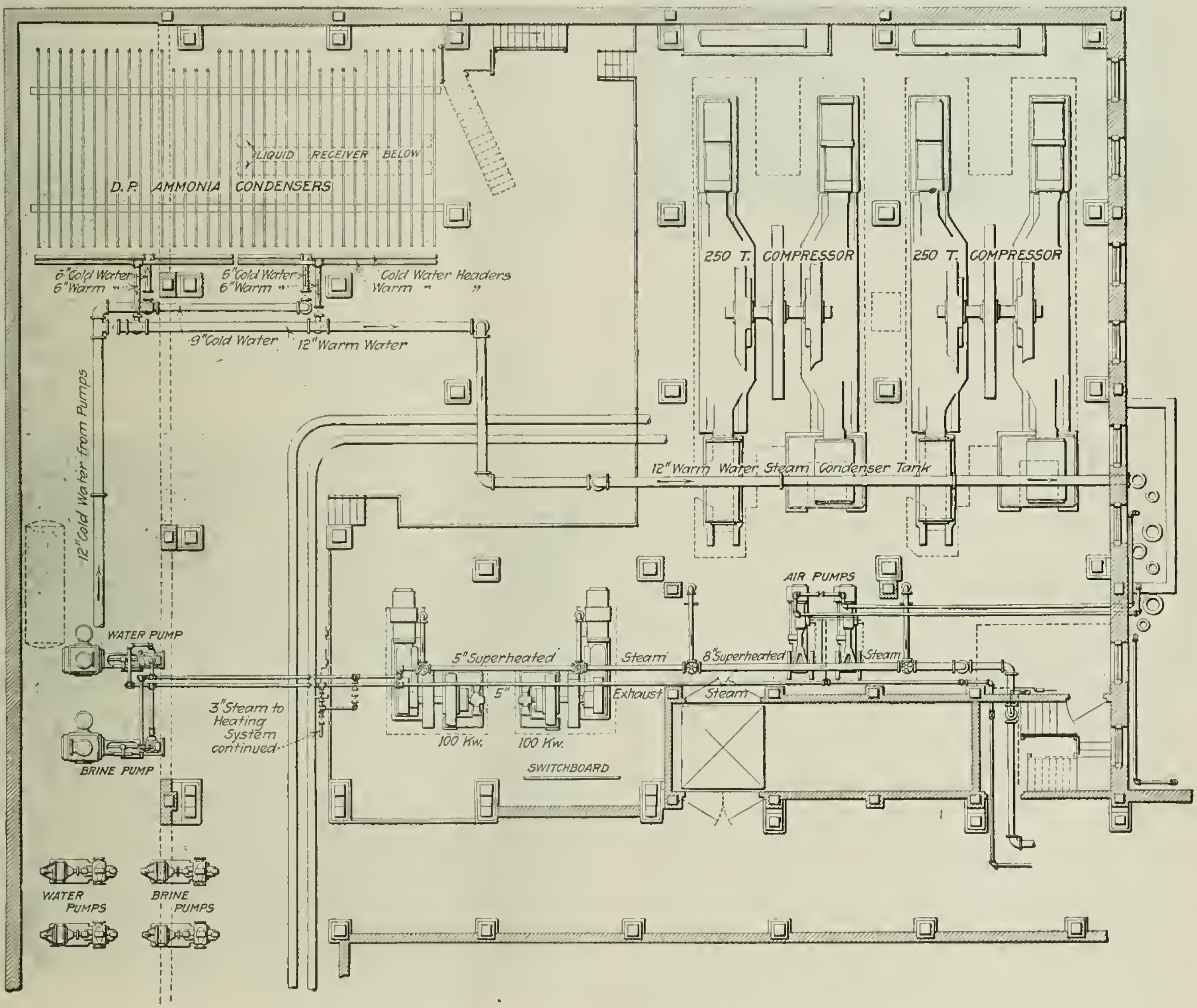

FIG. 2. LAYOUT OF EQUIPMENT, CENTRAL COLD STORAGE CO., CHICAGO, ILL.

To insulate the building required more than 1,500,000 board feet of corkboard. The insulation runs continuously from the second floor to the top of the roof slab. The first layer of cork was bonded to the brick surfaces of the walls by a ½-in. bed of portland-cement mortar. The second layer of cork was then erected against the first in a bed of hot asphalt and held in place by hickory dowel pins. All joints of the second course were broken, with respect to those of the first, and sealed with hot asphalt. All exposed surfaces throughout the building were finished with two coats of portland-cement plaster to a thickness of ⅝ inch.

All exposed wall areas from the second to the ninth stories were insulated with 5 in. of cork and wall surfaces abutting adjoining buildings with 4 in. of cork. From the ninth story to the roof where the freezers are located, 6 in. of cork, composed of two layers of 3 in. each, is used. Two partitions running from the second floor to the roof and dividing the building into three distinct sections, also have 6 in. of cork. The entire second floor was insulated with 4 in. of cork in two layers, and the third-floor ceiling over the offices and display rooms has 5 in. of cork insulation laid in concrete forms and suspended from the under-ceiling slab. The ninth floor is insulated also with 5 in. of cork in 3-in. and 2-in. layers laid in concrete forms, bound together with ½ in. of portland cement and adhered to the concrete slab when it was originally poured. The roof area was insulated with two layers of corkboard, one 4-in. and one 3-in., laid in hot asphalt and covered with seven-ply built-up roofing. The building columns from the footings in the sub-basement to the third-floor slabs are covered with two 2-in. layers of cork. Forms were then placed around the insulated steel columns and a layer of concrete poured over the cork.

In the sub-basement of the building is the refrigerating plant, the general layout, with the exception of the boiler room, being shown in Fig. 2. The compressors are of the double-acting cross-compound type. The low-pressure cylinder, or the first stage of the compressor, is 28-in. diameter by 48-in. stroke, while the diameter of the high-pressure cylinder is 20½ in. The compressor is directly connected to a cross-compound condensing engine, 20 and 42 by 48 in., the high-pressure cylinder being of the poppet-valve type designed for superheated steam and the low-pressure cylinder equipped with standard Corliss valve gear. The speed is 60 r.p.m. The flywheel is 18 ft. diameter and weighs approximately 28,000 lb., as compared to 300,000 lb. for the entire unit. The floor space occupied by each unit is approximately 18 × 46 = 828 sq.ft., or 3.3 sq.ft. per ton of refrigerating capacity.

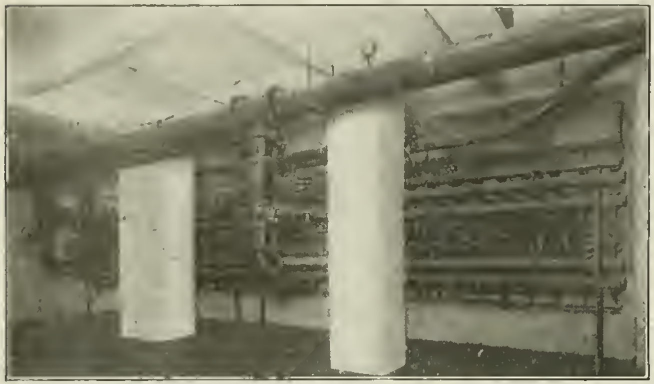
FIG. 3. DOUBLE-PIPE CONDENSERS

Both compressors and engines are equipped with a central oiling system with telescopic oilers on crank and crosshead pins and sight feeds on other bearings. The oil is supplied by gravity from an overhead tank. The surplus from the bearings is drained to a tank below the floor level and pumped back through a filter to the overhead tank. There are also force-feed pumps for cylinder lubrication and sight-feed oilers for the exhaust-valve levers of the high-pressure steam cylinders.

The steam end of each unit is supplied with a barometric condenser, giving about 27½ in. of vacuum, and the compressor end has a double-pipe ammonia condenser. The latter has 12 sections 12 pipes high, made up of 2- and 1¼-in. pipes 20 ft. 6½ in. long. The condenser is divided to give satisfactory distribution of the water, which is drawn from the river by any one of three circulating pumps. Two are centrifugal pumps, one for each unit, each having a capacity of 1000 gal. per min. and driven by a 40-hp. motor, while the third is a direct-acting 16 and 20 by 20-in. simplex steam pump. Under normal conditions, each condenser requires about 635 gal. of water per minute. After the water has passed through the ammonia condensers, part of it passes to a large tank between the second and third floors for boiler feeding and the balance through the barometric condensers back to the river.

Calcium-chloride brine of density 1.260 is used. Its temperature is lowered to 22 deg. F. below zero in four brine coolers of the horizontal shell type, two being provided for each compressor. Each cooler has twelve sections and a capacity to care for 150 tons of refrigeration. The brine is circulated through the house and discharged into an open tank on the top floor, returning thence to the pumps and again passing through the same cycle. The system is thus practically balanced, with only a 20-lb. friction head to overcome. In type, capacity and number, the brine pumps are the same as those used to circulate the condenser water, with the exception that the centrifugals are driven by 30-hp. motors.

Steam is supplied to the plant by two 400-hp. Stirling boilers generating steam at 175 lb. pressure and 103 deg. superheat. The boilers are served by chain grates and natural draft is supplied by a steel stack 6 ft. 4 in. diameter and 195 ft. 4 in. high above the boiler-room floor. Coal comes in on the railway tracks serving the building and is dumped directly into the coal bunker underneath and is wheeled to the boilers. From pits under the stokers the ashes are shoveled into the boot of a bucket elevator discharging into a concrete tank on the second floor, with a chute leading to the railway cars.

As previously stated, feed water comes originally from the river, first passing through the ammonia condenser, then to a large storage tank and finally under float control to an 800-hp. open heater. Duplicate simplex feed pumps, 10 and 6 by 12 in. take the water from the heater and feed it to the boilers. At each boiler is a manifold, from which the feed may be supplied to the boiler through a ¾-, 1- or 1¼-in. valve, the choice of valve depending upon the rate at which the boiler is being driven. In this way the demand for water can be followed closely and the pump maintained in constant operation, with little need for regulation.

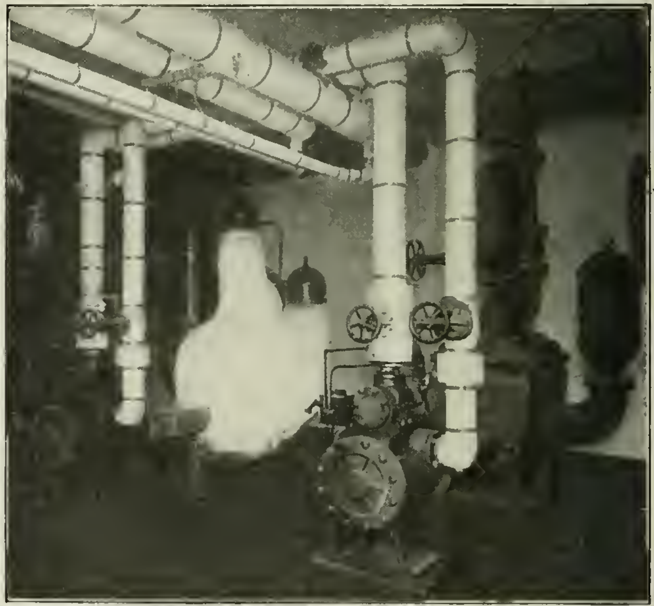
FIG. 4. BRINE AND WATER CIRCULATING PUMPS

To supply electric light and power to the six electric elevators serving the building and to the motors driving the pumps, fans and ash hoist, two 100-kw. direct-current generating units have been installed. The ammonia-compressor engines are of the uniflow type, 15 x 17 in. At the time of the writer's visit, one of the barometric condensers was serving a compressor engine and the two lighting units. The vacuum approximated 27½ in. The generators are directly connected and are rated to deliver 400 amp. at 240 volts. The load runs as high as 700 amp., so that the two units are frequently required.

Having reviewed the equipment of the plant, the ammonia cycle may be followed more clearly. Ammonia vapor from the brine coolers is drawn to the low-pressure cylinder of the compressor at a pressure of 1 to 4 lb. From the low-pressure cylinder it is passed to an intermediate drum having a pressure of 25 to 30 lb. The vapor heated by this compression is cooled by wet vapor coming from a liquid cooler located between the condensers and the brine coolers. There is also means of introducing liquid ammonia into this drum if required and a trap to return excess liquid to the liquid cooler. The vapor cooled to the temperature corresponding to the saturated point at this pressure then passes to the high-pressure cylinder and is further compressed to a condenser pressure of 165 lb. It is necessary to cool the liquid ammonia coming from the condenser to a temperature corresponding to its evaporation point before it can do useful work. Instead of doing all this in the refrigerator, or in this case the brine coolers, the liquid is passed through the liquid ammonia cooler, previously referred to, located between the condensers and the brine coolers. Ammonia from the liquid receiver at the condenser is expanded into the cooler and is returned to the high-pressure cylinder through the intermediate drum as previously explained. Coming from the condenser the liquid ammonia has a temperature of 90 deg. F., and when leaving the heat exchanger or liquid cooler, its temperature is reduced to 17.5 deg. F. This drop in temperature of 72.5 deg. is effected with a suction pressure of 25 to 30 lb. instead of the 1 to 4 lb. for the low-pressure cylinder. In the brine coolers the liquid must be cooled to its evaporating temperature, a comparatively small range. It is apparent that considerably less vapor than in the usual compression system must be handled by the low-pressure cylinder. It can therefore be made smaller and the power required per ton of refrigeration will be less.

Unfortunately, no complete test data are as yet avail-

FIG. 5. CENTRIFUGAL BRINE PUMPS AND BRINE COOLERS

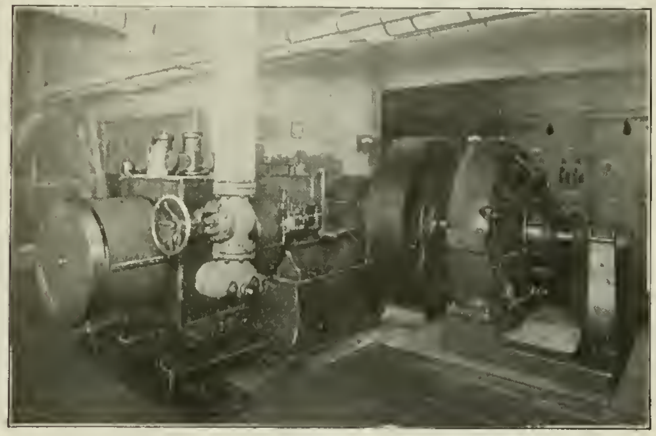

FIG. 6. ONE OF THE 100-KW. ELECTRIC GENERATING SETS

PRINCIPAL EQUIPMENT OF CENTRAL COLD-STORAGE REFRIGERATING PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Conpressors.	Two-stage	$20\frac{1}{2}$x28x48-in.	Compress ammonia vapor	Suction press., 1 to 48 lb.; discharge, 165 lb	Vilter Mfg Co.
2	Engines	Cross-compound	20x42x48-in.	Drive compressors	Steam press., 175 lb., 103 deg. superheat, 60 r.p.m.	Vilter Mfg Co.
2	Condensers	Barometric	9,000 lb. steam per hr.	Serve compressor engines	27 in. vacuum	Vilter Mfg. Co.
2	Pumps	Vacuum	$6\frac{1}{8}$x10x12-in.	Serve steam condensers		Union Steam Pump Co
2	Condensers	Double-pipe	12 sections, 12 high.	Serve ammonia compressors	165 lb. pressure	Vilter Mfg. Co.
4	Brine coolers	Shell-type	150 tons ref.	Cool brine	Outgoing temp., 22 deg., incoming, 16 deg.	Vilter Mfg. Co.
2	Pumps	Centrifugal	1,000 gal. per min.	Circulate brine	Driven by 30-hp. Crocker-Wheeler D C. motor	A. S. Cameron Steam Pump Works
1	Pump	Simplex	16x20x20-in.	Circulate brine		American Steam Pump Co
2	Pumps	Centrifugal	1,000 gal. per min.	River Water to Am. cond	Driven by 40-hp. Crocker-Wheeler D.C. motor	A. S. Cameron Steam Pump Works
1	Pump	Simplex	16x20x20-in.	River water to Am. cond		American Steam Pump Co
2	Engines	Uniflow.	15x17-in	Drive generators	Condensing, 200 r.p.m	Chuse Engine & Mfg. Co
2	Generators	Direct-current	100 kw	Generate electric current	240-volts, 400 amp., 200 r.p.m	(Western Electric) General Electric Co
2	Boilers	Stirling	400 hp.	Generate steam	175 lb. press., 103 deg. superheat	Babcock & Wilcox Co
2	Stokers	Chain-grate	80 sq.ft	Serve boilers		Babcock & Wilcox Co.
2	Superheaters	B. & W.		Serve boilers	103 deg. superheat	Babcock & Wilcox Co.
1	Stack	Steel, lined	6 ft 4 in diam., 195 ft. high	Serve boilers		American Bridge Co
2	Pumps	Simplex	10x6x12-in.	Boiler feed		American Steam Pump Works
1	Heater	Open	800 hp	Heat feed water	Exhaust steam from auxiliaries	Platt Iron Works
1	Pump	Simplex	7x$4\frac{1}{2}$x10-in.	House pump		American Steam Pump Works
1	Pump	Simplex	4x4x8-in.	Vacuum pump for office heating		American Steam Pump Works

Insulation, "Crescent" corkboard installed by United Cork Companies; Nugent Central oiling system and filter for compressor units; Richardson-Phenix force-feed lubricators for cylinders; Powell sight-feed lubricators for exhaust valve levers of high-pressure steam cylinders, Hills-McCanna force-feed lubricators for uniflow cylinders; Jenkins steam valves; Jenkins water valves; New Bedford stop and check valves; Gato blow-off valves; Crosby safety valves; American steam traps; Vilter refrigerating valves and piping.

able. For three months previous to the present writing the plant had been in operation, carrying at least 3,000,000 cu.ft. of storage space. This load has never required more than one machine, and the usual practice is to run this one machine about 16 hours out of the 24. If the compressor is developing its rated capacity, 12,000 cu.ft. of space is being refrigerated per ton of refrigeration, with the compressor running two-thirds of the time and approximately one-half the space for low-temperature work, 10 deg. below zero in the freezers and brine at —18 to —22 deg. F. The temperature of the returning brine ranges from —12 to —16 deg. F., giving a rise of 6 deg. F. through the house. The average daily coal consumption for lighting, power and refrigeration has been as follows: July, 12.2 tons; August, 12 tons; September, 10 tons. On a basis of 11.4 tons per day, the average for the three months, 950 lb. of coal would be burned per hour. Of this it is estimated that 240 lb. is required by the generating units, leaving 710 lb. of coal per hour for the compressors, air pumps serving the condensers and the brine and water circulating steam pumps. This reduces to 2.84 lb. of coal per hour per ton of refrigeration, or with an evaporation of 8 lb. of water per pound of coal, 22.7 lb. of steam. From previous test data it is expected that the steam requirement per hour per ton of refrigeration will be held close to 20 pounds.

While the figures given are only approximate, it is evident that exceptional efficiency is being obtained not only from the refrigerating plant, but from the insulation as well. Test data, to be available soon, will be received with interest.

D. I. Davis and Co., architects and engineers, designed the plant and the refrigerating equipment was installed by the Vilter Manufacturing Co. L. E. Gibbons is chief engineer in charge of operation.

Suspended Templets and Their Application[*]

By TERRELL CROFT

Something about suspended templets for use where large foundations are to be constructed. Their advantages are pointed out, and various methods of suspending them are shown.

A SUSPENDED templet may be defined as one that is supported over and at a considerable distance above the foundation for which it is to locate the anchor-bolt positions. Fig. 1 gives a graphic definition, wherein *A* is the suspended templet hung from the roof-truss chords over the foundation excavation immediately below it. The applications for which suspended templets are desirable are those where a very large foundation or one that will contain a considerable number of anchor bolts is to be constructed. A templet of this character may, where the excavating is to be done by, and the foundation material to be handled with cranes, insure more economical construction. The reason is that the templet is supported in such a position that the movement of the material will not displace it or displace the foundation-bolt locations which it determines. Furthermore, it cannot be displaced by careless workmen or by material dumped from the cranes. The disadvantage of the suspended templet is that it is more expensive to erect than is one which is supported directly over and by the forms for the foundation.

The method of locating anchor-bolt positions with a suspended templet may be understood by a consideration of Fig. 1. The templet, *A*, has a small hole bored through it over each of the anchor-bolt locations. When it is desired to locate an anchor-bolt position in the foundation under construction, a plumb-bob is fastened successively to each of the cords *D*, which are dropped through the hole in the templet above; thus the pocket *B*, which is to be provided under each anchor bolt, is located. The form for the pocket is constructed in its proper location on the foundation footing, and the anchor plate, if it is to be built into the foundation, is placed in position. The forms for the pockets may be of either brick or wood. Each anchor plate is centered on the top of the pocket under the plumb-bob *E* suspended from above.

The forms are then constructed and the anchor-bolt casings *C* are placed to provide holes through the foundation for the anchor bolts. The anchor bolts are not inserted until after the foundation has been completed and the machinery which is to be mounted on it has been set in position. The anchor-bolt casings are supported at their bottoms by the anchor plates or by the upper faces of the pocket forms. At its top each anchor-bolt casing is braced to the top of the foundation form. The location of the top of each casing is, after it has been erected, checked again by plumbing down from the templet above. When the drop-lines from the templets are not in use, they are tied up high enough to be out of the way. When the crane is to be used, all the drop-lines must, of course, be pulled clear up above the templet so that they will not interfere with the movement of the crane. The plumb-bobs on the drop-lines are used only for transferring the points down from the templet to the foundation while the forms are being erected and to check the accuracy of the locations as the installation progresses.

In constructing templets for suspension, practically the same methods are followed as are used in assembling the templet for any large foundation. Ordinarily, the templet is made of planed $\frac{7}{8}$-in. planks fastened together with screws. It is first laid out and assembled either completely or in sections in the carpenter shop. Then it is carried to the building where it is to be suspended and either put together on the floor to form a complete unit and raised to its position under the roof trusses, or it may be raised in sections and then assembled on the timbers provided for its support just under the roof-truss bottom chords.

In locating the templet in its position under the roof-truss chord, the principal center lines are, by means of a transit, transferred from some reference point, either on a roof truss, side wall or column, to

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[*] Copyrighted, 1918, by Terrell Croft.

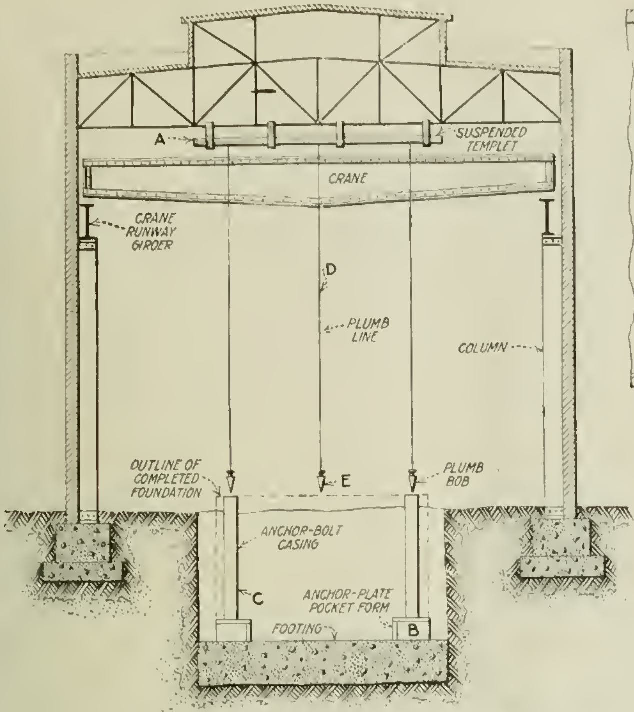
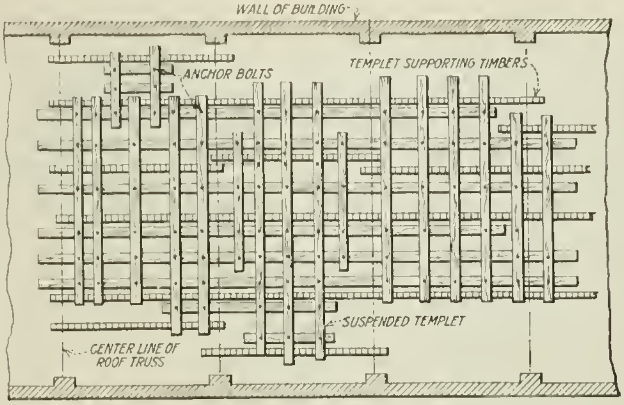


FIG. 1 APPLICATION OF SUSPENDED TEMPLET



PLAN OF SUSPENDED TEMPLET IN PLACE IN A MILL BUILDING

FIG. 2

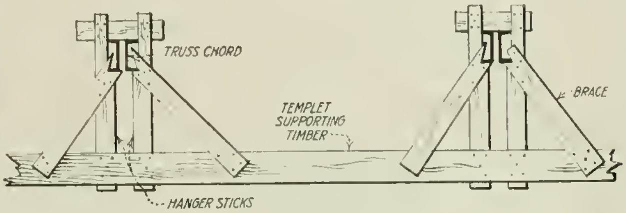
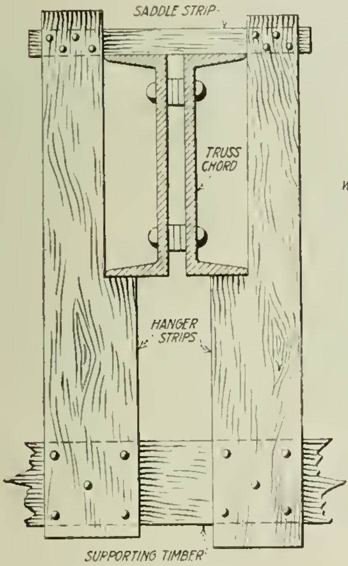
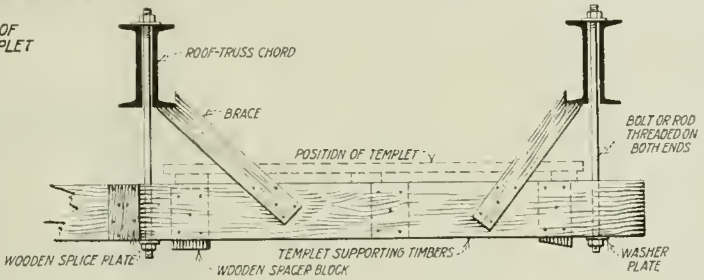


FIG. 3 WOODEN HANGERS FOR TEMPLET SUPPORTING TIMBERS



ONE METHOD OF HANGING SUPPORTING TIMBERS FROM TRUSS CHORDS

FIG. 4



TEMPLET SUPPORTING TIMBERS HUNG FROM ROOF-TRUSS ON BOLTS

FIG. 5

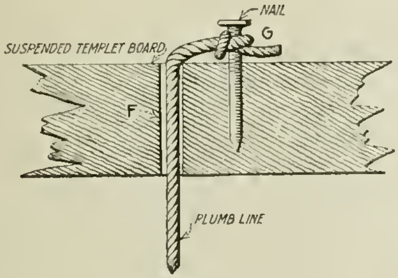


FIG. 6

METHOD OF ATTACHING PLUMB LINE TO TEMPLET

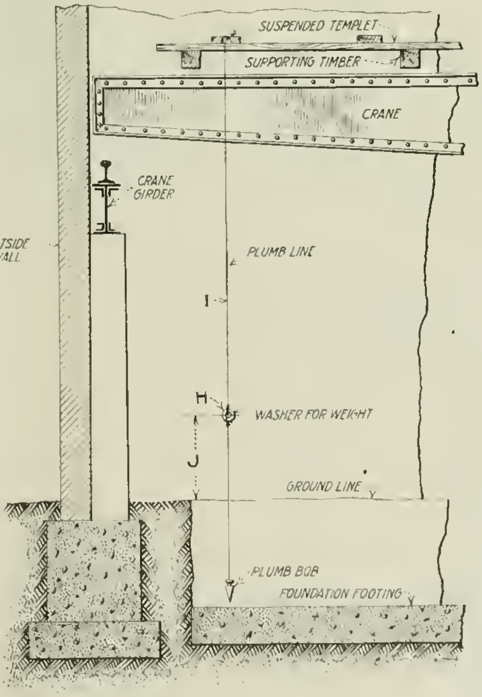


FIG. 7

APPLICATION OF WEIGHTED PLUMB LINE

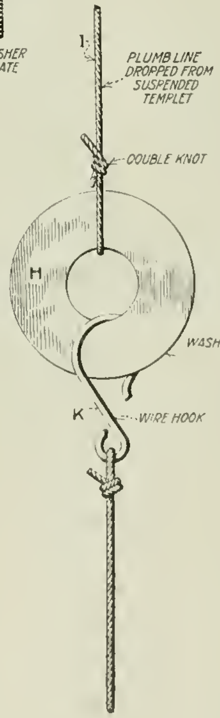


FIG. 8

DETAIL OF WASHER WEIGHT AND PLUMB BOB HOOK CONNECTION

FIGS. 1 TO 8. APPLICATION OF SUSPENDED TEMPLETS the templet itself, which must then be shifted on the timbers which hold it on the trusses until the templet has been accurately located in its position. A transit should be used, as just described, to center the templet both longitudinally and transversely. At the same time the principal center lines should be marked on some permanent member, such as a roof truss or wall, near the suspended templet so that the position of the suspended templet can, in the future, be checked for accuracy if necessary.

How templets are supported from the roof trusses is shown in Figs. 2, 3, 4 and 5. The planks upon which the templet rests (Fig. 3) are called templet-supporting-timbers. These have been shown shaded in the diagram of Fig. 2 so that they may readily be distinguished from the templet itself. These timbers are hung from the roof truss chords (Figs. 3, 4 and 5) and are braced in all directions so that they cannot shift after the templet has once been located in position and pinned to them with nails. For hangers, either portions of planks, bolts or iron rods threaded on both ends may be used.

Wooden hangers for templet-supporting timbers are assembled so that they form a yoke or tie over the roof-truss lower chords, as shown in Fig. 4. The assembly of Fig. 3 shows a templet-supporting timber sustained from each of two truss chords with wooden hangers. The braces provided to prevent longitudinal movement are also indicated in this illustration.

Hanger Bolts for Supporting Timbers

Bolt hangers for templet-supporting timbers may be employed as detailed in Fig. 5. The bolts thus used are available for other services after the foundation has been completed; $\frac{5}{8}$-in. rods threaded and provided with nuts on both ends constitute good tension rods for this service. Where hanger bolts are employed, two sticks with wooden separators between them are used to make up each girder. The bolt then passes through the space between the two timbers. A thorough system of bracing must be used to prevent any possibility of the shifting of the templet-supporting timbers. In Fig. 5 the position which the templet would occupy has been shown by dotted lines.

The best material for the drop-lines is a medium-weight linen fishline. Brown manila twine is probably next best. Ordinary white cotton twine is not satisfactory because it is not sufficiently strong.

The method of attaching the drop-lines to the templet is detailed in Fig. 6. *F* is a hole $\frac{3}{32}$ or $\frac{1}{8}$ in. diameter through which the drop- or plumb-line is passed to the foundation below. Into the templet near each hole a nail *G* is driven, to which the upper end of the plumb-line can be tied.

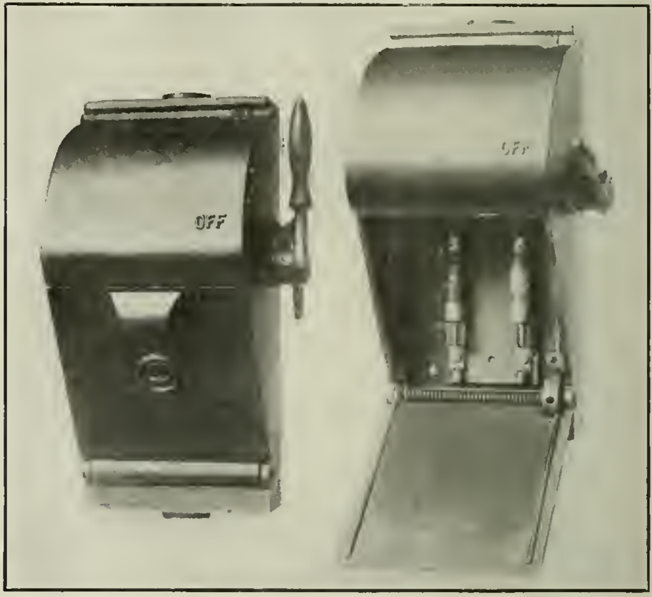
The drop-lines should be weighted at their lower ends to prevent them from becoming tangled with one another. Punched washers of sheet steel constitute excellent weights for this purpose. A washer *H* (Fig. 7) may be tied on the lower end of each drop-line *I*, as shown. The washers may be located at such a distance *J* above the surface of the ground that they can be readily reached; that is, it is not necessary or desirable to have the drop-line extend for the entire distance to the bottom of the foundation excavation. When an anchor-bolt location is to be determined, the plumb-bob line, which is provided with a hook *K* (Fig. 8), can be hung on the end of the main drop-line until the bolt location has been fixed. Then the plumb-bob line can be unhooked and carried to the next bolt location.

Safety-First Knife Switch

In all places employing men with practically no knowledge of electricity and its attendant risks, an absolutely safe switch has become a necessity. The real safe switch is one so constructed that all live parts are totally inclosed and inaccessible. Means should also be provided for preventing operation by unauthorized persons.

The switch shown in the figures, brought out by the Westinghouse Electric and Manufacturing Co., of East Pittsburgh, Penn., meets the foregoing conditions. The complete device consists of an ordinary single-throw knife switch and inclosed fuse holders mounted in a cast-iron box, with an operating handle outside the housing. The box is designed for conduit connection and has a partition separating the switch blades from the fuse holders.

The upper, or switch, compartment can be opened only by removing two machine screws and should be opened only when making connections or in case of inspection or repairs, as the switch is opened and closed by the operating handle, from the outside.

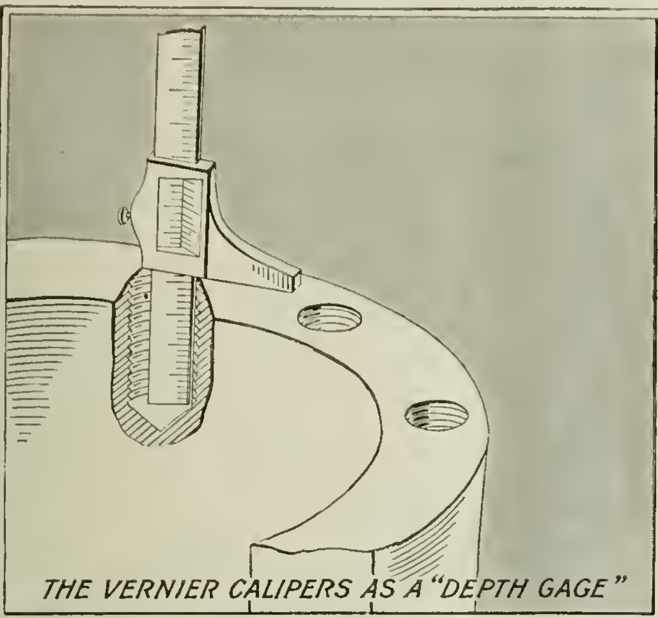


CLOSED AND OPEN VIEWS OF SWITCH

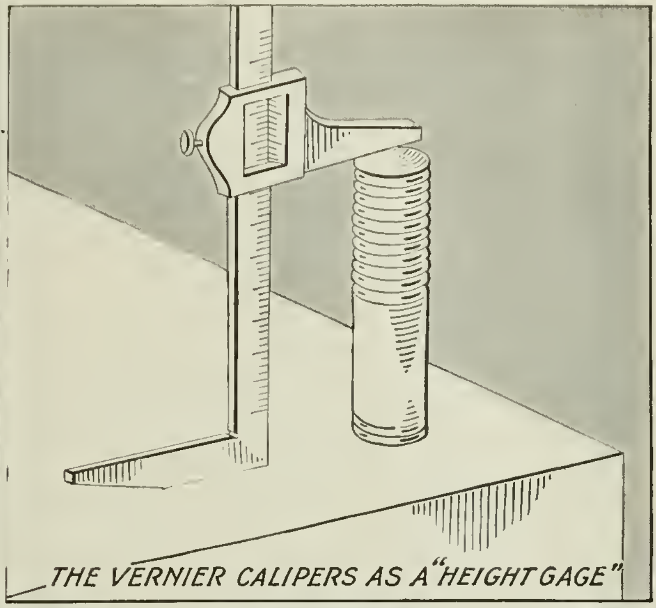
The lower, or fuse, compartment, containing the fuses and fuse holders, is the only part of the switch that need be opened, and then only to replace blown fuses. The door of this compartment is so interlocked with the switch that it can be opened only when the operating handle is in the off position and the circuit broken. Furthermore, with the door of this compartment open it is impossible to close the switch. The operating handle can also be locked with the switch in the open position, preventing tampering by unauthorized persons.

The City of Philadelphia has the distinction of having operated the first steam-pumped water system in the United States and also of operating the largest pumping plant in the world at present.

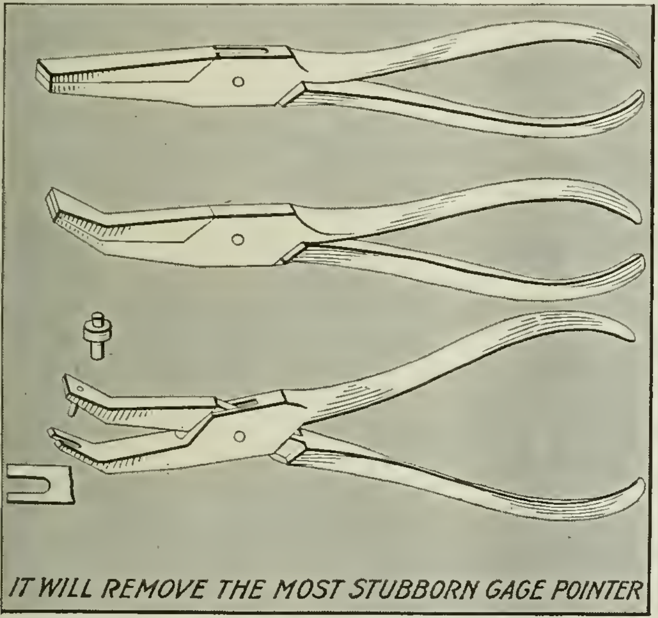
Kinks Worth Knowing



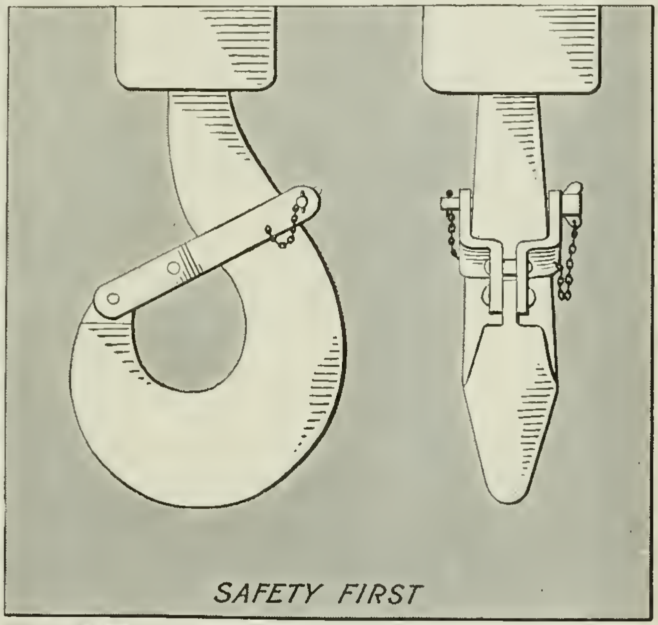
THE VERNIER CALIPERS AS A "DEPTH GAGE"



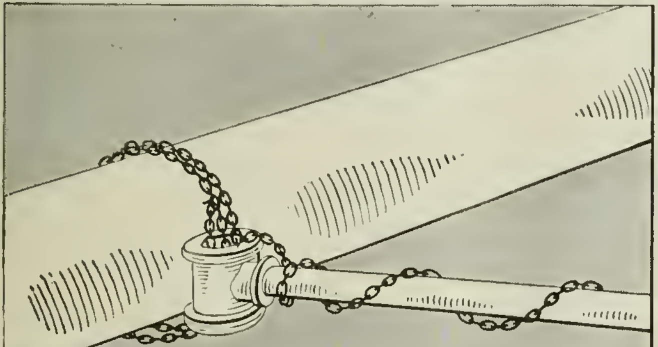
THE VERNIER CALIPERS AS A "HEIGHT GAGE"



IT WILL REMOVE THE MOST STUBBORN GAGE POINTER



SAFETY FIRST



AN EASILY-MADE WRENCH FOR LARGE PIPES

BOLTING A HOLE UNDER WATER

Selection of Coal and Ash Conveyors

By H. E. Birch
Structural and Mechanical Engineer, Philadelphia, Penn.

In selecting the equipment one should strike the best balance of operation, maintenance, investment and adaptability. Roller flight conveyor a desirable type. Flights over 24 in. should have two chains. Scraper conveyors limited to about 300 ft. length. Relative advantages of bucket and belt conveyors are considered.

There are four items which should control the selection of coal- and ash-handling equipment; namely, cost of operation, maintenance, interest on the investment and adaptability. These four are the constituent of the "O-M-I-A" formula, which should be applied in all cases to the bidders' competitive designs, to secure a well-balanced plant. A saving of several hundred dollars a year on power may warrant the investment in a more elaborate plant, but possibly this is offset by the greater depreciation factor or by the greater cost for labor required to operate it. All these items should be tabulated and a careful comparison made between the designs offered. The writer knows of one management corporation where the financial department makes the final selection after the engineers have secured all bids.

The benefits accruing through the installation of coal- and ash-handling equipment are many, the greatest probably being the saving effected in the wages. But this is not the only feature. There is the greater freedom from labor troubles, and the ease with which machinery can be managed, as compared with the management of unskilled workers. The unreliability of a large force of poorly paid and unskilled passers and ash men cannot be compared with the reliability of a few intelligent workmen operating well-designed and selected equipment.

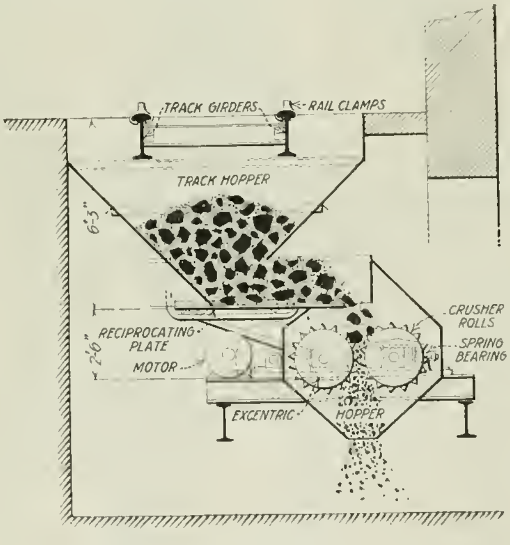


FIG. 1. TRACK COAL HOPPER AND CRUSHER

Many boiler houses have been equipped with coal- and ash-handling machinery, but many a man is often at a loss as to the type of equipment to install; and it is here that the first most serious mistakes are made.

It is desirable then, at this stage, to get the unprejudiced engineering advice of a coal-handling expert, to avoid building a monument of carelessness which will be costly to operate and maintain.

Realizing the need for service of this nature, several firms of contracting engineers have specialized in this branch, and at least one of them further attempts to build only coal- and ash-handling equipment for boiler and gas houses. To secure the most efficient plant it is often necessary to combine the wares of several manufacturers, but to successfully accomplish the desired result it is essential that the builder shall know thoroughly the uses and limitations of every standard device on the market. The result one is striving for is not necessarily the lowest first cost, but the proper balancing of the four factors—operation, maintenance, investment and adaptability.

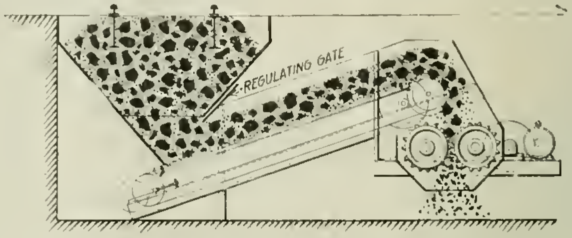


FIG. 2. ELEVATING COAL TO THE CRUSHER

There are two general ways of applying coal- and ash-handling equipment to a plant, one being to use one device for conveying both the coal and ashes, the other by providing separate machines for each duty.

The latter method is commonly referred to as the divorced system and is in use in nearly all the large Eastern power plants. The handling of ashes is usually considered as the severest duty that any conveyor may perform. The machinery must resist the destructive effect of the ashes in the chain joints, which cause rapid deterioration, and resist the distortion produced by hot ashes. Granting that the machine must be extra heavy and expensive to accomplish this result, it is unwise to use it for handling the coal, for although the ashes handled comprise but one-eighth to one-tenth of the total volume conveyed, the destructive action of the grit in the joints is in effect as long as the machine is in operation. For this reason chiefly the large stations years ago made the coal-handling machinery independent of that for handling ashes. When independent, one does not interfere with the operation of the other.

Let us assume the ideal condition of boiler-house location—that is, with the railroad track paralleling either the side or the end of the boiler house—and divide our study into three parts, as follows: (1) Unloading and crushing the coal; (2) elevating the coal vertically; (3) conveying the coal horizontally.

With the railroad track on the ground, a receiving hopper must be provided. One 10 ft. wide by 12 ft. long will be sufficient to receive the discharge from both doors of a standard 50-ton gondola. The outlet to this hopper is usually fitted with a reciprocating feeder which delivers to a double-roll crusher. The arrangement of this group is shown in Fig. 1.

Sometimes it is necessary or desirable to elevate the coal while feeding it to the crusher, when an apron feeder, Fig. 2, must be used. This arrangement is from two to three times as expensive as a reciprocating feeder, principally because the apron feeder should not be inclined more than 22½ deg., although the writer has seen one or two operating at 30 deg. This makes it a very expensive elevating device, and therefore it should not be used unless unavoidable.

Part 2 contains few machines to discuss. The leading devices used to directly elevate coal at boiler houses are all chain-and-bucket machines, varying in construction according to the use to which they are put. The oldest coal elevator consists simply of a single strand of short-pitch chain, having malleable-iron or steel buckets of cup-like form attached to it at suitable intervals, the size and spacing depending on the capacity desired, except that when they are too close, they will not dredge the coal properly. The discharge is effected by the speed at which the elevator runs, the centrifugal effect causing the material to leave the bucket. This machine is shown by Fig. 3. It is not used for first-class work or where the material is elevated very high, but for small capacities, 20 to 25 tons per hour, and where the conveyor does not work more than a few hours a day, it is economical and is to be recommended.

A far better type of machine for elevating the coal is the V-bucket elevator conveyor, Fig. 4. As built by Beaumont, it consists of two strands of steel chain with steel V-shaped buckets spaced at frequent intervals between the chains, the discharge being effected by gravity. To do this, it is necessary to change the path from the vertical to the horizontal, the usual methods of accomplishing this being shown diagrammatically in Fig. 4. The numerous paths through which this machine may operate, permit of its use in varied ways. Diagram *A* is the most common path, the horizontal run either extending for the full length of the bunker, if it is not too great, or arranging it to discharge into a scraper or belt conveyor immediately upon its assuming the horizontal path, as at *C*. The arrangement shown at *B* is often seen where this machine is handling coal for ground storage, the upper horizontal run discharging to a pile on the ground, while the lower run operates in a tunnel under the pile and reclaims the coal. This system was applied at the boiler house of the American Railways Co., Dayton, O., as shown by Fig. 5. Here, the V-bucket elevator conveyor serves both the boiler house and the ground storage, by adding the horizontal run of path *A* to path *B*. A cross-feeder is used to deliver the coal from the railroad cars to the lower run of the conveyor, first passing it through a double-roll crusher.

While the V-bucket elevator conveyor is undoubtedly the best elevating medium to use, it can be skimped, like any other good conveyor, until it is so cheaply built that good service is impossible. The chains are its "backbone," and these must be of steel for several reasons. If malleable-iron chains are used (as they sometimes are), the elevator will be subject to disastrous wrecks, for a casting is a casting and is liable to fail through various flaws to which castings are subject. A casting in tension is not the best thing in the world to depend upon. The connection of the bucket to malleable chains makes a weak point, for the connection holes are but a scant few inches apart and the buckets are liable to twist off when dredging the coal out of the feeding boot. Steel roller chains are not subject to any of these faults. Neither are the bucket connections weak, for they are attached to the pins at the chain joints. These pins should be large in diameter, say ⅞ in., and of 0.30 to 0.40 carbon steel. They should be unbushed and not attached to the chain side bars; the pin is then a floating pin, free to turn easily, thus distributing the wear over the entire surface. Cast-iron rollers are used at each chain joint, these coming into play on the horizontal runs and at turns in direction, where they are engaged by the sprocket wheels.

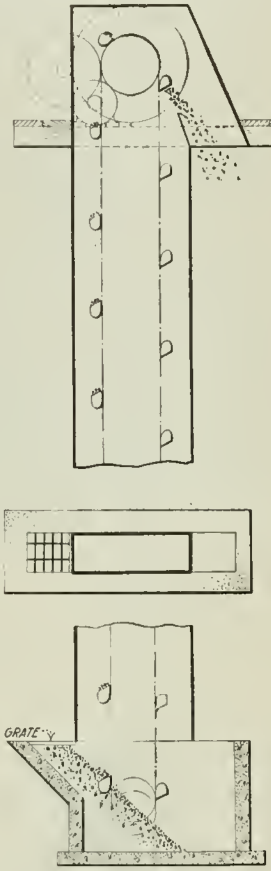


FIG. 3. SIMPLE BUCKET CONVEYOR FOR LIFTS UP TO 40 FEET

The buckets may be made of No. 10 plate as the coal does not wear them rapidly.

The trough is rectangular in cross-section, usually constructed of steel, with angle sides and a bottom plate at least $\frac{3}{16}$ in. thick. The upper flanges of the angles should have renewable wearing strips ¼ in. thick, for the roller chains to travel on.

The vertical runs are usually inclosed in steel-plate casings, No. 12 gage, and having corner angles to stiffen, besides connecting the plates. Sometimes the plates are flanged, but if this is done, look with suspicion on the rest of the equipment.

The capacity of a V-bucket elevator conveyor can easily be determined by simple arithmetic, but to avoid going through all these figures a good, conservative rule is: The cubic contents of the bucket in inches (water capacity) divided by 12 gives the tons (2000 lb.) per hour for a speed of 100 ft. per minute, the buckets being 12 in. apart. Other speeds and spacings are easily determined from this.

All sprocket wheels should have at least eight teeth, and shafts should be designed for both torsion and bending, allowing a working unit stress of not over 11,000 pounds.

A modification of the V-bucket machine is the continuous bucket elevator, which will operate in a vertical path and discharge directly over the head wheel, thus obviating the necessity of running horizontally to effect a discharge. This machine will also operate on an incline at any angle between about 45 deg. and the vertical. When discharging from the vertical position each bucket utilizes the back of the bucket in advance, as a chute, to deflect the material to the permanent chute delivering to the conveyor. Fig. 6 shows this machine in detail. The remarks concerning the V-bucket apply to this machine also, except, of course, there is no trough to convey horizontally. The last two machines are without doubt the best elevating mediums to use, regardless of to what they deliver.

The centrifugal discharge elevator should not be used except for small lifts at low capacity and where the machine does not work often.

Conveyors may be divided into two general classes—flight conveyors, and belt or pan conveyors. The first class is by far the commonest and is further divided into four types—the single-strand chain-scraper flight conveyor, the single-strand roller-flight conveyor, the double-strand roller-flight conveyor, and the screw conveyor. Figs. 7, 8 and 9 show the first three in the order named. The scraper-flight conveyor is much used for handling anthracite coal in retail yards, where breakage is a serious factor. It does not cause breakage because it is slow-moving and discharges easily through openings in the trough and also because the flight scrapes directly on the trough plate, avoiding the grinding of coal between the flight and the trough, which would happen with any of the other three types. It has been much used in boiler-house work on account of its simplicity and low cost, but it has lately been superseded on first-class work by the single-strand roller-flight conveyor, in which the chain and flights are supported above the trough by cross-spindles and rollers which travel on the channel sides of the trough. These rollers reduce the friction and the noise made by the scraper conveyor and such conveyors have greater capacity. The scraper-flight conveyor has malleable-iron flights with beveled corners to carry them over the gate openings in the trough and uses a single strand of malleable-iron chain.

The roller-flight conveyor uses a much stronger and more reliable steel chain and has steel-plate flights. The scraper flight is usually 5 in. deep and either 12 or 15 in. wide, depending on capacity, while the roller type of conveyor has flights 8 in. deep by 16 in. wide as a minimum, with 10 x 20-in. and 10 x 24-in. flights for greater capacities. Flights wider than this should not be used on a single-strand chain, for they will wobble.

Neither of the foregoing conveyors will handle run-of-mine coal, owing to the impossibility of getting the large lumps in the trough, which is obstructed by the chain in the center. For this reason the double-strand chain-roller flight conveyor is used for this purpose, and also when the conveyor is so long or so large that two chains are necessary to properly take the stress. Flights over 24 in. wide should have two chains, as already mentioned.

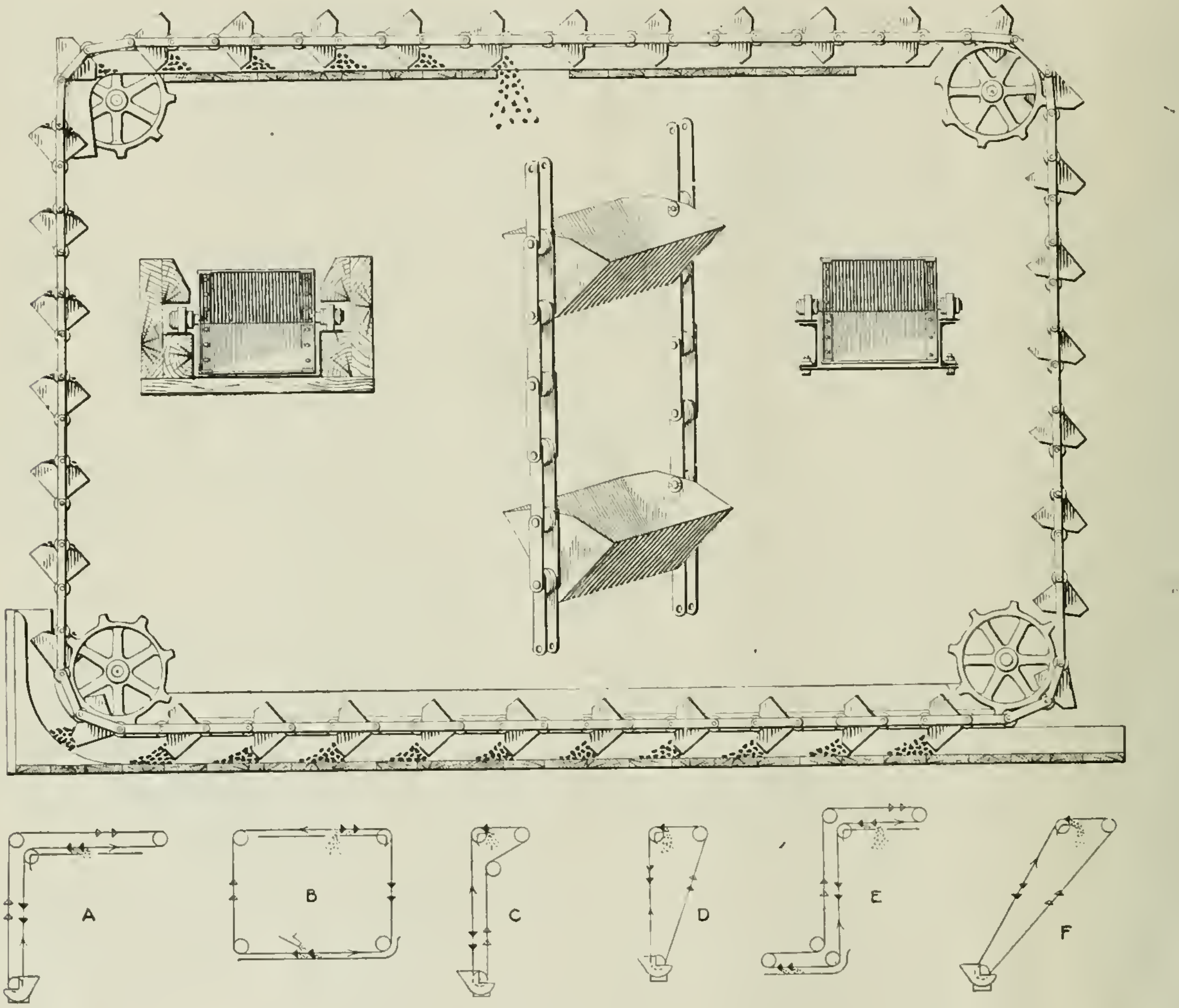


FIG. 4. V-BUCKET CONVEYOR AND ITS APPLICATIONS

A double strand of chain is used when it becomes necessary to bend the conveyor from an inclined run to a horizontal one, making a "hump." With a single-strand roller-flight conveyor, the stress imparted to the cross-spindles by the chain would probably bend them, although under small stress the resulting bending movement on the cross-spindle would be almost negligible. A scraper conveyor, where the flights scrape directly on the trough, could not be used this way, but would have to be broken, the conveyor on the incline discharging the coal into the horizontal conveyor.

SCREW CONVEYOR UNSUITED TO COAL

Troughs for these conveyors should be at least $\frac{3}{16}$ in. thick and should be bolted to the supporting channels to facilitate renewals. The remarks concerning chains, sprockets and shafts, previously made, apply here. The fourth type, the screw, mentioned for the sake of completeness, is not much used for conveying coal, being mostly used for grain and cement. The usual application to a boiler house is where pulverized coal is used. They consist of a blade wound spirally around a central shaft, the whole revolving in a U-shaped trough. The frictional losses are so large and the danger of breaks due to foreign material jamming at the shaft hangers are their bad features. They are very cheap, however, and this perhaps is the reason they are seen in boiler houses.

As to the second main class of conveyors, belts and pan arrangements, the former is by far the most popular; the latter can, in fact, be dismissed from coal handling at boiler houses, except for short feeders carrying run-of-mine coal to the crusher.

As a conveyor, it has two difficulties, one being the high cost and the other the impossibility of securing a discharge, except over the end of the conveyor.

The rubber belt has three advantages, but only two apply to boiler-house outfits. The first is lower power consumption and the second quietness of operation. The third is that they convey materials 1000 ft. or more, while scraper conveyors are limited by good practice to about 300 ft. Manifestly the length of the average boiler house does not exceed the maximum length of the flight conveyor.

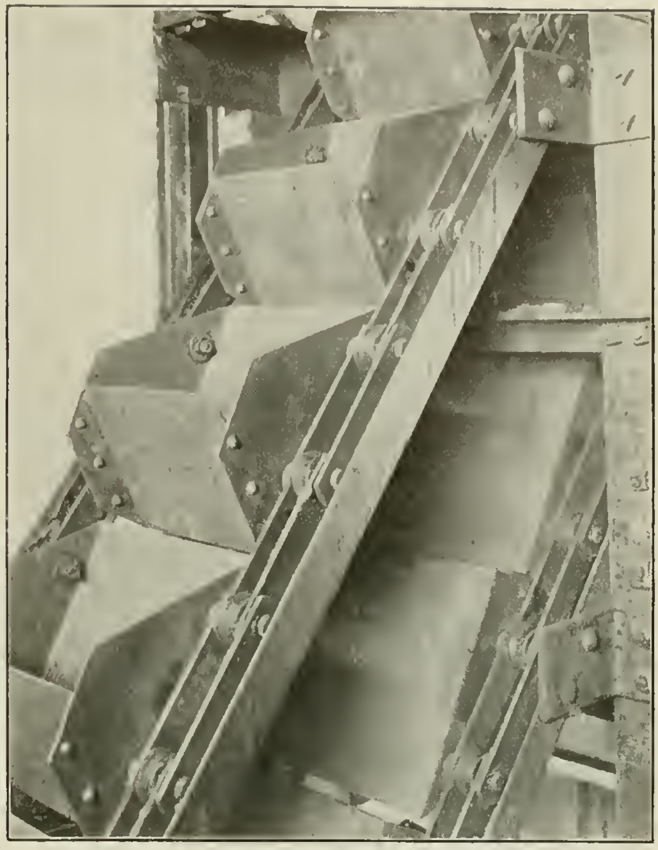


FIG. 6. CONTINUOUS BUCKET ELEVATOR

A belt-conveyor installation has several disadvantages which perhaps outweigh the few advantages. It is not easy to load and requires a ponderous device to

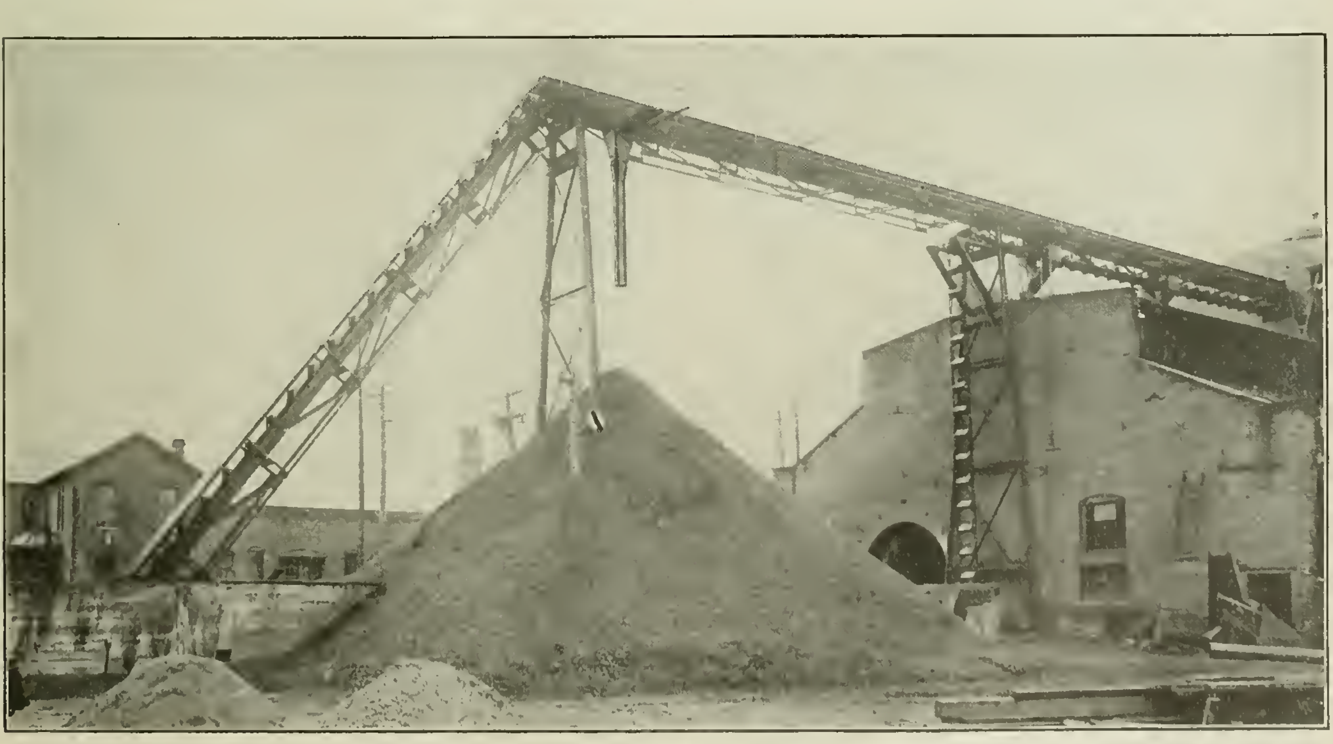


FIG 5. BUCKET CONVEYOR AT THE AMERICAN RAILWAYS CO., DAYTON, OHIO

effect a discharge. It is hard to load because of the difficulty of delivering the coal to the belt at the same speed and in the same direction as the belt is running. This requires side guard plates extending along the length of the belt for a distance of four or five feet, as the difference between the speed of the coal and the belt at the point of impact causes a great deal of splashing. This loading condition is aggravated by the necessity of depressing the end of the belt conveyor, until it operates on an angle of 18 to 20 deg. This is due to the belt tripper, for when this device is at the loading end of the conveyor, the belt would rise directly from the end pulley if the belt was not depressed, and would be cut to pieces by the previously mentioned side guards. This is avoided by depressing the belt, but the danger of the guards sagging and cutting the belt is always present.

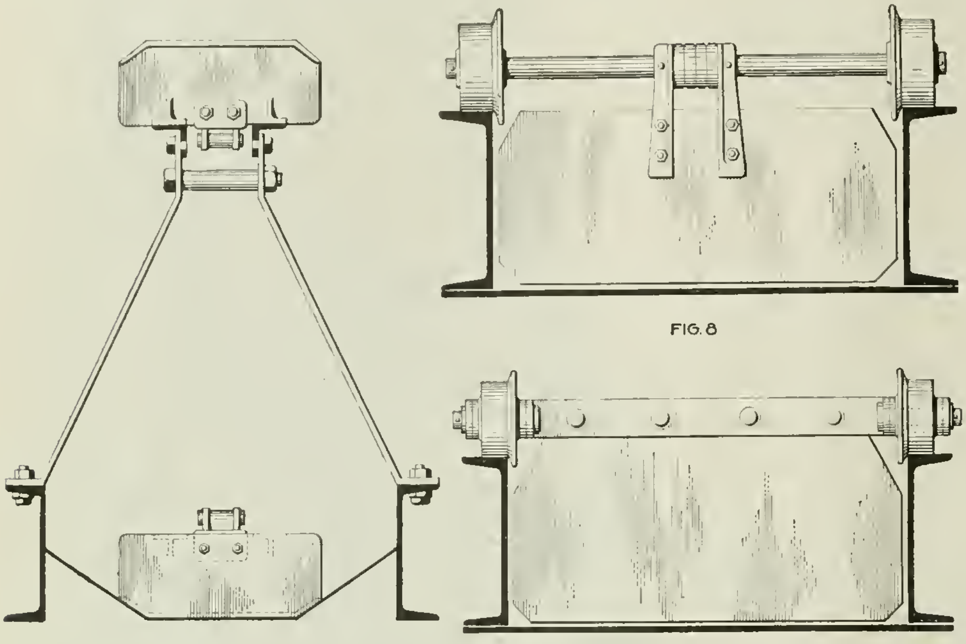


FIG. 8

FIG. 7

FIG. 9

FIGS. 7 TO 9. TYPES OF SCRAPERS FOR FLIGHT CONVEYORS
Fig. 7—Thick edge flight. Fig. 8—Square-corner roller flight. Fig. 9—Double-strand roller flight

Should the belt be ruined suddenly in this manner, it means a long wait until a new one can be secured, for it is expensive to keep a new belt in stock and even then run the chance that it will harden before it is needed.

Wear on Rubber Belts

Belt conveyors require more attention than flight conveyors. The idlers are rather delicate mechanisms and require constant attention, otherwise they will not turn and the belt simply scrubs over them, wearing it out and consuming more power. Also, when the run is short, they wear out quickly, the wear being due to the impact of the coal on the belt at the loading point. It is obvious that in a conveyor twice the length the impact is distributed over twice the belt area of the shorter one for a given quantity of coal handled. Remember that a flight conveyor can be wrecked badly and put in service again by a local blacksmith, but a belt conveyor is dependent on the factory for repairs.

A typical belt conveyor installation is shown by Fig. 10, this being a view over the coal bunker at the boiler house of the Norton Co.,[2] Worcester, Mass. As to the first cost of the belt conveyor compared with the flight type, this varies according to the length. A belt conveyor without the tripper is more costly than the bevel-scraper flight type but cheaper than the roller types, but when the tripper is added (it is necessary) the belt is the most expensive one to use. If the length of the short conveyor is doubled, the cost is not, for one does not need another expensive tripper and then the belt is cheaper than the flight conveyor, but only slightly.

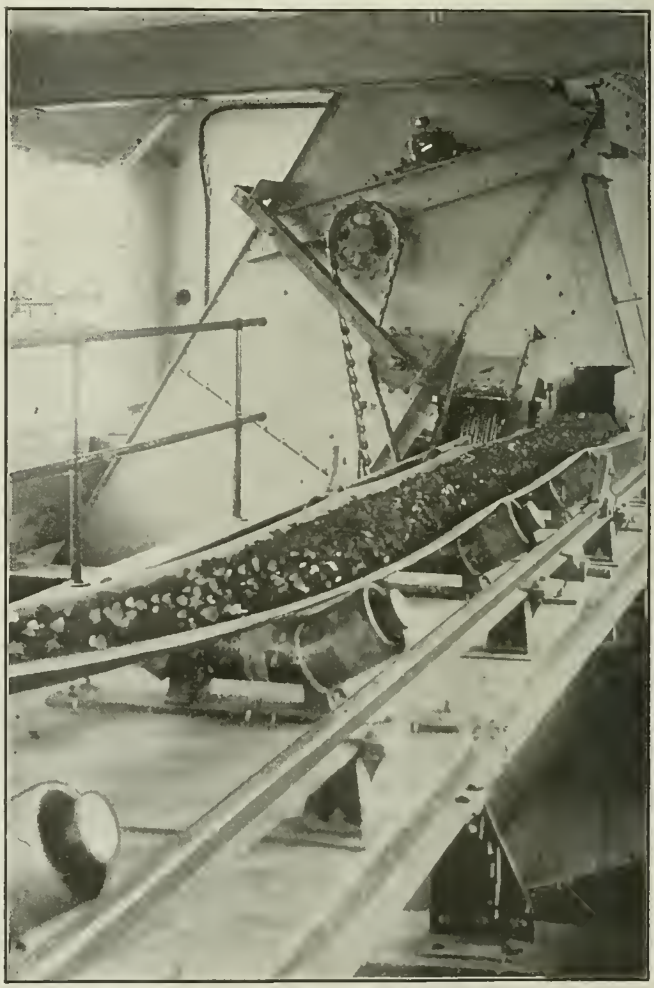


FIG. 10—BELT CONVEYOR, NORTON CO., WORCESTER, MASS.

It is always well to bear in mind that low first cost often means high maintenance charges, as pointed out previously. The wear and tear on coal and ash conveyors is especially severe, and care in their selection is paramount.

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[2] John A. Stevens, engineer; R. H. Beaumont Co., contractors for coal-handling machinery.

The Electrical Study Course—Direct-Current Armature Construction

The development of the direct-current armature core is briefly described, and some of the defects in the earlier types are pointed out.

DIRECT-CURRENT armatures may be classed under two general types—ring and drum. Both types get their name from the shape of the core. The core of the ring type consists of an iron ring about which the coils are wound, as shown in section in Fig. 1. In the earlier type of machines the ring-armature construction was used to considerable extent, but it has since been practically abandoned. Some of the objections to this type of construction are that only one side of the coil is effective in generating voltage. Why this is so is explained in Fig. 2, where a ring armature is shown between the poles of a two-pole frame. It will be seen that all the lines of force are only cut by the conductors on the outer surface of the core. Therefore, only these parts of the coils are effective in generating voltage.

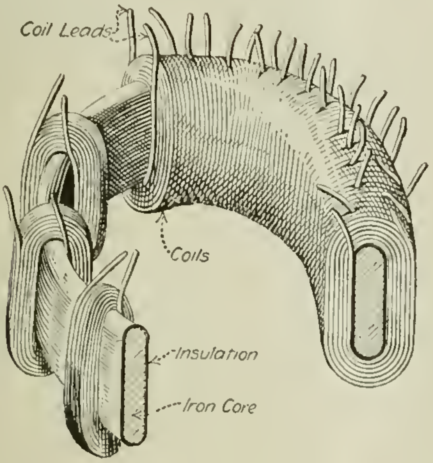


FIG. 1. SECTION THROUGH RING ARMATURE

There is always a leak across the space in the center of the ring; that is, a small percentage of the lines of force, instead of flowing around through the core, take the path across the space in the center of the ring, as indicated in Fig. 2. The conductors on the inside of the ring cut the lines of force that leak across from one side of the ring to the other, in the same direction as the conductors on the outside of the core. Consequently, a voltage will be induced, in the same direction, in the side of the coil on the inner periphery of the ring, as in that on the outer.

In Fig. 2, consider the ring revolving in the direction of the curved arrow; then under the N pole the voltage in both sides of the coils is up through the plane of the paper, and under the S pole it is away from the reader. In either case it is evident that the voltages generated in the conductors on the outside and inside of the ring oppose each other. Since only a small percentage of the flux leaks across the ring, only this percentage will be cut by the conductors on the inner periphery, and the voltage generated in these conductors will be only a small percentage of that in the outside, the difference between the two being the effective voltage in the coil. The foregoing is another objection to the use of a ring armature.

Another difficulty is in winding the coils on the core, they have to be wound in place by hand. On account of having to thread the coils through the center of the core, the placing of the winding is a somewhat long and tedious job. These and other structural and electrical defects have caused this type of construction to be practically abandoned in favor of the drum type of armature.

The core of the early types of drum armatures consisted of a cast-iron cylinder keyed on a shaft, as in Fig. 3. Pieces of fiber were placed in small slots in the corner of the core, as shown, to facilitate the spacing of the coils around the periphery. One of the serious objections to the use of solid cast-iron cores was that they had heavy current generated in them, which not only greatly increased the temperature for a given load, but also loaded up the machine.

The foregoing will be understood by considering Fig. 4, which shows an iron core between the N and S poles of a magnet. If the cylinder is revolved in the direction of the curved arrow, then the side of the core under the N pole will be cutting lines of force in a right-hand direction and will have a voltage induced in it that will tend to cause a current to flow toward the reader. On the other hand, the side of the cylinder under the S pole is cutting the flux entering the pole in a left-hand direction, and consequently has a voltage induced in it that will tend to cause current to flow away from the reader. This is just what we found out about a loop of wire revolved between the poles of a magnet in the last lesson.

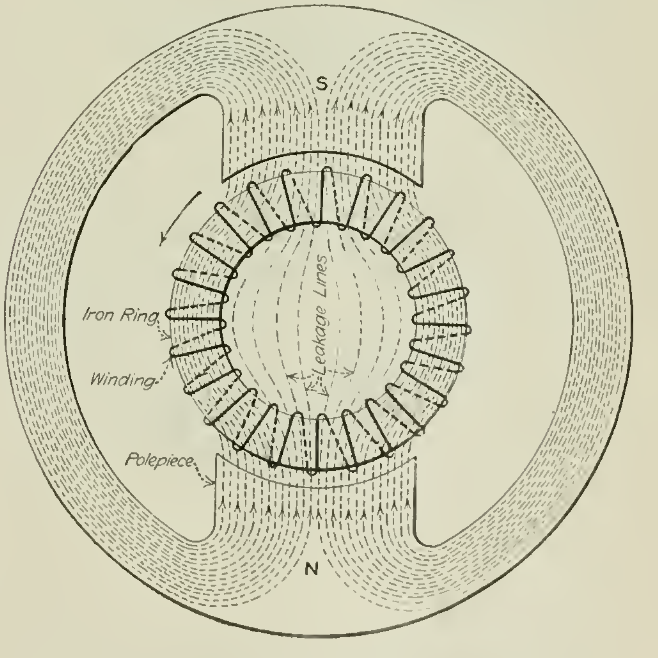


FIG. 2. MAGNET FLUX IN RING ARMATURE

The condition in Fig. 4 is such that the voltage generated in one side of the core is assisting that in the other side. Consequently, a current will flow around in the core, as indicated by the dotted loop and arrowheads. This current is entirely independent of the winding on the armature and external circuit, and just as long as the field poles are excited and the armature revolved, a current will circulate or eddy around in the core. Since these currents circulate or eddy around in the core as water in a whirlpool, they are called eddy currents.

These eddy currents represent a distinct loss, not only in capacity, but also in the power used to drive the generator or motor. Eddy currents increase the temperature of the machine, consequently reduce the useful temperature range. For example, if the normal no-load temperature of the armature, if eddy currents did not exist, is 80 deg. F., and the maximum temperature that the machine can be operated at is 212 deg. F., then the machine can be loaded to the extent that would increase the temperature from 80 to 212 deg. F., or 132 deg. But on the other hand, suppose that the no-load temperature of the armature, due to eddy currents, is increased to 100 deg. F.; then the machine is only capable of carrying a useful load that will increase the temperature from 100 to 212 deg. F., or 112 deg. Consequently, the useful capacity of the machine under the latter conditions will be reduced.

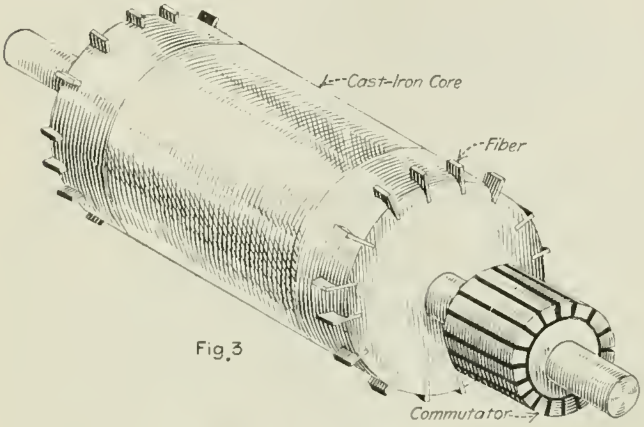


Fig.3

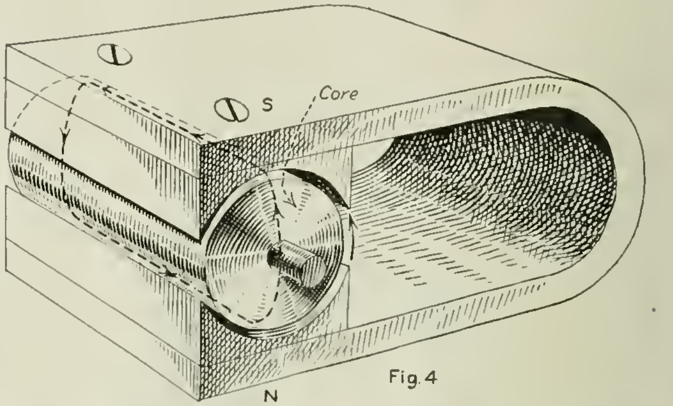


Fig.4

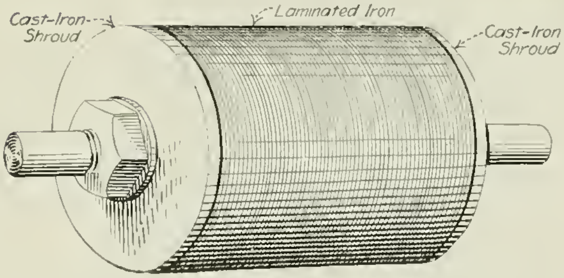


Fig.5

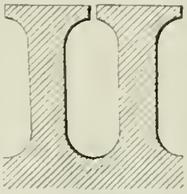


Fig 7

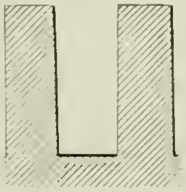


Fig.8

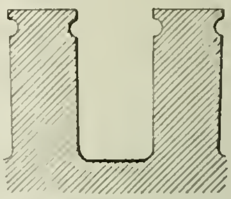


Fig.9

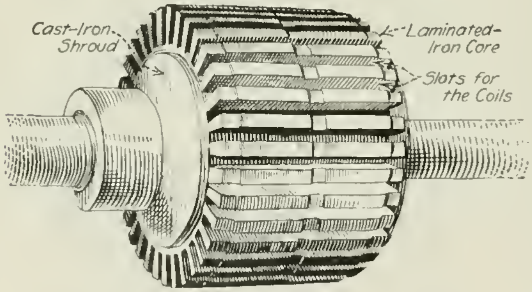


Fig.6

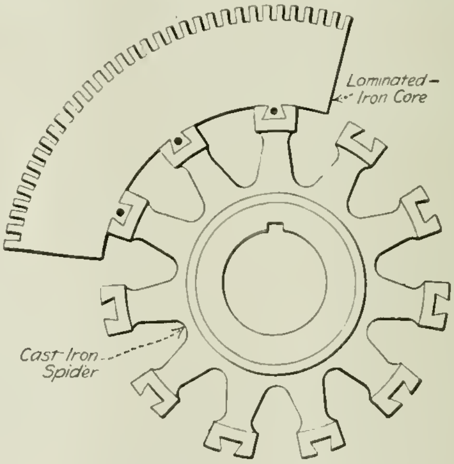


Fig.10

FIGS. 3 TO 10. DIFFERENT TYPES OF DRUM-ARMATURE CONSTRUCTION

It should be kept in mind that the amount of load that can be carried by any electrical machine is limited by the heating effect of the load. For a machine insulated with fibrous material this temperature must be limited to about 212 deg. F.

Another effect of eddy currents in the armature is to increase the power necessary to drive the machine. This will be understood by referring to Fig. 4. Here the generated current due to the core revolving, in the direction indicated by the curved arrow, in the magnetic field is indicated by the dotted loop and arrowhead in the core. Current flowing in the magnetic field will cause a pull to be exerted upon the core, just as explained for a single conductor carrying a current in a magnetic field in the lesson in the Dec. 4 issue.

The direction of the pull on the core may be determined by the rule for the direction of a motor, or, in Fig. 4, it will be found that the eddy currents in the core will produce a pull against the direction of rotation.

In other words, we assume that the core is revolving in the direction of the curved arrow, but the direction of the eddy currents in the armature core produces a pull in the opposite direction. Consequently, the source from which the armature is driven will have to develop power enough not only to drive the armature to supply its useful load, but also to overcome the effect of the eddy currents in the core.

ELIMINATING EDDY CURRENTS

From what we have just seen, it is apparent that, if possible, these eddy currents should be eliminated. This is done to a very large degree by building up the armature core of thin sheets of soft iron or steel, as in Fig. 5. These sheets are from 0.01 to 0.03 in. in thickness. In the early type of machines the oxide on the surface of the sheets was very largely depended on to insulate one from the other. Although this did not completely insulate the disks from each other, it offered considerable resistance to the flow of the current in the core parallel with the shaft. In the modern machines the iron sheets that the core is made of are given a very thin coat of insulating varnish on one side, which practically entirely eliminates the effect of eddy current.

On account of the insulation the core has to be made slightly longer than a solid core would be, in order to get in the same volume of metal. Armature cores that are built up of thin sheets of iron are said to be laminated, and the sheets are frequently referred to as the laminæ. The cores of small-sized armatures are keyed to the shaft and held between cast-iron shrouds, or retaining plates, which are held in place by a nut threaded on the shaft, as in Fig. 5, or by bolts run through the core.

OBJECTION TO SMOOTH-CORE ARMATURES

With these smooth-core armatures, the winding had to be placed on the surface of the core. There were several objections to this, such as the coils, being on the surface of the core, were exposed to mechanical injury; sufficient space must be allowed between the armature core and polepieces for the winding. On account of the comparatively long space between the armature core and polepieces, considerably more power is required to be expended in the field coils to cause the line of force to flow from the latter to the former, or vice versa, than if the core was as near the field poles as would be consistent with good mechanical construction.

Another serious objection is that the coils are wound on the core by hand, one coil at a time. Consequently, the coils can only be removed the reverse of the way they are put on. Therefore, if two or three coils are injured in the winding, it generally means that the whole winding must be removed and a new one put in its place, whereas, if the coils are made up separately, as in modern machines, the injured coils can generally be removed and replaced by new ones, by removing only a small part of the total winding.

All the difficulties cited are practically eliminated by slotting the core as in Fig. 6. The core is built up of thin sheets as in Fig. 5, but instead of the outer periphery of the disk being smooth as in Fig. 5, it has slots cut in it. These slots take different forms, some of which are shown in Figs. 7 to 9. However, when the coils are made up and insulated before they are put on the core, the slots in the core must be open at the top, as in Fig. 8 or 9. Where the coils are made up separately and insulated before placing on the armature, it is evident that the winding is not only more easily put in place, but can be better insulated.

The placing of the coils in slots in the armature core protects them from mechanical injury in case the bearings wear and allows the armature to rub on the polepieces; it also allows the space between the core and the field poles to be reduced to a minimum consistent with good mechanical construction. Consequently, the magnetic field is set up with a minimum power expenditure in the field coils. In the larger-sized armatures a cast-iron spider, as it is called, is keyed to the shaft and the laminated core built upon the spider, as in Fig. 10.

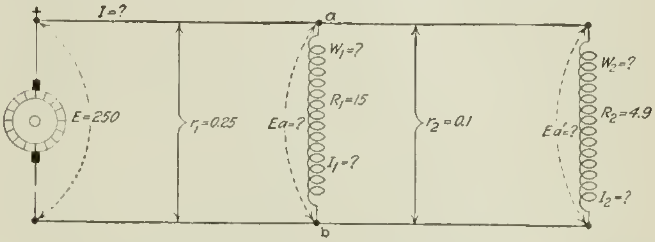


FIG. 11. COMPLEX CIRCUIT

The layout of the study problem is given in Fig. 11. The resistance from a at R_1 around through R_2 to b at R_1 is $R'' = r_2 + R_2 = 0.1 + 4.9 = 5$ ohms. This resistance of 5 ohms is in parallel with $R_1 = 15$ ohms, and the joint resistance of R'' and R_1 is

$$R' = \frac{1}{\frac{1}{R''} + \frac{1}{R_1}} = \frac{1}{\frac{1}{5} + \frac{1}{15}} = \frac{1}{\frac{3+1}{15}} = \frac{15}{4} = 3.75 \ ohms$$

The total resistance of the circuit is $R = r_1 + R' = 0.25 + 3.75 = 4$ ohms. Then $I = \frac{E}{R} = \frac{250}{4} = 62.5$ amperes. To cause a current I to flow from the armature through the resistance of the two conductors r_1 will require a voltage $E_d = r_1 I = 0.25 \times 62.5 = 15.625$. Therefore, only a voltage $E_a = E - E_d = 250 - 15.625 = 234.375$ volts is available at R_1 to cause a current to flow through the circuit. The current that will flow through R_1 is $I_1 = \frac{E_a}{R_1} = \frac{234.375}{15} = 15.625$ amperes, leaving a current of $I_2 = I - I_1 = 62.5 - 15.625 = 46.875$ amperes flowing through R_2. To cause a current $= I_2$ to flow through the connecting wires between R_1 and R_2 will require a voltage of $E_d = r_2 I_2 = 0.1 \times 46.875 = 4.6875$. Hence, $E'_a = E_a - E_d = 234.375 - 4.6875 = 229.6875$ volts. The current flowing through R_2 is also $I_2 = \frac{E'_a}{R_2} = \frac{229.6875}{4.9} = 46.875$ amperes, which checks with the other calculation, showing that the work is correct. The total watts $W = EI = 250 \times 62.5 = 15{,}625$; total kilowatts $= \frac{W}{1000} = \frac{15{,}625}{1000} = 15.625$; and the total electrical horsepower $= \frac{W}{746} = \frac{15{,}625}{746} = 20.9$ horsepower.

A load consisting of 37.5 hp. of motors, allow 3.8 amperes per horsepower, and sixty-four 75-watt lamps is supplied over a two-wire feeder, 475 ft. long. If the voltage is 240 at the source, what size will the conductors have to be to maintain 235 volts at the load end of the feeder when transmitting the total load? If the load is used on an average of 6.5 hours per day for 26 days, find the cost of power at 7.5c. for the first 800 kw.-hr., 6c. per kw.-hr. for the next 1000 kw.hr. and 4.5c. for the remaining kw-hr. consumption. The kilowatt-hour meter is located at the load end of the feeder.

Testing for Ammonia in Brine

Leaks in coils carrying ammonia and surrounded by brine or water are difficult to detect and usually continue until the brine or water has the odor of ammonia. If one suspects that coils are leaking, a sample of the brine may be drawn into a test tube or other receptacle (glass preferred) and a few drops of Nessler's reagent added. If the brine contains a little ammonia, it will take on a yellow shade; if there is much, the brine will turn brown when the reagent is added.

Nessler's reagent may be made as follows: Dissolve 17 grams of mercuric chloride in 300 c.c. (approximately 10.6 oz.) of distilled water. Next dissolve 35 grams of potassium iodide in 100 c.c. (about 3.5 oz.) of distilled water. Add the potassium-iodide solution to the mercuric chloride and stir until a red precipitate is formed. Now add 120 grams of potassium hydrate dissolved in 200 c.c. (about 7 oz.) of water. As the solution will get hot when the potassium is added, it should be allowed to cool before being stirred. When cool, pour in distilled water until there is 1 liter (about 1 qt.) of solution. Next add more mercuric chloride until a permanent precipitate again forms.

The liquid should stand until the precipitate has settled and left the solution clear, after which pour it into a dark-brown or blue glass-stoppered bottle, and keep it in a dark place.

Handy Gate Lock

It is frequently advisable to prevent visitors to power plants from having free entrance to the operating floor. An engineer may be busily engaged on work that requires his undivided attention only to be interrupted by the presence of some intruder who has wandered into the plant, there being nothing to prevent him from roaming at will about the premises. It does not cost much to erect a pipe railing covered with wire netting at the inside entrance of the plant, with a gate which is fastened by a lock that can be operated only by an attendant from the inside.

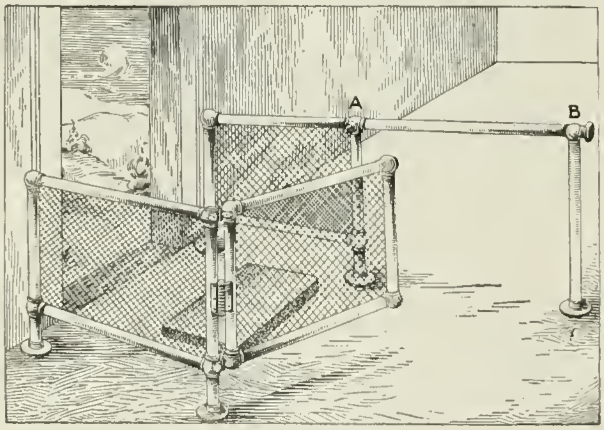


FIG. 1. LOCKING GATE FOR POWER PLANT

Such an arrangement is shown in the illustration. The locking point is at *A*, Fig. 1, and the lock can be operated only by turning the handwheel at the end of extension *B*. Details of the locking device are shown in Fig. 2. The latch *D* slides in the pipe connection and the end enters an opening in the joint at the top of the gate frame. The bolt is fitted with a pin *E* and is kept in the locked position by the spring *F*. Engaging with the pin *E* is a slotted block *G*, which is secured to the rod *H* and is fitted with a handwheel *B*. When it is desired to admit passage through the gate, the handwheel *B* is turned toward the left; this will move the pin *D* from the gate and permit of its being opened.

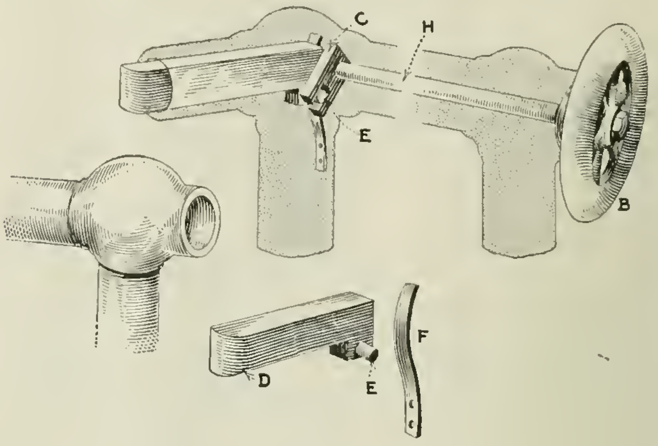


FIG. 2. DETAILS OF THE LOCKING DEVICE

Spring hinges are used on the gate, and after it has been opened it will spring shut and automatically lock, the bolt end acting the same as the catch on an ordinary house door, the end being made at an angle so as to slide over the end of the gate when it is closing.

The shortage of fuel of all kinds in Denmark has kept the large users of power anxiously looking toward Sweden for electric power, which at times they have in abundance. According to *Commerce Reports* the water power now developed in Sweden seems not to furnish any surplus power beyond the country's own needs during dry seasons, but during about half of the year there is generally a considerable exportable surplus. The villages in the northern part of Sjælland have been obtaining some small quantities of electricity by cable across the sound, and occasionally some of it has been used in Copenhagen. Now arrangements are being made to lay additional cables across the sound, with the intention of furnishing the street-car service of Copenhagen and Frederiksberg with a large amount of power. The difficulty in obtaining copper cables and electric transformers is delaying this work. It is expected that most of the power will come from the Laga Lakes and the Trollhättan Falls in Sweden.

Industries making war materials and supplies will of course get coal even if those producing luxuries get none. We have the paradox of the engineer engaged in war worrying less than he of the antique furniture factory.

Editorials

Chances for Promotion in Power Plants

IT IS no exaggeration to say that there never was a time in the history of power-plant service when the prospects of promotion were better than they are today. There are many reasons for this, but among the most important are the vital necessity power has become for war and peace tasks alike and the sure and sustained demand for low-cost energy which will be felt in many parts of the world after hostilities have ceased. To overlook present difficulties in power-plant operation would be a mistake; conditions are very trying with regard to fuel supply, prices of all materials and of labor in a great number of stations. In a number of cases central stations have taken over the service of independent plants, but it by no means follows that even a major share of these plants will always find purchased energy cheaper than their own production. Costs are rising in the central station itself, and it is a daring company indeed today which will make a new power contract without a coal clause in its heart which in a measure seeks to offset increasing fuel prices by additions to the unit energy rate, and vice versa.

The great majority of our productive industries must continue to function, war or no war. "Business must go on" is a true expression of the situation. The war, it is obvious, brings many changes to industry. No small number of engineers are serving their country at the front or in immediate preparation for active military or naval duty, but thousands upon thousands are quietly doing their bit at the old stand, working hard to overcome the handicaps the present supply prices and shortages impose and striving to prepare themselves for larger responsibilities. The duties of civil life must be performed, and the work behind the firing lines could not continue without the loyal service of the coal passer, the engineer, the switchboard operator, pumpman, repairer and all the rest of the staff upon which continuous and efficient production of high-class energy depends. Now the changes which the war brings carry into the industrial world in countless places and in unexpected ways. The war must be won, no matter what the cost to ourselves and our allies. Shifts from one plant to another take place; sometimes the engineer is obliged to lose his hold upon a most satisfactory position; but in the long run, in fact almost in the short run, things will work out to his interest if he makes the most of his opportunities. The world cannot lie back and simply refuse to take advantage of all skilled and highly trained men in the engineering field not called to direct military service; it must utilize such men to the full, even if a period of readjustment accompanies the change from one service or post to another.

This is a time when it is good to realize the vast amount of work which lies ahead of us all—not only now but during the reconstruction period to follow the war, for it is inconceivable that such a period will not come. The peculiar talents of the engineer will be in demand indefinitely, so far as we can see. Now is the time, then, to realize the sound fundamental conditions of the power-production industry as related to the allied world's economic needs, and to make personal devotion to the cause of world efficiency one's watchword. Specific opportunities for promotion may be out of present vision, but we are now in a great transition period and those opportunities are bound to come to him who is prepared to meet the new professional standards, or at least who holds the larger outlook and deeper training for the coming years.

Conservation of Fuel

THE Government has asked that every true American conserve as much as possible the fuel which is so necessary to the effective conduct of the war. It should be considered the patriotic duty of every engineer and fireman to see that the last elusive B.t.u. in the coal he burns, is harnessed and made to do its share of the work his plant is engaged in.

There is little doubt but that many seekers after personal gain will attempt to use this plea of the Government to further their own selfish interests.

We may expect a revival of ash-burning schemes and similar fakes, as well as a greater effort on the part of those who sell more legitimate apparatus, intended to economize fuel, to increase their sales.

While every device and improvement that will reduce coal consumption is exceptionally desirable at this time, production is hampered by lack of man-power, transportation is clogged, and the engineer should realize that the saving he can make without the outlay of money is the kind that counts most.

If your employer's money is spent without a very considerable return in the way of fuel saving, the ends of the Government are more certainly defeated than if no change was made. Every cent saved in the purchase of nonessentials and applied to the purchase of necessary things makes a balance of two cents on the right side of your plant account. This is the kind of saving that will do the Government, as well as the "Boss," the most good at this time. Such saving may be made by the proper use of the tools at hand. The common ways that fuel is wasted in the boiler room are by improper firing methods, dirty boilers and leaky settings and piping. These wasteful defects may all be corrected in the average plant without any considerable outlay in money. Generally, where two or more boilers are used, the failure to balance the draft properly between them is a serious source of waste.

It is a simple matter to see that the dampers are adjusted so that the proper amount of fuel is burned under each boiler to make it do its share of the work in accordance with its size. In connection with the efficient operation of boilers it should be remembered that while it is necessary that the boilers be kept clean internally—and that this is also necessary from the standpoint of safety—the greatest returns in fuel saving are secured from the careful cleaning of the surfaces in contact with the gases. This is especially so with those surfaces in contact with gases of lower temperature, such as the tube surfaces in the horizontal-tubular boiler. Soot is liable to collect on such surfaces, and there are probably few substances that are better nonconductors of heat than soot. Clean the tubes out at least once every day and watch results at the coal pile. This is hard, dirty work, but you will derive satisfaction from the fact that you are performing a patriotic duty in saving fuel without an outlay of money, which counts at both ends. Tell the "Chief" of your patriotic ambition to save fuel in this time of need, and he will no doubt coöperate with you and see that you are given necessary assistance.

Must Efficient Management Be the Most Expensive?

IN A recent hearing before one of the public-utility commissions of New England the opponents of a rate increase urged that a more efficient and less expensive administration would solve many of the problems under consideration.

The relation between efficiency and cost of management is a question of much interest. It comes directly home to the operating executive of the power plant, and many an engineer knows that his employer's ideas on this subject are in need of revision.

In a nutshell, the issue raised is whether the cheapest service is the best. Translated into power-plant engineering, it is simply a question of getting service out of the station of lowest cost and out of the poorest-paid staff, and deluding oneself that the combination represents maximum efficiency. There are low-paid station organizations accomplishing wonders with equipment that represents anything but the most modern designs, it is true. There are also administrations that may well be looked upon as extravagant by the less fortunately circumstanced. Admit all this, and still the fact remains that A-1, first-class, top-notch service costs real money. Here is the point: That service is the best which costs least *per unit*, taking *all* the factors into account—not merely operating expenses, but fixed charges, and in addition to these, quality of output with respect to regularity and reliability.

Now, management is only one factor, though a most important one, in this total cost, in this minimum unit cost which represents the best performance of the investment and its personnel. In a narrow sense efficient management costs more than cheap administration; in the long run and in a broad sense it costs far less. It all comes down to "making good." If by paying higher salaries and wages the cost of production, taking all items into account, decreases per unit of output, there can be but one answer to the question at the head of this article, and that answer is "No." On the other hand, if the unit cost of output is found in a given case to be higher *in toto* with a poorly paid staff and correspondingly lower total payroll, the answer is: "Pay enough to secure and maintain an efficient administration; measure results not by total outlay but by cost per unit, and everyone will be better off." Maximum efficiency, of course, is costly, but if the conditions demand maximum efficiency or the nearest approach to it that can be realized, anything less may be utter extravagance, or money thrown away.

Giving Credence to Rumors

RUMORS are rife these days regarding mismanagement in this, that and the other thing, all of which are detrimental to the country as a whole regardless of whether they are true or not.

In the Eastern States the public recently indulged in excitement because of the rumor of a salt shortage, which does not exist. The real shortage of sugar, the cause of which is debatable, has given the rumormonger an opportunity to howl calamity and foster in a small measure discontent in the minds of many householders; the coal shortage has produced a state of mind in others bordering on a panic; and so it goes.

There will doubtless be other real and imaginary shortages that the American public will experience before the war is over, and it is about time that we began to realize that our manner of living must be changed to meet the conditions brought about by our country entering into war against Germany. What cannot be cured must be endured in this country, as it is in others that are not so well off as ourselves.

An American just returned from France, after serving with the French at the front, said that he had heard more grumbling over a little sugar shortage since returning to America than he had heard regarding conditions in general during his entire service in France. That the American people are gullible in some respects is well known, and they are prone to swallow almost anything that is put before them without waiting for the proof of the pudding.

For instance, public statements have been made to the effect that anthracite coal, of which there has been a real shortage in New York and other cities, has been delivered to the army cantonments in excessive supplies and that it is being wasted. As a result of these reports the Anthracite Operators' Committee has made an investigation through its secretary, E. W. Parker, who visited Camps Merritt, Dix and Upton, and his findings are given in a statement signed by F. W. Warringer, Chairman of the Operators' Committee, as follows:

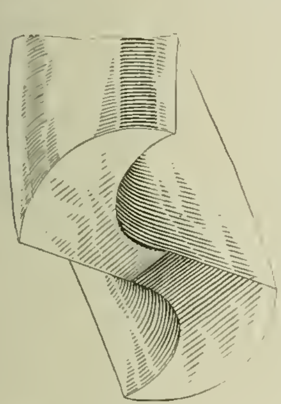
> Referring to reported waste of anthracite, Mr. Parker says that the quantity of coal wasted has been negligible, and where it has been scattered some distance from the car, care has been taken to gather it up and reshovel it into the piles.
>
> Mr. Parker reports that only on one occasion at any of the camps, and then owing to a washout on the spur track leading to the cantonment, was there any congestion in the delivery of anthracite or the return of empty cars. His judgment is that anthracite is being delivered at the cantonments in no greater amounts than is necessary nor faster than it should be to keep a safe forward supply, also that it is being received with regularity.

The probabilities are that many such rumors will, when investigated, prove to be without foundation, and all Americans should give scant attention to them, as they are doubtless started with a purpose on the part of someone who is interested in creating discontent in the minds of the people.

Correspondence

Drilling Metal by Hand Power

Occasions frequently arise in the course of an engineer's duties when holes must be drilled by hand for all sorts of purposes, from an air vent in a pipe or radiator to drilling out a broken stud. The job can often be finished with a breast drill or an ordinary bit brace before the conventional ratchet and "old man" equipment can be rigged up—and without any great physical effort. The one thing necessary is to drill a small hole first, followed with the large drill and if necessary with intermediate sizes until the finishing size can be operated easily. The philosophy of the thing is simply that the center or flat part of a drill cannot cut the metal; it only scrapes it off when great pressure is exerted to force it down and the larger the drill the wider this flat point is. Therefore if a hole is first drilled that is equal in diameter to the width of the "nose" of the larger drill, the pressure required to make the drill "bite" will be comparatively little. Try it and see.


END VIEW OF TWIST DRILL

Another advantage of drilling a small hole first is the fact that a drill cannot cut "oversize" when not ground evenly, as it otherwise will. As to the reason for choosing a brace against a geared breast drill, the latter is usually geared for speed and the drill cuttings are necessarily thin—mere scrapings—because the turning power is limited, but with a long-sweep brace the leverage is greater and heavier chips can be cut out. In other words, it takes more strength to remove the metal in pulverized form than in chips of reasonable size. In using a ratchet drill about one-third of the time and effort is lost on the return or non-cutting stroke. A geared drill—geared down—is a whole lot better because the full sweep is utilized. A small blacksmith drill press can often be utilized if bolted to a light timber of convenient length to block in place.

Frequently an old flat drill is considered good enough for use in a ratchet, while twist drills are cheap and so much better that they should be procured if possible—at least up to a reasonable size—and the flat drill used only for large or odd-sized jobs. J. LEWIS.

New York City.

Ammeters Were Reversed

Indicating ammeters and voltmeters of the permanent-magnet type will indicate the polarity of the voltage that is applied to them. This is because a reversal of the external polarity reverses the flux of the movable coil, but does not reverse that of the permanent magnet. Therefore a reversal of the polarity of the source reverses the throw of the needle for the same reason that interchanging the field or the armature connections of a direct-current motor reverses the direction of rotation of the armature. Meters of other than the foregoing type will not indicate the reversal of the polarity of the source to which they are connected, for such changes reverse the fluxes of both the controlling and the deflecting fields, leaving the polarity relations of the two fluxes the same as they were before the reversal, for the same reason that reversing the line connections of a d.c. motor does not affect its direction of rotation.

If a direct-current generator in normal operation has imposed upon it suddenly sufficient overload to greatly reduce the speed of its prime mover, the polarity of the generator may become reversed. The reason for the reversal is that at low speed and heavy current, the voltage on the shunt field is low, which decreases the flux from the field poles where the reaction of the heavy armature current is able to reverse the magnetism of the polepieces, before the circuit-breaker acts to relieve the situation.

An operator complained that the two ammeters used with two generators that were operated in parallel had reversed, although the voltmeter used for paralleling the machines had not. An inspector investigated and found that the voltmeter was of the separately excited type while the ammeters were of the permanent-magnet type; therefore what had happened was to be expected under the circumstances, which were as follows: A few days previous the generators had been subjected to an overload so heavy that the governors had tripped out the waterwheels driving the generators. It was then that the polarity of the generators had been reversed and for the reasons just given. As there was no objection to the reversed polarity, the ammeter leads were reversed on the instrument shunts in order to make the needles deflect in the proper direction.

Brooklyn, N. Y. E. C. PARHAM.

[Where the polarity of a direct-current generator is reversed when a heavy short-circuit occurs, it does not necessarily follow that the reversed polarity is due to armature reactance alone. When a generator slows down, which is supplying a motor load that has considerable inertia, the mechanical load drives the motors as dynamos, and they in turn supply a reversed current through the series-field windings of the generator, which in many cases is heavy enough to reverse the polarity of the latter.—Editor.]

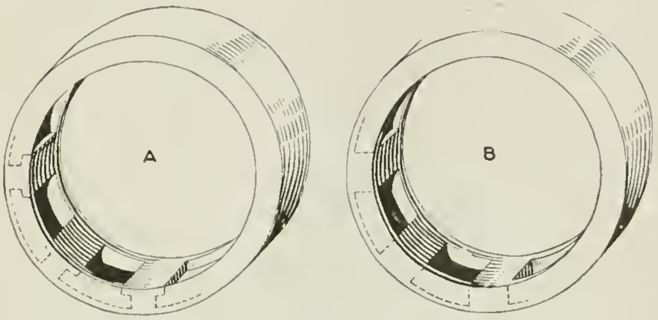
Publicity About Turbine Accidents

Referring to the article by C. H. Camp regarding turbine accidents, published in *Power* for Nov. 20, 1917, I wish to state that he has been misinformed about the Port Huron Electric Co. No such accident ever occurred to my knowledge, and I have been here for some time.

Port Huron, Mich. D. J. RICHARDS.

Poorly Designed Bull Ring

It was recently necessary to put a new bull ring in an engine, and when it arrived it was found to be made about as shown in the sketch *A*. The skeleton form was designed for lightness and was made with cross-bridges to support the keys and to strengthen and stiffen the ring. It will be seen that between the bridges pockets are formed which extend under the top of the bridge about ¾ in., thus making a receptacle for scale and core sand, which is difficult to remove. Although care was taken to clean out these pockets by means of chisel, scrapers, brushes and air blast, trouble developed soon after the engine was started, and upon the ring being removed, it was found that a small amount of grit had been loosened by the action of heat and cylinder oil, thus causing the cylinder to be badly cut and scored.



TWO DESIGNS OF BULL RINGS

Had the ring been constructed as shown at *B*, all particles of sand or grit could have been scraped out easily and considerable time and expense saved. The ring would have been but little heavier, and it would have been easier to mold. **Charles W. Oakley.**

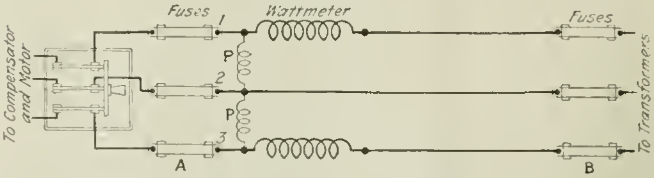
Passaic, N. J.

Lamp Test Indicated a Ground

Each of the three conductors of a three-phase three-wire service involves two of the phases of the circuit, and an open-circuit in any one of the three wires will interrupt two of the phases. With only one phase active, there will be no phase rotation, therefore a three-phase motor will be unable to start if connected to the circuit.

The figure shows the line circuit for a 220-volt three-phase motor, which was complained of because it could not be started. The two sets of fuses shown were active on both positions of the starting compensator. A test with a 220-volt lamp showed that the middle fuse located at the transformers about 200 ft. away from the motor, was blown. The test lamp would light when applied across lines 1 and 3, but would only glow dimly when applied to 1 and 2 or to 2 and 3. The motor trouble was a plain case of single-phase operation which was remedied by replacing the blown fuse. The fuses at *A* and *B* were all of 60-amp. capacity and a fuse was as liable to blow at *B*, which was inaccessible, as at *A*, which was immediately above the motor. In order to insure that the next fuse would blow in a convenient place, 45-amp. fuses were substituted for the 60-amp. fuses at *A*.

As pointed out in the foregoing, when testing for voltage the lamp showed an appreciable glow when held across conductors 1 and 2 or 2 and 3; this suggested the existence of a leak to ground. The operator spent some time in trying to locate a ground, when he happened to think of the watt-hour meter, the connections of the potential coils of which are indicated at *P*. On disconnecting the potential coils, all wires tested clear.



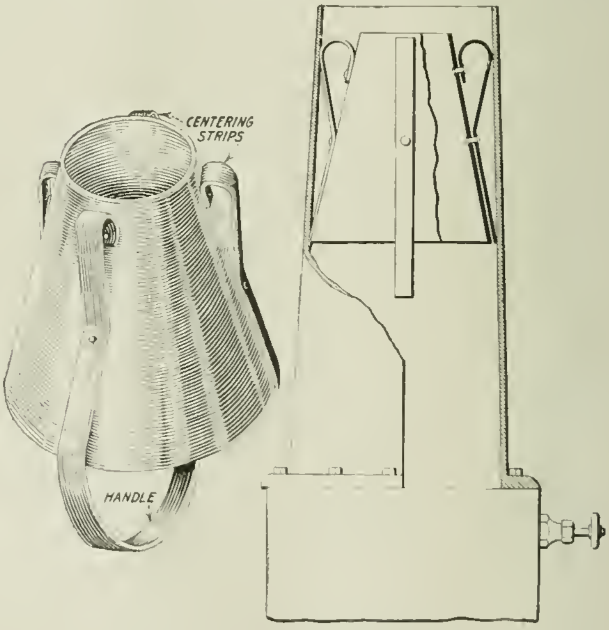
THREE-PHASE-MOTOR LINE CIRCUIT

Brooklyn, N. Y. **E. C. Parham.**

Reducer for Gas Burners

In a boiler plant using natural gas as fuel it sometimes becomes necessary to turn the gas very low, often resulting in the gas firing back into the burners, or to run with one burner nearly full on, which is undesirable and likely to deposit sediment in a form that causes blistering or bagging. To overcome this I hit upon the idea of reducing the nozzle of the burners from 5 to 3 in. in the manner shown in the illustration.

No. 20 gage galvanized iron was used to form a funnel-shaped reducer to fit into the regular burner with three or four strips ¾ in. wide riveted on in the manner shown, to center the small end. A handle is also provided to insert and remove the reducer. By using these reducers, it is possible to reduce the gas so that three burners can be kept going in place of one, giving a better distribution of heat and a more economical mixture than could be obtained with the large burner burning low without the reducer.

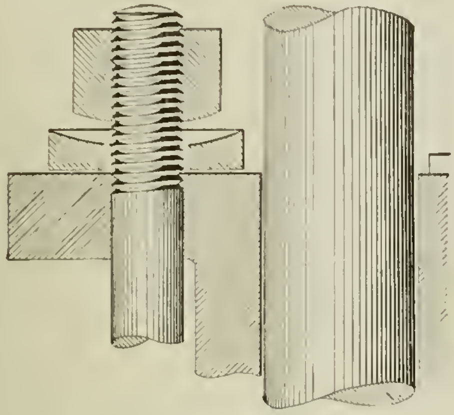


NOZZLE OF GAS BURNER REDUCED

Calgary, Alta., Canada. **W. H. Dance.**

Relieving Side Strain on Studs

To keep studs or gland bolts from breaking from side strain, I make a washer a loose fit over the bolt and flat on one side but concave on the other. The nut is then made convex to fit the hollow side of the washer, forming a ball joint. The washer will slide one way or the other and adjust itself to the pull so that the stud does not bend repeatedly and finally break. The illustration shows the shape of the nut and special washer as described. R. A. DAVIDSON.



NUT AND WASHER FORM A BALL AND SOCKET JOINT

Colton, Calif.

Ammonia-Compressor Diagrams for Discussion

The indicator diagrams shown in Figs. 1 to 4 are from a 10-ton Wolf-Linde ammonia compressor, 9½ x 15 in., running at 80 r.p.m. normally, and motor-driven. I shall be pleased to have readers of *Power* discuss the diagrams. J. C. HARRISON.

El Campo, Tex.

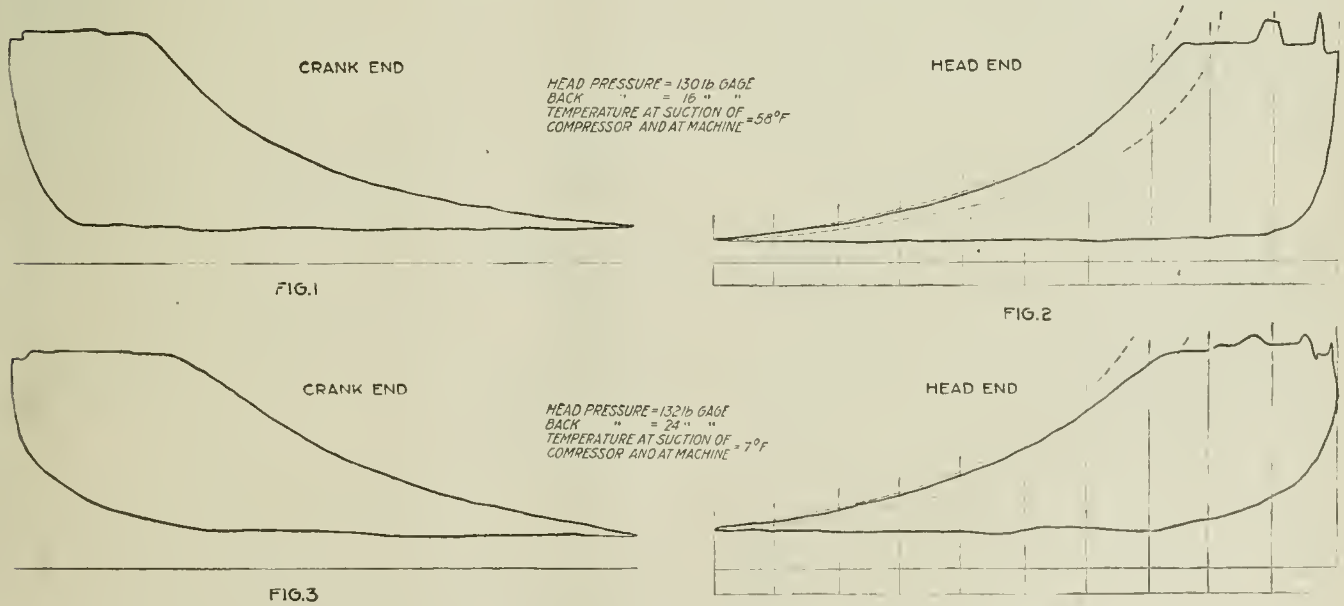
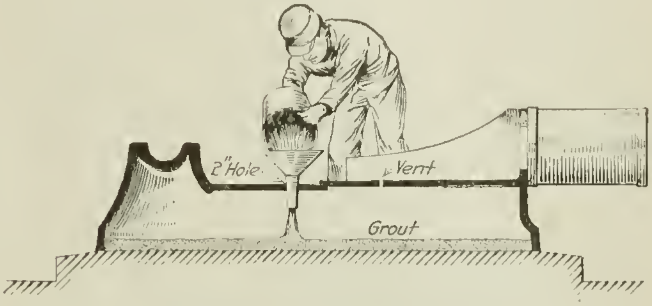


FIG.1 FIG.2 FIG.3 FIG.4

FIGS. 1 TO 4. AMMONIA-COMPRESSOR DIAGRAMS FOR DISCUSSION

Grouting in an Engine Bedplate

Sometimes the hollow bedplates of machinery will move slightly on the foundation if insufficiently grouted, and cases of this kind are aggravating and difficult to correct. The usual cause is that the grout was not forced into all the interstices under the heavy casting, consequently there is not sufficient bearing surface. One way to correct such a defect is to drill a hole, about two inches diameter, in the top of the bed and another for an air vent and pour in grout enough to fill the inside of the bedplate to a depth of several inches. This will usually stop any motion of the frame on the foundation. D. R. SHEARER.



GROUT POURED INSIDE OF HOLLOW BEDPLATE

Johnson City, Tenn.

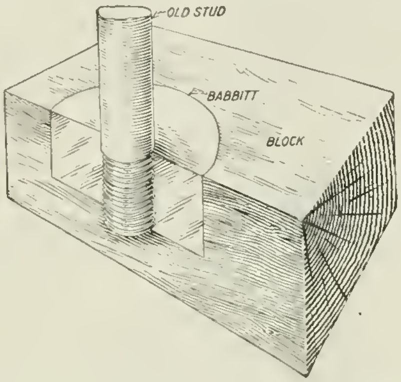
Insufficient Protection Around Flywheel

In a station that I visited recently, there was an immense flywheel in motion just at the end of a runway, about six inches from the end of the walk, the floor being about level with the hub of the wheel. There was a single wooden handrail around it, nailed to the top of posts, leaving the whole space below unguarded. The engineer in charge said that one man had slipped into this wheel, but no better protection had been placed there to prevent anyone else from meeting with a similar accident. Failure to improve conditions after one such accident seems like gross negligence.

Philadelphia, Penn. W. H. **Nostan.**

Babbitt Templet for Thread Size

Following is a shop kink that may be of interest to readers of *Power*. I recently bought a set of new ¾-in. studs for the water valves of a duplex pump, but the threads had not been cut deep enough to screw into the seats properly and as they were special threads it was necessary to "chase" them in a lathe. The pump could not be spared from service long, and the question arose as to how we would know when they were "chased" to the proper depth. This was solved by boring a 1½-in. hole in a wood block to the depth of the threaded portion of the studs. The threaded portion of an old stud was then set in the hole in the block and melted babbitt poured around it. When it had cooled, the stud was backed out, leaving a templet of the thread in the metal, as shown in the illustration. The new threads, cut to fit this templet, fit perfectly in the valve seats.



TEMPLET MADE BY POURING BABBITT AROUND OLD STUD

Ithaca, N. Y. C. B. **Hudson.**

Induction Motor Heated

When a three-phase induction motor of standard design has trouble that causes abnormal heating even when the motor apparently is operating without any connected load, the source of disturbance very likely will be unbalanced voltage, which may be determined by connecting a voltmeter across the different phases, or an ammeter is successively connected into the different supply wires. If under such conditions the readings prove to be balanced, the motor either is not what the nameplate calls for or the seat of trouble is elsewhere.

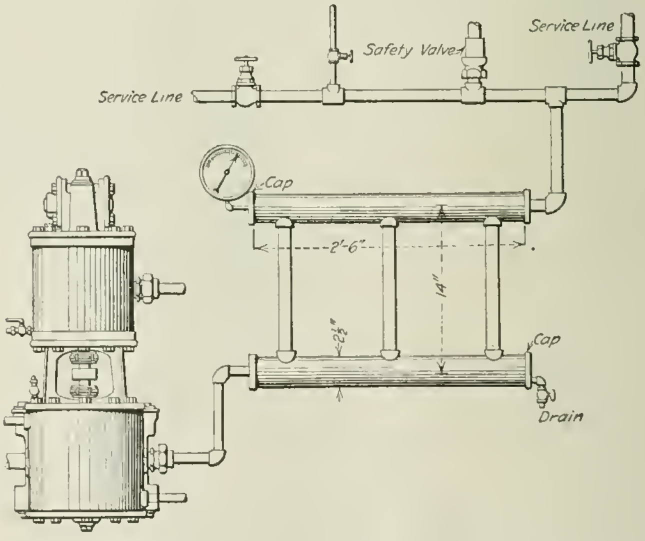
The operator of a motor-generator set which consisted of a three-phase induction motor coupled to a shunt-wound direct-current generator, complained that the motor got so hot as to smoke even when the generator was carrying no load. An inspector was sent to investigate and by means of an ammeter and a voltmeter determined that there was nothing the matter with the motor as far as the meter readings would indicate.

During the taking of the no-load readings of the motor, the generator was entirely disconnected electrically and therefore could not even excite its field poles. In order to determine whether the proposed field connections were correct for the given direction of rotation, the inspector held the free field terminal to one of the armature terminals. Almost immediately the character of the noise that was emitted by the set changed, and it was evident from the drop in the speed that the motor was heavily overloaded. Shutting down the set and feeling of the generator's armature disclosed that it was very hot. Inspection revealed that the generator-bearing lining on the commutator end was melted and had been for some time. As long as the generator was not excited, the bolted coupling was able to hold the armature free from the polepieces; on exciting the field coils, however, the armature was pulled against the polepieces, thereby creating a most efficient brake, which overloaded the motor. E. C. **Parham.**

Brooklyn, N. Y.

Receiver Eliminates Moisture

The illustration shows a home-made air receiver, connected to a Westinghouse air compressor, which has been found efficient in separating the moisture from the air. No moisture is perceptible on the hand held within four inches of the end of the service pipe with the valve wide open. The headers were originally used on an ammonia pipe system and are made of 2½-in. pipe with lugs or saddles for 1¼ pipe attached. The size is of no great importance except that the air velocity through the connecting pipes should be low. The construction may be easily understood by referring to the illustration. The air from this compressor is used in four "dry" sprinkler systems and one "wet" system and also for "blowing out" the generators, so it is highly desirable that the air be as free from moisture as possible. The result has been so satisfactory that I want to pass the suggestion along.



AIR RECEIVER MADE FROM OLD AMMONIA PIPING

Quincy, Ill. C. L. **Boyle.**

Have you been appointed supervisor of illumination in your mill or building? Maybe you have not advised the boss that one is necessary, though your observation of the charts and meters tell you there is.

Inquiries of General Interest

Working Pressures for Pipe, Valves and Fittings—What is the safe working steam pressure for standard and extra-heavy pipe, valves and fittings? S. E.

"Standard" pipe, valves and fittings are assumed to be suitable for working steam pressures not in excess of 125 lb. per sq.in. and "extra heavy" pipe, valves and fittings are assumed to be suitable for working steam pressures to 250 lb. per square inch.

Fluctuation of Electric Pump-Pressure Regulator—The operation of an electrically driven pump is very irregular on account of hammering of the pump that causes continual fluctuations of the pressure regulator and making and breaking of the electric circuit. How can this be remedied? E. E. F.

The pump discharge should be provided with an air chamber for equalizing the discharge pressure, and the pressure connection to the regulator should be throttled so as to dampen the pulsations.

Beveling of Safety-Valve Seat at Angle of 45 Deg.—Why is a safety valve beveled at an angle of 45 deg.? C. V. S.

Valve seats are straight-beveled or rounded, to afford better facilities for grinding the valve to its seat. Beveling at approximately 45 deg. gives a good form for a beveled seat and that angle probably is easier than any other for manufacturers to obtain and duplicate. The adoption of 45 deg. as a standard is purely conventional. Any other bevel might be taken as a standard for safety valves, provided the rated discharge capacities of different diameters are based upon a specified lift and angle of beveling.

Saving by Increase of Feed-Water Temperature—For generation of the same amount of steam at 100 lb. per sq.in. boiler pressure, what per cent. of coal should be saved by increasing the temperature of the boiler-feed water from 50 deg. F. to 150 deg. F.? F. B.

Each pound of the steam generated at 100 lb. boiler pressure, or 115 lb. per sq.in. absolute, would contain 1188.8 B.t.u. above 32 deg. F., and conversion of each pound of the feed water from 50 deg. F. into steam at the pressure would require 1188.8 + 32 — 50 = 1170.8 B.t.u. With the feed water at 150 deg. F. each pound of the feed water would contain 100 B.t.u. more than when the temperature of feed water is 50 deg. F. Hence for each pound of the feed water at 150 deg. F. generated into steam, there would be a saving of 100 ÷ 1170.8 = 0.0853, or about 8½ per cent.

Objections to High Initial Pressure with Light Load—What are the objections to operating a noncondensing Corliss engine with high initial pressure for carrying a light load with very short cutoff? W. H. C.

For given variations of load the required range of governor action will be less and there will be greater hunting action of the governor, accompanied by less regularity of speed, and for derangement of the valve gear the engine is more likely to race from a high than from a low initial pressure with a light load. There also will be less uniformity of rotation during one revolution. Unless compression is adapted to the conditions, the percentage of clearance waste will be higher, because there will be the same volume of clearance space steam of greater density. When the initial pressure is high, with cutoff so short that expansion occurs down to or below atmospheric pressure, the rush of air into the cylinder when the exhaust opens results in cylinder cooling that is detrimental to economy and usually is accompanied by clattering of the exhaust valves and injury to the exhaust valves and their seats.

Heat Value of Fuel and Theoretical Evaporation—What is meant by the heat value of a fuel and the theoretical evaporation per pound of the fuel? J. H. H.

The heat value of the fuel is the number of British thermal units that would be realized by theoretically complete combustion of a pound of the fuel, a British thermal unit (usually designated by the abbreviation B.t.u.) being $^1/_{180}$ of the quantity of heat required to raise 1 lb. of water from 32 deg. F. to 212 deg. F., though in most practical computations 1 B.t.u. is roughly taken as equal to the quantity of heat required to raise 1 lb. of water 1 deg. F. When no other conditions are stated, evaporation is understood to refer to evaporation from water at 212 deg. F. and at atmospheric pressure, commonly expressed as "evaporation from and at 212 deg. F." Evaporation of 1 lb. of water from and at 212 deg. F. requires the latent heat of evaporation, or 970.4 B.t.u. If a fuel has a heat value of 14,000 B.t.u. per pound, the theoretical evaporation from and at 212 deg. F. would be 14,000 ÷ 970.4 = 14.42 lb. of water per pound of the fuel. On account of losses of the fuel through the grates, imperfect combustion, losses of heat by radiation and heat wasted in the chimney gases, the actual evaporation, or evaporative efficiency of boilers, is only 50 to 75 per cent. of the theoretical, depending on the type of boiler and other conditions.

Water Delivered by 4-In. Pipe—What number of gallons per hour will pass through a 4-in. pipe about 1 mile long with the pressure at the entrance 90 lb. per sq.in. and with discharge taking place against a pressure of 45 lb. per sq.in.; and what would be the velocity in feet per minute? D. T.

The velocity of flow will depend on the roughness of the interior pipe surface from construction, corrosion and incrustation. Darcy's formula for loss of head in new cast-iron pipe reduced to English measures is

$$h = \left(0.01989 + \frac{0.001666}{d}\right)\frac{l}{d} \times \frac{v^2}{2g}$$

in which

h = Loss of head due to friction, in feet;
d = Internal diameter of pipe in feet;
v = Velocity per second in feet;
l = Length of pipe in feet;
$2g$ = 64.32.

In the problem, the loss of head due to friction is 90 — 45 = 45 lb., or 45 × 2.309 = about 104 ft.; $d = \frac{1}{3}$ ft. and l = 5280 ft. The velocity is to be found by substituting the given values of d and l, and, by assuming different velocities, determining the value for v which will most nearly satisfy the equation. In the example the nearest velocity will be about 4.09 ft. per sec. or 245.4 ft. per min. As the cross-sectional area of 4-in. pipe is 12.566 sq.in., the flow per hour would be $\frac{4 \times 4 \times 0.7854 \times 245.4 \times 12 \times 60}{231} =$ 9611 gal. for new 4-in. cast-iron pipe.

For pipes that have been in use under average conditions h in the formula is to be multiplied by about 1.25 for 5 years' service, by about 1.5 for 10 years' service and by about 1.75 for 25 years' service.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Boiler-Room Efficiencies*

By GEORGE F. WEATON†

Labor conditions make high efficiency more difficult than ordinarily and increase very considerably the operating costs. Suggested equipment for a 1000-hp. plant. Judging combustion by observation of flame through violet glass. Results in the boiler room of a typical manufacturing plant. Discussion on the paper.

So much does design influence the efficiency possible in the boiler plant that it is desirable to review what is wanted as to equipment. Though a few years ago a plant could be operated at the then standard of economy with simple equipment, this is no longer true. Labor was obtainable at such a wage that the installation of much mechanical apparatus was questionable in plants of fairly large proportions; plants of 1000 hp. and over were seldom provided stokers, coal- and ash-conveying machinery, fuel economizers, mechanical draft, etc. However, the change in labor has been so radical, coupled with its scarcity and high wage, and the difficulties of maintaining discipline and organization in a plant of moderate capacity so extreme, that it is safe to say that no plant of, say, 1000 hp., should be without boiler units of as large a unit capacity as can be installed after considering lay-offs for cleaning, repairs, etc. I should suggest three 350-hp. boilers, fuel economizers, underfeed stokers, coal and ash conveyors and overhead coal storage. Two men could economically operate such a plant; there is boiler capacity sufficient to lay off a boiler for repairs and cleaning, stoker and draft apparatus are sufficient to operate economically above rating and carry the load on the remaining two boilers. The returns on such an investment, although not so much as on a larger plant, will be greater than for a smaller investment for a more simple plant.

Oil Versus Coal as a Fuel

Oil as a fuel at the present here in New England appears as a more or less vigorous competitor of coal. In this section its use will be limited to a few plants. Oil presents many qualities that make it an ideal fuel, such as large overload capacities, cleanliness, no ashes or other bulky material to handle; the handling apparatus is not subject to such rapid deterioration as is coal-handling apparatus; ease of regulating the air supply to the exact amount required for most efficient combustion and small labor requirements.

It appears that oil might be seriously considered in plants of moderate capacity; but the considerations must extend much farther than a tidewater storage for a large plant. Every precaution must be taken against the possibility of cutting off the fuel supply. That a large oil company has storage supply normally of thousands of gallons at tidewater is not sufficient guarantee of unbroken supply to a large consumer. Oil-field labor is mostly turbulent, although not so much might be published about their doings as the coal miners' troubles, oil being of lesser importance than coal as a fuel. Transport by sea is subject to Government requirements, and transport by rail may make oil prohibitive in price. Oil as a marine fuel is used in increasing quantities, and it appears that oil will be the marine fuel of the near future. It will not supplant coal either in quantity or in price as a land fuel unless new and extraordinary fields are discovered. Coal must receive the most consideration by engineers.

Economy in the use of fuel is now being preached as never before. While the sermon is highly commendable, economy should be practiced at all times, not as a war measure only; if it can be done in war time, it can be done during peace. If this war will cause the more general practice of economy, not only in fuel but also in many of our vital resources, the ill wind will blow some good.

Of first importance in the burning of coal is control of combustion; second, the condition of the boiler in respect to cleanliness and repair; third, the condition of the setting in relation to the loss by radiation and the dilution of the gases and cooling of heating surfaces by air leakage.

First, it must be understood that the combustion of fuel is distinctively a chemical process consisting of the rapid oxidation of whatever is combustible, before combustion can take place. The combustible must be brought up to a temperature where chemical union with oxygen will take place; these temperatures vary for different fuels.

Second, there must be available a sufficient and not excessive supply of oxygen heated to the proper temperature, or good results will not be had. Each pound of carbon by theory requires 2⅔ lb. of oxygen, but in practice it is usually calculated that an excess of 40 per cent. is required. In late plants of good design this excess requirement has been made as low as 20 per cent., and the boiler efficiency obtained is 82 per cent.

Third, the gases from the fuel and oxygen must be brought into intimate physical contact.

The construction of the furnace must be such that these conditions are fulfilled and combustion aided or skill cannot get good results.

The Control of Combustion

In the ideal plant the control of combustion would be as automatic as it would be possible to make it. This requires stokers where the air supply would be controlled by the rate of coal feed, which is in turn controlled by the demand for steam. The coal would be uniform in size and in moisture content. This requires coal crushers and overhead sheltered storage of a supply sufficient for a number of days. The draft should be so regulated that there would be a practically balanced pressure in the setting and out to minimize air leakage in through the setting and escape of gases from the setting. Next, the fireman or man in control of the fires should be among the most intelligent of the plant, and should receive the highest wage of anyone in the plant except the man in charge. He could and would save many times his wage in the average large plant. The great majority of firemen are totally ignorant of the principles of combustion.

Provided we have a well-designed furnace, we can check results by at least four ways; three of these may be termed indicating and one recording. Of the three indicative methods, that of gas analysis is the simplest and the most reliable. Every plant should have at least an Orsat or similar hand apparatus for the determination of the CO_2, CO and O_2 content of the gases. While samples of gas are being drawn, the temperature of the gases should be taken. Carbon-dioxide recorders are desirable but not necessary, as conditions can be fixed and followed from time to time by the hand apparatus, which has the advantage over the CO_2 recorder inasmuch as its gives the CO_2, CO and O_2, which the recorder does not do.

Another method is by judging the colors of the products of combustion in the furnace. Men who have had experience together with the study of the principles of combustion can judge a fire very accurately. For this purpose peepholes are built into the furnace walls and dense violet-blue glasses are used, as it is impossible to observe the color changes with the naked eye. The natural color of the gases when combustion is perfect is a bright red or white-red; it is a haze. After fuel has been thrown on, the gases rising are streaked with a dun-colored opaque gas, indicating that all the combustible gases have not been ignited. This gas, upon entering the combustion chamber, should become transparent as before. These changes cannot

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*A paper before the Providence (R. I.) Engineering Society, Dec. 14, 1917.

†Chief engineer, The J. & P. Coats Co., Providence, R. I.

be observed with the naked eye unless the furnace temperature is too low to give efficient thermal results.

When using glasses, the color changes can be observed closely. Imperfect combustion is indicated by dark streaks obscuring the opposite sides of the furnace; perfect combustion by a clear lavender-gray color. Red and yellow flames, which interfere with the naked-eye vision, are cut out by the glass and these rays, when passing adjacent cool surfaces, possess little light that is capable of passing through blue glass. Therefore, perfect combustion takes place at a temperature that will produce light powerful enough to penetrate blue glass, indicating a high actinic power and intense chemical action. The dun-colored gases rising from the fuel bed should, upon entering the zone of perfect combustion, disappear, leaving the clear lavender-gray color.

The third method is by means of the temperature of the furnace. With a room temperature of 60 deg. F., burning one pound of carbon to complete CO_2 will produce a temperature of 5002 deg. F. This in practice is impossible. For good practical results the furnace temperature is from 2800 to 3000 deg. Fahrenheit.

While these checks are indispensable in obtaining good results, the most reliable check is the actual results secured. These can be obtained only by means of metering the feed water fed to the boiler and making allowance for all water blown out of the boiler or used for other purposes if drawn between the meter and the boiler, by accurately weighing the fuel and by periodic temperature readings of the steam, feed water, flue gas, etc., also steam-pressure observations. No plant should be without these valuable adjuncts that give such information, and any plant not so equipped, unless it be very small, will waste enough in a surprisingly short time to pay for the outfit required. Unless results are checked daily and conditions kept at their best by the lessons taught instruments are useless.

Boilers should be cleaned periodically, internally and externally. Cleaning should not be put off until someone thinks it is needed, as the judgment of man is too erratic to be efficient. There have been developed a few good soot blowers, and their installation is desirable. I have yet to find the man that will blow tubes with the steam hose and do it properly unless the ax is held by a thread over his head.

Keep the setting air-tight and well insulated. Brick settings are never tight, and painting will not make them tight, as the paint dries out so rapidly that the expansion and contraction cause it to develop miniature cracks, which, upon close examination, will be found to be caused by like cracks in the setting. If the hand is carefully passed over the setting, the temperature changes felt will show air leakage in a setting thought to be tight. There are some good elastic cements with which settings may be plastered and which do not harden and will maintain a tight setting. Doors set in masonry will be found probably the worst offenders if mortar is depended upon for the joint. Painters' putty applied about the joint and then painted will keep them tight for a long time. These remarks apply likewise to the flues, economizers and chimney—air leaks anywhere cost money.

THE EFFICIENCY OF LABOR HAS FALLEN

Three years ago it was possible with study and patience to weld labor into an efficient organization. Today it is rather the other way—labor draws the heat. The "efficiency" of boiler-house labor has in three years fallen easily 30 per cent. Three years ago our boiler plant had a manual efficiency, based on time studies, of 60 per cent., and on some operations as high as 70 per cent. All have fallen some, the most decided slump being on the part of the firemen. Coal handlers give the most trouble as to the steadiness of the workers. In the last few months it has been irksome to keep them on the job, and the prospects of holding the efficiency are poor indeed notwithstanding that over 32c. per hour is paid. When it comes to a choice between fuel efficiency and labor efficiency, the labor efficiency must be sacrificed to keep down operating costs.

The following describes the operation of passing coal in the plant I have in mind. Coal is dumped alongside the boiler house on a level with the floor. From here it must be wheeled from 50 to 150 ft., then lifted 8 ft. to the stoker hoppers. Two-wheeled balanced barrows are used with a nominal capacity of 500 lb.; the average load will be about 530 lb. We have had men who by skillful loading would carry 700 lb. to the trip. Loading is done with a No. 5 scoop. If the coal is lumpy, the passer must break it to lumps not larger than his fist to avoid clogging the stoker hopper.

The operator handled on an average for the day 679.32 lb. per trip. This is higher than the average. The distance wheeled was more than 20 ft. over granite-block paving, 15 ft. over brick, up on an elevator and then on 80 ft. of steel plate, from which the coal was dumped into the stoker hopper. The time-study efficiency was 70.26 per cent.; fifty-nine trips were made, the average time per trip including all operations being 7.17 min.; the total coal handled was 40,080 lb. At present five men handle approximately 190,000 lb. in 24 hours, an average of 38,000 lb. each, which gives a cost for handling of about 21.5c. per gross ton. I do not believe that this figure can be reduced under the conditions.

Our operation for the boiler plant is as follows: One boiler is operated Sundays, five additional boilers are fired anew each Sunday night, so six boilers are operated days during the week and four are operated at night excepting Saturday and Sunday nights. The fires in the five boilers are allowed to burn out Saturday afternoon.

For general plant-operating economy the results of the week ending Nov. 10 may be taken as typical:

Total coal consumed (includes coal used for banking and starting), lb.	1,113,670
Total net evaporation, lb	10,435,060
Live steam to mill heating, per cent. 8.45, lb	883,150
Live steam to mill processing, per cent 22.9,	2,389,800
Live steam to mill power generation, per cent. 68.65, lb	7,162,110
Actual net evaporation per pound of coal, lb	9.37
Equivalent evaportation from and at 212 deg. F. per pound combustible, lb	13.1
Kilowatt-hours generated	386,730
Kilowatt-hours, output	354,600
Power coal per kw.-hr. generated, lb	1.98
Total coal per kw.-hr. generated, lb	2.89

The boiler-house percentage charges for the year ending June 30, 1915, with a boiler load factor of 33.45 per cent., were as follows:

Fixed charges	19.45
Management	3.70
Water, lubricants, tools and miscellaneous	0.35
Labor	7.17
Carting ashes and refuse	1.14
Fuel	62.9
Supplies	0.52
Repairs	4.77
Total cost of 1,000 boiler horsepower-hours, dollars	10.58
Cost of 1,000 lb. of steam from and at 212 deg. F., cents	30.67

Eliminating the item of fixed charges, fuel cost was 78.25 per cent of the operating expense.

Actual net evaporation per pound of coal, lb	9.215
Equivalent evaporation from and at 212 deg. F. per lb. combustible, (includes the economizers), lb	12.45
Kilowatt hour output	10,106,750
Coal per kw.-hr., lb	2.165

The cost of 1,000 lb. of steam at 212 deg. F., including all charges is approximately 49c. at present.

DISCUSSION

H. A. WILCOX: I believe that this lack of equipment which Mr. Weaton mentions is due to lack of education on the part of owners and managers as to what could be done in the way of boiler-plant economy. It may safely be stated that managers were and are today unwilling to spend a cent on the nonproducing part of their plants and the boiler plant has, until late years, been considered a necessary evil rather than the heart of the plant. This feeling has gradually undergone a change, due to the entrance of highly trained efficiency engineers into the field and to the retaining of expert engineers by the manufacturers of boiler-plant accessories. These men are capable of bringing clearly into the understanding of managers the benefits to be derived from the installation of their equipment and therefore the use of stokers, coal conveyors, etc., has grown apace. Mr. Weaton ascribes this to the present high wages paid for labor, but I cannot agree entirely with him, as the price of the finished product has advanced correspondingly, leaving as large a margin of profit as in previous years.

It has been suggested that for a plant of 1000 hp. three 350-hp. boilers, economizers, underfeed stokers, etc., should be used. I am inclined to think that this statement is rather broad. The nature of the industry to be served must be considered, such as: (1) Is 24 hours of operation at 1000 hp. required every day in the week? (2) Will there be exhaust steam available for heating the feed water and can exhaust steam be used in process work? (3) Do the summer and winter loads vary greatly? (4) What provision must be made for future expansion? (5) Is the location of the plant such that it will be able to receive fuel deliveries by rail or by water? (6) Finally, commercial efficiency, based upon the foregoing considerations, will determine the equipment desirable for the plant. By commercial efficiency is meant thermal efficiency properly modified by monetary values. In other words, owing to plant location, nature of the product or like considerations, a plant may be equipped to burn a high grade of bituminous coal of 14,500 B.t.u. and costing $4 per short ton, at 75 per cent. thermal efficiency. This should produce 1000 lb. of steam at a fuel cost of 17.85c. If there is in the same market a poorer grade of coal having 12,000 B.t.u. per lb. and costing $2 per short ton, this same plant should operate at only 68 per cent. thermal efficiency, but would develop 1000 lb. of steam for 11.9c., which shows a fuel-cost saving of about 33⅓ per cent. Considering commercial efficiency, it would therefore seem that a decision for underfeed stokers is somewhat premature before it has been determined whether bituminous or anthracite coal will be used, because underfeed stokers will burn bituminous coal at very high efficiency, while to obtain 68 per cent. efficiency with clear anthracite, such as buckwheat, culm and barley, chain or traveling grates are a necessity.

Assume that these items have all been considered and that the equipment, as outlined previously, has been found most desirable. There is some doubt as to whether two men could operate such a plant economically. I believe that one man would be needed to run the stokers, tend the water, etc.; one man to operate and look after the maintenance of the coal- and ash-handling machinery; and one man for cleaning economizers, cleaning and repairing each boiler as it is laid off, and doing general odd jobs which would naturally develop in a plant of this size. In a plant of several thousand horsepower there is no doubt but that an allowance of two men per 1000 hp. would be ample. In a plant equipped with stokers, however, I think that a plant of only 1000 hp. would require the force enumerated in addition to the chief engineer. I also believe that the installation of stokers, if of the proper type, will materially improve plant efficiency and cut down the payroll as compared with hand-firing.

Use of Oil To Increase

I heartily indorse the opinion that oil appears to be a vigorous competitor of coal, but disagree with the statement that its use in this section will be limited to a very few plants. A few installations in this vicinity named from a long list will serve to illustrate. These plants are not especially selected, but as you will note, vary considerably in size: The Shepard Co., the Boston Store, the Atlantic Mills, Providence; the Lorraine Manufacturing Co., Slater Manufacturing Co., D. Goff & Sons, the Memorial Hospital, Pawtucket; the River Spinning Co., the Nourse Mill, the Social Mill, Woonsocket; and the largest New England mills of the American Woolen Co. are either already equipped to use oil fuel or have contracted for its immediate installation. The "Meypet" list comprised of their New England customers contains the names of 47 plants. I am informed that the oil fields which supply the plants named are located in Mexico and are worked by native laborers who are paid much higher wages than they would receive at their ordinary occupations. It is probably due to these facts that these oil fields have remained entirely unmolested during the recent upheavals in that country. A glance at any reliable newspaper is sufficient evidence as to labor conditions in the coal regions. As to transportation, all are aware of the rapid movement of all kinds of rail shipments. Present activity in shipbuilding indicates that transportation by water, which is the only economical method of supplying fuel oil to the northern and eastern sections of this country, should be facilitated rather than retarded. If this reasoning is correct, we can only assume that shipping facilities from all these fields will grow in direct proportion to their development. So it is likely that after the present emergency oil will be an even greater competitor of coal. I therefore believe that the use of oil as a fuel will largely increase during the next few years in this section as well as in others.

A source of considerable waste, which has not been mentioned, is the loss of combustible through the grates and in cleaning fires. A glance at the ash pile or an analysis of the ash of many plants now in operation will clearly reveal this loss.

Having determined what factors are of prime importance toward attaining maximum fuel economy, the question arises as to how we shall know when we have reached and are maintaing the highest possible standard of economy. The answer is simple: Periodic, frequent layoffs and examinations externally and internally will demonstrate the state of cleanliness and repair of boilers, stokers, economizers, etc., and a frequent analysis of the ash will determine the loss of combustible through the grate. This examination is such an important factor in the maintenance of fuel economy that it should not be beneath the dignity of the chief engineer to make sure that it is properly carried out even if it becomes necessary for him to make a personal investigation.

Importance of Gas Analyses

I am inclined to think that inspection of the fire through violet glasses, as outlined by Mr. Weaton, is not a very reliable indication, by reason of the liability to error in human judgment. I do not wish to be understood that his examination is without any value, as the general condition of the fuel bed with respect to holes, clinker, etc., may be absolutely determined in this way.

Fortunately we have an exact means of controlling combustion, called by Mr. Weaton "Indicating." I believe that a CO_2 recorder and an Orsat are both requisite. There are too many variables entering into combustion to permit of fixing conditions which can be followed for any length of time. Therefore, a recorder or a sampling tank capable of drawing a sample of flue gas over a long period of time is essential; it gives the average operation for any period of time, and any deviation from good practice is at once noticeable. Of course, in the installation of automatic apparatus for the analysis of flue gas it is vitally important that it be so located and arranged that the record of conditions at any one time is made within the least possible interval of time from the occurrence of the conditions. This is to simplify the determination of the causes of any change that may occur. An Orsat should be used from time to time as a check upon the recorder and to determine the location of trouble arising from a deficiency or excess of air, etc. I believe, with Mr. Weaton, that recording instruments giving flue temperatures, drafts, amount of feed water, weight of coal fire, etc., are indispensable aids to fuel economy.

Recommends Heat Balance

These instruments are all valueless unless their indications are intelligently interpreted. An exact interpretation is possible by the use of the heat balance. By the use of the recording instruments mentioned, a heat balance, covering any period of time, may be made and the exact extent and location of any preventable losses readily determined. Steps may then be taken to minimize these losses, a new heat balance made and the result of changes or the amount of improvement will be seen.

The human factor is at least equal to design in importance. By human factor I mean not only the fireman, but the management also. Given a plant such as described in Mr. Weaton's paper, I consider that the following additional conditions must exist to develop the highest plant efficiency attainable:

First, the management must be of a type which will take an interest in maintaining the highest boiler efficiency by an intelligent scrutiny of the daily records and a systematic method of keeping after the man on the job; second, the man on the job or chief engineer must be an intelligent and highly paid man—a man who has familiarized himself with the theory and practice of combustion and its control.

May I suggest that a paper by a member of the society on the general methods of investigating and overcoming preventable wastes in existing boiler plants would be valuable?

Following Mr. Wilcox, F. N. Connet, chief engineer, Builders Iron Foundry Co., Providence, described the installation and operation of the venturi meter. He emphasized the need of freedom from vibration and the desirability of nonpulsating flow for accurate measurement by the meter. This, he said, was given by the centrifugal feed pump. Mr. Connet also mentioned the good effects of feeding water to the boilers so as to anticipate coming loads. He showed several charts, both from the venturi meter (quantity fed) and from recording thermometers recording feed temperatures, to reveal how the average feed temperature was much more constant when steam demands were anticipated by raising the water level during periods of light steam demands and closing off the feed-control valve during heavy demands. It was interesting, he mentioned, that for years design of feed-water regulators had been to give continuous feed, while now design was tending to give periodic feed, with the aim of anticipating demands.

Henry Ballou, of Jenks & Ballou, consulting engineers, Providence, agreed that the many instruments and apparatus mentioned by Mr. Weaton and Mr. Wilcox were desirable, but said it was his observation that 98 out of every 100 average plants did not have them. He spoke of the Manning boiler as one in which air leaks were nil on account of the enclosed firebox. Mr. Ballou said that the use of oil was influenced more by the freedom from labor troubles consequent to its use than by questions of economical combustion. He spoke of the oil-burning plant of the Tamarack Mills, Pawtucket, R. I., which recently went into service and which was designed exclusively for oil. [See *Power*, Mar. 27, 1917, for brief description of this plant. A full description is now in preparation for an early issue of *Power*.]

Charles H. Bromley, associate editor of *Power*, presented many data on the coal and freight (rail and marine) situation, and read a communication from the Bureau of Mines calling attention to current coal containing from 50 to 200 per cent. more ash than in normal times. He dwelt on the futility of getting large returns by attempting to educate the fireman, something that had for years been tried and proved a failure. General adoption of approved furnace design and the employment of highly competent supervision for the boiler-room force were the requirements that held forth the great and only promise in fuel conservation on a large scale.

W. B. Lewis presided. The next paper in the Power Section was "From the Coal Pile to the Lamp," by Jesse E. Gray, chief engineer, Narragansett Electric Light and Power Co., Providence, read Dec. 21.

Deterioration in Heating Value of Coal During Storage

There is a marked agreement in the conclusions reached by the United States Bureau of Mines, as published in Bulletin 136, and the Engineering Experiment Station of the University of Illinois, Bulletin 97, in regard to the effect of storage upon the heating value of coal. The tests show that the deterioration of coal in heating value during storage has commonly been overestimated. Except for the subbituminous Wyoming coal, no loss was observed in outdoor weathering greater than 1.2 per cent. in the first year, or 2.1 per cent. in two years, but the Wyoming coal suffered somewhat more loss—2 to 3 per cent. in the first year and as much as 5.5 per cent. in three years.

In general the conclusion to be drawn from the tests by the Bureau of Mines on New River coal is that under severe conditions of outdoor exposure to the weather it deteriorates in heating value approximately 1 per cent. in the first year, 2 per cent. in the first two years, and not over 3 per cent. in five years. Storage under water prevents practically all deterioration during one year, and no more than 0.5 per cent. has been found in any test for two years or less. Salt water possesses no advantage over fresh water in preventing deterioration. Intermittent exposure and partial drying of the submerged coal probably causes deterioration in some degree, although very small, therefore submergence storage of New River coal is not to be recommended for the sake of preventing deterioration in heat value—its advantage lies only in insuring against spontaneous combustion.

The amount of deterioration of coal from the Pittsburgh beds in one year's open-air storage at the University of Michigan was practically negligible, even in the upper six inches of the exposed coal. During the second, third, fourth and fifth years the deterioration proceeded very slowly and did not reach an amount greater than 1.1 per cent. in five years. The submerged portions may be said to have suffered practically no loss measurable by the degree of accuracy used.

Tests of Pocahontas coal at Panama show that during one year's outdoor exposure it deteriorated very slightly (less than 0.4 per cent.) in heating value, and that the deterioration took place entirely during the first six months (June 15 to Dec. 15). There was a further deterioration of 0.4 per cent. during the second year.

Exposure Increases Weight of Coal

Laboratory experiments have shown that coal ordinarily increases slightly in weight on exposure to the air. It is possible, therefore, that the net losses in heating value may be slightly less than reported, since the actual weight of fuel substance present may be somewhat greater, although its heat value per pound is less than when the coal was stored.

In the storage of Sheridan (Wyo.) coal for more than three months, covering the bins is not as advantageous as the use of air-tight bottoms and sides (of concrete, for example) and the accumulation of a protecting layer of fine slack on the surface. The deterioration of Sheridan coal in heat value can probably in this manner be kept below 3 per cent. in one year, and will probably not increase to more than 4 per cent. in two or three years if the coal remains undisturbed. Physical deterioration (slacking) is also largely prevented in the under portions by the formation of a closely packed layer of slack, at least 12 inches thick on the surface.

Although no indications of spontaneous heating were noted in the tests described, it is found in practice to be dangerous, on account of heating, to store Sheridan coal in piles greater than about ten feet in depth or width. In large masses of coal radiation of spontaneously developed heat is restricted, to a dangerous degree. Submergence under water would probably prove particularly advantageous as a means of safely storing sub-bituminous coal of this type.

Summary of University of Illinois Experiments

The facts established by the investigations by the University of Illinois Engineering Experiment Station may be summarized as follows:

1. Freshly mined coal is chemically very active. Certain constituents have a marked affinity for oxygen, with which they enter into combination at ordinary temperatures. While the extent of this reaction depends upon the variety of the coal and the amount of these active constituents, an important factor is the fineness of division, or the sum total of the superficial areas of the particles, and the accessibility of oxygen to the mass.

2. The actual loss of heat value resulting from storage is small. It is evident that upon mining out the coal from the bed certain volatile constituents of the marsh-gas variety are set free. The heat values represented by such exudations are not great. The tendency to absorb oxygen from the air is also a marked characteristic of freshly mined coal. This is in reality a chemical process, and is accompanied by the generation of a small amount of heat, but these heat losses, compared with the total heat available in the coal, are insignificant. Indeed, it may be fairly questioned whether the heat losses are not more apparent than real, since there is an increase of weight due to the absorption of oxygen. Such increase will in itself lower to a corresponding degree the indicated heat value per pound of coal.

3. There is an increase of "fines" or slack resulting from storage, greater with some coals than with others. This,

together with the saturation of the free-burning constituent with oxygen, slows up the fire and gives the appearance of being lacking in heat value. However, with an increase of draft and a correct understanding of the combustion conditions to be maintained, a most excellent over-all efficiency can be secured even from coals that have been in storage for long periods.

4. Bituminous coal can be stocked without appreciable loss of heat values provided the temperature is not allowed to rise above 180 deg. F. Any method of storage, to be successful, must either check or prevent the absorption of oxygen to such an extent that the generation of heat shall not proceed faster than the dissipation and loss of heat due to absorption or radiation.

5. Under-water storage prevents loss of heat values and is not accompanied by deterioration in physical properties, such as slacking. The water retained by the coal upon removal is substantially only that held by adhesion or capillarity.

6. Dry storage is safer and more satisfactory if the fine material is screened out at the storage yard and lumps only, preferably sized, are stocked.

It will be seen from this summary that the most serious part of the problem relates to the matter of spontaneous heating, and probably the least serious phase relates to deterioration and actual loss of heat values. It is certain that at the present time a better understanding of these difficulties has been reached, and there is reason for believing that this better understanding of the fundamental principles involved will lead to some practicable and safe procedure for the stocking of bituminous coal.

The general summary covering the behavior of the coal in steam generation after six years of storage, as set forth in Bulletin 78 of the University of Illinois Engineering Experiment Station, is as follows: (1) Burning weathered coal is largely a question of correct handling and ignition. Under these circumstances it gives as good results as fresh screenings. (2) Weathered coal requires a little thinner fire and more draft than fresh screenings. (3) When using weathered coal, the fuel bed should not approach any nearer to the water-back than from four to six inches, otherwise trouble with clinker is experienced. (4) Practically as high capacity was obtained with weathered coal as with the other coals used, and, if anything, the fuel bed requires less attention.

ACTUAL HEAT LOSS IS SMALL

In this connection attention is called further to the fact that the results obtained and the conclusions presented are based on the heat values in the coal as fired and do not take into account the matter of deterioration. But it has been pointed out that the deterioration is largely apparent in a physical change and that the actual loss of heat value is small. Hence, the efficiency factors developed in the tests may be accepted as fairly representing results obtainable on weathered coal in which the heat loss resulting from weathering is practically negligible.

The facts presented in the bulletin justify the following conclusions: (1) Bituminous coal can be stocked without appreciable loss of heat values provided the temperature is not allowed to rise above 180 deg. F. In fact, there is no appreciable evolution of CO_2 at temperatures below 260 deg. F. (2) The indicated heat loss per pound of coal is due more largely to an increase in weight of a unit mass of coal resulting from the absorption of oxygen than to an actual deterioration or loss of heat units. (3) Freshly mined coal has a large capacity for absorbing oxygen, which combines chemically with both the organic combustible and the iron pyrites present. (4) The combination of oxygen with coal at ordinary temperatures generates a small increment of heat. (5) The rapidity with which oxygen is absorbed depends upon the temperature of the mass and the extent of the superficial area exposed; that is, the fineness of division of the coal. (6) If heat is generated by this slow process of oxidation more rapidly than it is lost by radiation, the acceleration of the reaction causes a rise in temperature which quickly brings the mass up to the danger point. A temperature of 180 deg. F. is named as the danger point because, if the coal reaches that temperature, practically all the free moisture is vaporized and the further rise in temperature will be very rapid. (7) Any method of storage to be successful must either check or prevent the absorption of oxygen to such an extent that the generation of heat shall not proceed so rapidly as to exceed natural heat losses due to radiation. (8) Under-water storage prevents loss of heat values and is not accompanied by deterioration in physical properties, such as slacking. (9) Dry storage is far more safely undertaken if the fine material is screened out at the storage yard and the lumps only, preferably sized, are stocked.

How To Save Coal

The Bureau of Mines, Department of the Interior, recently asked the advice of a number of prominent fuel engineers as to the best way to conserve in the use of coal. Martin A. Rooney, of Detroit, Mich., has the following to say:

In every trainload of coal hauled from the mines to our coal bins, one carload out of every five is going nowhere and worse. In a train of 40 cars the last eight are dead load that might better have been left in the bowels of the earth.

Every fifth shovelful of coal that the average fireman throws into his furnace serves no more useful purpose than to decorate the atmosphere with a long black stream of precious soot. These are not meaningless statistics nor a "goblin" story, but cold facts on a warm subject. At best, one-fifth of all our coal is wasted. And it is shamelessly and needlessly wasted. Instruments and machinery for getting out all of the heat there is in it are not nearly so complicated nor expensive as the cash register which you use to keep tab on your cash receipts or the truck which you operate to clip a few cents off of your delivery costs. Carbon-dioxide temperature and draft are easier subjects to comprehend than bank discount or freight rates.

The moral is, Mr. Coal Dealer, get busy and learn what they are and how to use them. The time is coming when the Government is going to limit the amount of our coal that is dumped down your chute and in the name of fairness, when we must deny fuel to some manufacturer, let it be to him who cannot show that he is going to use it efficiently. In the name of fairness to the miner who digs it, to the heavily burdened railroad which transports it, to a number of our people whose very existence and whose future happiness depend absolutely on the use we make of this most precious of our resources, let us make efficiency the criterion to judge by when we come to determine which shall survive.

And in fairness to the manufacturer who is patriotically operating his properties at nearly to the breaking speed and who is giving up a large part of his profits for the general good, let the Government show him how to conserve this most important of his raw materials. Let us send into our furnace and boiler rooms men who can show our engineers and firemen how to burn their fuel with the least waste, as we have sent them among our fields and orchards to show the farmer how to increase the productivity of his soil.

—By Coffman in New York *American*, with amplification by Weil

HIS SHARE

Early Action Expected on the Administration's New Water-Power Bill

On the night of Jan. 4, 1918, President Wilson held a conference at the White House with members of various committees of the House of Representatives for the purpose of speeding up action in the House on the passage of water-power legislation. The President committed to the care of Representative Pou, chairman of the House Rules Committee and a member of the delegation whose members conferred with him, a copy of a new water-power bill, to be known as the Administration Bill, which attempts to coördinate water-power legislation proposed for several years past in both Houses of Congress, not only on the public domain, but in navigable streams; and it is expected that the result of the White House conference will be that the House Rules Committee will bring in a rule peremptorily requiring the House of Representatives to vote on and pass water-power legislation at an early date.

What is to take place in regard to water-power legislation in the Senate is not yet known, as that body passed the Shields bill, and there is a difference between the provisions of that measure and those of the Administration measure. The Shields measure, in fact, is by way of amendment to the Act of 1906 to regulate the construction of dams across navigable waters and does not deal with water powers on public lands, which are dealt with by a different Senate committee from the Committee on Commerce, which favorably reported the Shields bill. To the fact that there have been so many committees of both the House and the Senate dealing with so many different phases of proposed water-power legislation has been due, more than to anything else, the delay in passing water-power legislation which was promised the country among the so-called "Administration Conservation Measures" when President Wilson took office five years ago. In the House the red tape which has caused this delay seems in a fair way to be cut by the Presidential conference of Jan. 4; for the President, who has had many conferences with members of the House and Senate and their differing committees, without obtaining legislation, committed the new Administration bill not to the chairmen of any of the House committees dealing with water-power matters, but to the chairman of the Rules Committee. The President is reported by those who attended the conference to have explained with the greatest tact to the committee chairmen that he did not know which committee among the water-power committees to entrust with the bill, in view of their differences, and that he would solve the problem by giving it to the Rules Committee, which, as official Washington views it, carried with it the plain implication: "Pass the bill!"

SENATORS EXPECT WHITE HOUSE CONFERENCES

Senators in charge of water-power legislation in the Upper House are also expecting to have White House conferences; it is certain that the Administration bill will be introduced in the Senate or that its provisions will come before a Senate committee in some form, so that when the House passes the Administration bill there may be a conference between the House and the Senate, giving opportunity to mold the differences between the Administration bill, the Shields bill already passed by the Senate, and the provisions of any measure relating to the public lands which may come from the Lands Committee of the Senate, in case there is no agreement in the Senate to substitute the Administration bill for the Shields bill. It is not at all certain that Senators will accept the Administration bill, and there are some who will not fail to exercise the "I object" made famous by "senatorial courtesy," unless they can be made to see that the safety of the country imperatively demands the passage of water-power legislation at once because of the shortage of coal and consequently of power, which was President Wilson's impelling motive in committing the new Administration bill to the House Rules Committee.

Although most of the water-power legislation delay has been due to Congress, some of it has been due to opposing views held by members of the Cabinet. These views have now been reconciled in the new Administration bill, which provides for a water-power commission to be composed of three Cabinet officers—the Secretary of the Interior, the Secretary of Agriculture and the Secretary of War. It provides for an executive officer of the commission, who shall be appointed by the President for a term of five years. It provides for the payment of rentals, a feature to which there has never been objection of consequence by any interest, and it grants licenses for water power on public lands as well as public streams for a term of 50 years. At the end of the license period the licensee will be allowed to renew the license and remain in undisturbed possession until the proposed commission shall have done one of three things: First, issue new licenses under laws at that time applicable; second, give licenses to new licensees who shall pay for the fair value of the property; third, take the property over upon paying a fair value, the fair value defined to include all work and main transmission lines plus severance damages for all property not taken over and damaged by reason of severance.

ENHANCEMENT OF VALUES NOT PROVIDED FOR

The new Administration measure does not include any allowance for enhancement of values on land, or water rights, or for any good will for a going concern, etc. It provides for alteration, amendment or repeal by Congress, Congress expressly reserving such rights; but in case of alteration, amendment or repeal, such shall not extend to the licensees who have exercised rights or spent money under the bill.

The bill was drawn by General Black and Colonel Keller, of the Army Engineer Corps, representing the War Department; Edward C. Finney, water-power expert for Secretary Lane; former Representative Lathrop Brown, of New York, now a special assistant to Secretary Lane, representing the Interior Department; and O. C. Merrill, chief inspector of the Forest Service, representing the Agricultural Department, who several years ago compiled a mammoth report on water-power companies, their banking affiliations, etc. Present at the White House conference on the night of Jan. 4 were Thetus W. Sims, chairman of the House Committee on Interstate and Foreign Commerce, who has recently succeeded Judge Adamson in that position; Scott Ferris, of Oklahoma, chairman of the House Public Lands Committee; Asbury F. Lever, of South Carolina, chairman of the House Agricultural Committee; Edward W. Pou, of North Carolina, chairman of the House Rules Committee; and Finis J. Garrett, the ranking member of the House Rules Committee. Representative Garrett and Representative Sims, as well as Senator Shields, are Tennesseeans, so that Tennessee will have much to say, it so falls out, as to the passage of water-power legislation by the present Congress.

At the Presidential conference it was agreed that a committee of five members each from the House Committee on Interstate and Foreign Commerce, Agriculture and Public Lands, or fifteen in all, should be created to compose differences as to the various bills which have been under consideration heretofore in the House and to bring together such radical views as have been expressed by Representative Ferris during public debate on water powers with the more moderate views as to water-power development expressed by others. The committee of fifteen, it is felt in Washington, will be materially aided in its labors by the fact that after mature deliberation, advice and conference, President Wilson himself has presented a bill upon which he believes all can agree.

It is gross negligence for the operator of an electric-power plant to permit a switchboard carrying a dangerous voltage to remain exposed near a passageway used by employees, rendering him liable for resulting injury to or death of such an employee. The fact that an employee killed under such circumstances had been warned against the danger of coming in contact with the appliances did not necessarily charge him with contributory negligence where he inadvertently came in contact with the switchboard while stepping aside to avoid another employee who was passing with tools on his shoulder. (Kansas City, Mo., Court of Appeals, Lightner vs. Dunham, 195 Southwestern Reporter, 1055.)

A. S. M. E. Presented with Bust of Admiral Isherwood

At its annual meeting in December, 1917, the American Society of Mechanical Engineers was presented with a portrait bust of Admiral Benjamin Franklin Isherwood, who was for many years, up to the time of his death, an honorary member of the society. The bust was a gift from a number of the friends and admirers of the admiral. The presentation address was to have been made by Commodore George W. Magee, U. S. Navy, who had been an old friend and assistant of Admiral Isherwood; unfortunately, however, Commodore Magee was taken ill, and that pleasant duty devolved upon W. M. McFarland.

Mr. McFarland pointed out that the special glory of Admiral Isherwood's work was that he helped to establish a number of the important basic principles of the science of engineering. He stated that the first reproduction of actual indicator cards from a marine engine published in any book was in Isherwood's work on "Engineering Precedents," published about 1856. He said further:

BUST OF ADMIRAL ISHERWOOD

> His reports of experiments are models of what such reports should be. They include a complete description of the apparatus; and the log of the experiment, in each case, gives all the data which could be observed, whether they were immediately applicable to the purpose of the experiment or not. The result of this is that these reports constitute a mine of valuable information; and other engineers, many years after, seeking information on an entirely different line from that for which the experiment was conducted, find in the complete and careful record just the information they want, and which often can be found nowhere else.

The written address of Commodore Magee, which was read by Mr. McFarland, referred to the great value of Isherwood's experimental work on such subjects as the expansive working of steam, screw propellers, the use of superheated steam and the use of forced draft. Commodore Magee characterized Admiral Isherwood as "the greatest marine engineer who has thus far appeared in our country," and "not only a great engineer, but a great administrator and executive."

Dr. Hollis, president of the A. S. M. E., in accepting the bust on behalf of the society, spoke of his personal acquaintance with Admiral Isherwood at the Naval Academy and said he considered his service for the admiral as perhaps the proudest of his life. Continuing, he said:

> I think of him as perhaps the father of our great research laboratories in engineering, as his investigations in connection with steam engines and with boilers preceded all of our schools of mechanical engineering. I think of him also as the father of high speed on the sea. Few people realize that it was Benjamin F. Isherwood who during the Civil War planned and carried to its completion the first ocean greyhound, a ship which went outside along the Jersey coast and made four hundred miles in one day with ease, something that was not equaled again for twenty years.

Annual Report on Locomotive-Boiler Inspection

The annual report of the chief inspector of locomotive boilers for the fiscal year ended June 30, 1917, shows a considerable increase over the previous year in the number of accidents, injuries and casualties due to locomotive-boiler defects and explosions. Much of this increase is explainable on the grounds of the unusual operating conditions, and the shortage of labor and material for suitable repairs. On the other hand, some carriers appeared to consider the use of defective locomotives excusable because of the congestion of traffic. The number of locomotives inspected during the year was 47,452, which is considerably fewer than the year before; and of those inspected, 54.5 per cent. were found defective, an increase of 7.5 per cent. over the previous year. The number of locomotives ordered out of service was 3294. Crown-sheet failures due to low water were responsible for almost three-fourths of the 62 fatalities during the year, and as might naturally be expected, engineers and firemen were the chief sufferers. Of the defects discovered by inspection, broken stay-bolts, faulty injectors and connections, and defective brake equipment headed the list. The report forms another strong argument in favor of the efficient periodic inspection of high-pressure boilers.

An American pipe line played an important part in the recent capture of Jerusalem according to the statement of Maj. Gen. F. B. Maurice, chief director of military operations at the British war office. The campaign which led to the fall of Jerusalem was carried out mainly by British territorial troops supported by small bodies of Australian and New Zealand mounted men and British yeomanry. "In the campaign as a whole," he said, "the great accomplishment has been not the defeat of the Turks, but the conquest of the Sinai Desert. The troops who fought at Gaza drank water from Egypt pumped through an American pipe line and were supplied over broad-gage railroad laid across the 150 miles of the Sinai Desert, which has defeated almost everybody who tried to conquer Egypt for centuries. Every ounce of material for the pipe line, the railroad and the other works came either from Great Britain or from the United States. The fall of Jerusalem was made possible by industry, organization and by the help of material from the United States."

Peat production in Norway in 1914 was 12,000 tons, and 22,000 tons in 1916, but the production in 1917, it is said, will probably go up to 100,000 tons. In Denmark, in 1915, the production was 90,000 tons, in 1916 200,000 tons, and in 1917 it is hoped to produce 500,000 tons. Sweden produced 100,000 tons in 1916. There are 216 peat machines now working in Norway, as compared with 55 in 1916 and 36 in 1914. Among the machines in use are two automatics; these cost £2700 apiece, and can each be handled by two men, the daily output per machine being 30 to 40 tons of peat.—*Gas and Oil Power.*

New Publications

TESTS OF OXYACETYLENE-WELDED JOINTS IN STEEL PLATES

Bulletin No. 98 of the University of Illinois Engineering Experiment Station, by Herbert F. Moore, research professor of engineering materials, treats of tests of oxyacetylene-welded joints in steel plates from 0.14 in. (No. 10 gage) to 1 in. in thickness. Welds made by skilled workmen in a plant especially equipped for oxyacetylene welding were tested for their resistance to tensile, bending and impact stresses. For joints made with no treatment after welding, efficiency for static tension was found to be about 100 per cent. for plates one-half inch in thickness or less and to decrease for thicker plates. When account was taken of the additional thickness at the point of fracture—that is, when the efficiency was computed upon the cross-sectional area of the metal ruptured—the efficiency was not greater than 75 per cent. The joints were strengthened by working the metal after welding and were weakened by annealing at 800 deg. C. (about 1400 F.). Practically the same is true of the bending or repeated-stress test. The impact tests show that oxyacetylene-welded joints are decidedly weaker under shock than is the original material. For joints welded with no subsequent treatment the strength under impact seems to be about half that of the material. If the welded joint is worked while hot, the impact-resisting qualities are slightly improved though this does not make the joint equal to the original material in impact-resisting quality, which is little affected by annealing from 800 deg. C. In general the test results tend to increase confidence in the static strength and in the strength under repeated stress of carefully made oxyacetylene-welded joints in mild-steel plates.

THE J. E. ALDRED LECTURES ON ENGINEERING PRACTICE

A course of lectures on "Engineering Practice" was established about a year ago at Johns Hopkins University through the generosity of J. E. Aldred, and the first series, given by prominent practicing and operating engineers, has recently been published. These lectures, nine in number, present the essential features of planning, construction and operation of modern engineering projects and, being open to the public, were well attended by the engineers of Baltimore.

The subjects in the order in which the lectures were delivered, from Mar. 16 to Apr. 20 inclusive, are as follows: The Operation of a Hydro-Electric Plant, by A. E. Bauhan, station superintendent, Pennsylvania Water and Power Co., Holtwood, Penn.; Some Things Engineers Should Know Concerning the Rudiments of Corporate Finance, Ralph D. Mershon, consulting engineer, New York; The Development of Power from the Standpoint of the Boiler Room, C. F. Hirshfield, chief of research department, Detroit Edison Co., Detroit, Mich.; Power and Service in Industrial Plants, R. J. S. Pigott, superintendent of motive power, Remington Arms Co., Bridgeport, Conn.; Gas Manufacture, Construction and Operation, George P. Marrow, assistant engineer, in charge of Gas Manufacture, Consolidated Gas, Electric Light and Power Co., Baltimore; Rapid Transit Problems in American Cities, George Staples Rice, engineer of the Sixth Division of the Public Service Commission, New York; Some Practical Problems Met With in the Design and Construction of Bridges and Similar Structures, W. W. Pagon consulting engineer, Baltimore; Experimental Engineering, Particularly the Construction of Testing Stations on Water and Sewerage Problems, Langdon Pearse, division engineer, Sanitary District of Chicago; Public Utility Engineering and Finance, Herbert A. Wagner, president, Consolidated Gas, Electric Light and Power Co., Baltimore.

A limited number of paper-bound copies of this course of lectures, about 250 pages 6 x 9 in., including numerous illustrations with additional folders of charts, maps and diagrams inserted, can be obtained from the Johns Hopkins Press (Baltimore, Md.) for $1 each.

Personal

C. P. Coleman was elected president of the Worthington Pump and Machinery Corporation at a meeting of the Board of Directors held on Dec. 31.

R. H. McLeod has been appointed general superintendent of the Philadelphia and Titusville plants of the Philadelphia Rubber Co., being promoted to this position from that of mechanical engineer. He is a graduate of Columbia.

Edward H. Tenney has been promoted from assistant chief engineer to chief engineer of the Union Electric Light and Power Co., of St. Louis, succeeding John Hunter, who is in charge of the Government emergency ship construction of the New Jersey district.

John Hayes Smith, consulting engineer of Milwaukee, has accepted a position as assistant engineer to the Public Service Commission of Pennsylvania. Mr. Smith became associated with the Westinghouse Electric and Manufacturing Co. shortly after graduation from Columbia University, remaining in their employ about six years. He was the first manager of the "Electric Journal," Pittsburgh, and later became editor of the "Electrical Age," New York. He was with the Milwaukee Electric Railway and Light Co. for two years.

Engineering Affairs

The Philadelphia Section of the A. S. M. E. will hold a meeting on Feb. 26, at which Carl G. Barth will present a supplement to "Taylor's Art of Cutting Metals."

American Association of Engineers—Edmund F. Perkins, consulting engineer, Chicago, and president of the American Association of Engineers, will address the New York Chapter of the association at the Hotel McAlpin, on Tuesday, Jan. 15, 8 p.m., on the subject of "National Association Service for Engineers." All interested are cordially invited.

Miscellaneous News

A Four-Inch Tube in a boiler at the Philadelphia Navy Yard blew out on Jan. 1, killing two men, injuring six severely and one slightly. It is believed the explosion was due to a defective tube.

The Boiler of a Freight Locomotive on the Chesapeake and Ohio R.R. exploded at Marmet, W. Va., on Dec. 22, killing the fireman and injuring the engineer. The cause of the explosion is not known.

A Boiler Exploded at the plant of the Beaver Clay Co., at New Galilee, Penn., on Dec. 26, causing considerable damage to the boiler room and surrounding structure and severely injuring a workman who was near the boiler when it let go. The cause of the explosion is not known. The damage done was estimated at $2000. Because of a partial suspension of work during the Christmas period many of the employes were not in service, which fortunately accounts for lack of casualties perhaps.

Large Providence Turbine Started—The 45,000-kw. Westinghouse cross-compound turbine at the South Street Station of the Narragansett Electric Lighting Co., Providence, R. I., was started for the first time Wednesday morning, Jan. 9. The turbine is perhaps the largest in the world in point of dimensions, although the two-cylinder turbine at the Duquesne plant, Pittsburgh, is of the same capacity. The Providence turbine has a double-jet Leblanc condenser, which "Power" will describe after it has been in service long enough to determine what performance it will give.

U. S. Requisitions Power Plants at Niagara Falls—In order to assure an adequate supply of power for establishments engaged in war work at Niagara Falls and Buffalo, the Government has requisitioned the electric power produced, imported and distributed by the Niagara Falls Power Co., the Hydraulic Power Co. of Niagara Falls and the Cliff Electrical Distributing Co. Canadian demands that approximately 100,000 hp. of current imported from the Canadian side be applied exclusively to war work were said to have been a determining factor in the Government's decision to requisition all power. About 110 factories not working directly on war contracts will be obliged to curtail their power somewhat and use it at times when munition factories are making their smallest demand. They will also substitute steam for electricity as much as possible.

England Out of Gasolene?—Our London correspondent writes: "Apparently while you are not short of petrol, we in England are. Instead we use gas, a bag to contain a charge being placed on top of the lorry, omnibus or other vehicle. Depending on the thermal value of the gas, the equivalent is about 250 cu.ft. to the gallon of petrol. Some busses have gas bags to hold about 700 cu.ft. In one instance, motor busses carrying 35 people run a mile on 60 cu.ft. Compression of gas has been suggested, but this means special machinery and special cylinders to support the increased pressure. The cost of charging varies according to the district. To take Birmingham as an example, the minimum fee is 1s. (25c.), this being the cost of 250 cu.ft. of gas." It seems likely, therefore, that gasoline engines, whether for automobiles, stationary, electric-generating or pumping sets, are now compelled to use gas.

Business Items

The Ridgway Dynamo and Engine Co., of Ridgway, Penn., has appointed the Blake Electric Manufacturing Co., 1 Rowes Wharf, Boston, Mass., as its sales representative for the New England States.

The Little Giant Truck Co. is the name of what was formerly the motor-truck department of the Chicago Pneumatic Tool Co., which on account of its growing proportions has branched off as a separate organization. The new company is owned and controlled by the Chicago Pneumatic Tool Co.

Albany Grease is celebrating its fiftieth anniversary. In 1868 the Albany Lubricating Compound and Cup Co. was founded at Albany, N. Y., by Adam Cook. The name Albany Grease was given to Albany Lubricating Compound by the engineers of the country, who quickly gave it a name of their own make. In four years the small plant at Albany became too small to take care of the business, and in 1872 larger quarters were secured along the river front at 231 West St., New York City. Nine years later the business was moved to still larger quarters at 313 West St. Still the business grew, until, by the purchase of neighboring warehouses, the Albany plant extended clear through the block from West to Washington St. After a stay of 30 years the West and Washington St. plant was abandoned, and the modern commodious plant at 708-10 Washington St. was placed in service. Many satisfied customers unite in wishing Albany Grease many happy returns of the day.

Trade Catalogs

Files Hand Stoker. The Files Engineering Co., Inc., Providence., R. I. Catalog. Pp. 8; 6 x 9 in.; illustrated.

Ellison Draft Gages. Lewis M. Ellison, 214 Kinzie St., Chicago, Ill. Pamphlet. Pp. 36; 3½ x 6 in.; illustrated

Westinghouse Motors and Generators for Direct-Current Circuits. Westinghouse Electric and Manufacturing Co., E. Pittsburgh, Penn. Catalog No. 30. Pp. 78; 8½ x 11 in.; illustrated.

Getting Maximum Pulley Efficiency. The American Pulley Co., Philadelphia, Penn. A pamphlet containing data and information compiled by this company relating to belt pulleys. Pp. 38; 6 x 9 in.; illustrated.

Falls Automatic Engine Stop. Falls Machine Co., Sheboygan Falls, Wis. Catalog Pp. 24; 6 x 9 in.; illustrated This contains information regarding the operating of overspeeding engines and shows application of engine stops.

Reverse-Phase Circuit Breakers. The Palmer Electric and Manufacturing Co., Boston, Mass. Bulletin M1; pp. 4; 6 x 9 in.; illustrated. Describes circuit-breakers for protection of polyphase motors against single-phase and reverse-phase operation.

Just About Boilers is the title of a pamphlet issued by the Badenhausen Co., 1425 Chestnut St., Philadelphia, Penn., which gives comparisons of principles of current boiler designs and details of construction of the Badenhausen boiler. Pp. 32; 8½ x 11 in.; illustrated.

Electric Welding. The Wilson Welder and Metals Co., 52 Vanderbilt Ave., New York. Catalog No. 2. Pp 64; 6 x 9 in.; illustrated. This describes in detail the Wilson electric welding system and specially prepared metals. Blueprints showing layout of complete equipment are included.

Automatic Pumps and Receivers. Worthington Pump and Machinery Corp., 115 Broadway, New York. Bulletin D-1301. Pp. 12; 6 x 9 in.; illustrated. Describes a number of types of apparatus manufactured by the Deane Works of the Worthington corporation for maintaining free and unobstructed circulation of steam in heating systems and machinery using steam.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 10, 1918	One Year Ago	Jan. 10, 1918	One Year Ago
Buckwheat	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Jan. 10, 1918	One Year Ago	Jan. 10, 1918	One Year Ago
Clearfields	....	$3.00	....	$4.25—5.00
Cambrias and Somersets	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.69. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 10, 1918	One Year Ago	Jan. 10 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$6.00—7.00
Buckwheat	4.30—5.00	2.75	5.50—6.00	5.50—6.00
Rice	3.75—3.95	2.20	4.50—5.00	5.00—5.50
Barley	3.25—3.50	1.95	4.00—4.25	3.75—4.00
Boiler	3.50—3.75	2.20	....	....

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Jan. 10, 1918	1 Yr. Ago	Jan. 10, 1918	1 Yr. Ago	1 Year Ago
Buckwheat	$3.15–3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65–3.65	1.25	3.65	2.15	3.35
Boiler	2.45–2.85	1.10	3.55	2.00	....
Barley	2.15–2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 10, 1918	One Year Ago	Jan. 10, 1918	One Year Ago	Jan. 10, 1918	One Year Ago
6-in. lump	$2.65–2.80	$3.50	$2.65–2.80	$3.50	$2.65–2.80	$3.50
2-in. lump	2.65–2.80	....	2.65–2.80	....	2.65–2.80	3.25–3.50
Steam egg	2.65–2.80	3.50	2.65–2.80	3.50	2.65–2.80	3.25–3.50
Mine run	2.40–2.55	3.50	2.40–2.55	3.25	2.40–2.55	3.00–3.25
No. 1 nut	2.65–2.80	3.50	2.65–2.80	3.50	2.65–2.80	3.50
2-in. screen.	2.15–2.30	3.25	2.15–2.30	3.25	2.15–2.30	3.00–3.25
No. 5 washed	2.15–2.30	3.25	2.15–2.30	3.00	2.15–2.30	3.00

Williamson, Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ariz., Kingman—The Desert Power and Water Co. plans to extend its transmission line to the Hackberry Consolidated Mill. Estimated cost, $90,000. A new line will also be extended to the Cyclopic, near Chloride. F. A. Wilde, Jr., Mgr.

Calif., Los Angeles—City has plans under consideration for the erection of power plant No. 2 in San Francisquita Canyon. W. Mulholland, Ch. Engr. Estimated cost, $750,000.

Calif., Mare Island—(Vallejo P. O.)—(Official)—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids to deliver at Navy Yard, Mare Island, under Schedule No. 1639, 400,000 ft. plain bell wire.

Iowa, Eddyville—City plans an election soon to vote on $7000 or $8000 bond issue for improvements to the electric-lighting system.

Mass., Boston—(Official)—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for delivering at Navy Yard, Boston, under Schedule No. 1640, brass gate valves, flanged gate valves and globe angle flanged valves.

Mass., Ipswich—The Newburyport Gas and Electric Co. plans to build a transmission line through certain streets in the city. C. S. Spaulding, Newburyport, Supt.

N. C., Graphiteville—The General Graphite Co., Birmingham, Ala., plans to build a hydro-electric plant here. Estimated cost, $75,000.

N. J., Jersey City—The American Sugar Refining Co., 117 Wall St., New York City, is having plans prepared for the extension and alteration of its power house on Washington St. Estimated cost, $10,000.

N. J., Newark—The Butterworth-Judson Co., Roanoke Ave., plans to build a 1-story, 87 x 94-ft. boiler house. Estimated cost, $18,000.

N. Y., Andover—City has plans under consideration for the erection of an electric-lighting plant.

N. C., Tuxedo—The Blue Ridge Power Co. plans to build a hydro-electric plant on the Green River. Estimated cost, between $800,000 and $900,000.

Penn., Philadelphia—Shane Bros. & Wilson, Bourse Bldg., is having plans prepared by J. M. Whitham, Arch., for the erection of a new 1-story, 35 x 40-ft. power house in connection with its plant on 63rd and Market Sts.

Penn., Pottsville—The Eastern Pennsylvania Light, Heat and Power Co. has petitioned the Public Service Commission for permission to issue $10,500 in bonds; the proceeds will be used in improvements to its system. W. B. Rockwell, Mgr.

Penn., Philadelphia—The United States Government plans to build a 1-story power house at the Frankford Arsenal.

Penn., Reading—The Reading Transit and Light Co. has been granted permission to issue an appropriation of $150,000; the proceeds will be used in extensions and improvements to its system. W. S. Barstow, Mgr.

Penn., West Chester—The Philadelphia Suburban Gas and Electric Co. plans to build a transmission line from its electric plant on the Schuylkill River at Crombie to Coatesville. J. D. Shattuck, Philadelphia, Mgr.

Penn., White Haven—The Wilmot Engineering Co., Hazleton, plans to build several additions to its plant including new power stations.

Tex., McAllen—The Rio Grande Public Service Corporation plans to install new machinery and equipment in its electric-lighting and power plant. Estimated cost, $40,000.

Tex., San Benito—The Commonwealth Electric Light and Water Co. plans to enlarge its power house and install new equipment including a new 100-hp. engine in its electric-light and power plant here.

Wash., Puget Sound—(Bremerton P. O.)—(Official)—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for delivering at Navy Yard, Puget Sound, under Schedule No. 1641, low pressure, iron, steam and water unions and brass composition, steam and water unions.

B. C., Trail—The West Kootenay Power and Light Co. plans to extend its transmission line to the plant of the Canada Copper Co., Princeton, about 110 miles. J. B. McDonald, Rossland, Gen. Supt.

Ont., Bartonville—Barton Township plans to purchase electrical equipment. Estimated cost, $55,000.

Ont., London—The Board of Utilities plans to build a brick and steel addition to its hydro sub-station. Estimated cost, $35,000. E. V. Buchanan, City Hall, Gen. Mgr.

POWER

Vol. 47 NEW YORK, JANUARY 22, 1918 No. 4

How Engineer Tim Got a Raise of Pay and Promotion

Contributed by M. E. GRIFFIN

TIM had been chief operating engineer in a cotton mill for fifteen years, and during that time had received only one raise of pay, and that mainly because of his heroic work during a fire.

Some time ago he decided to ask for a raise. Nerving himself for the ordeal, he finally had courage enough to go to the manager's office and in a straightforward way stated his case. The manager answered that the firm always recognized him as a good, faithful, conscientious engineer and felt proud of the care he took of the power plant, but owing to the increased cost of material and generally high running expenses, it was not possible to raise his pay, at least at that time.

Tim returned to the engine room somewhat downhearted, but he knew that it would be useless for him to try for a job elsewhere, as the pay would not be greater and he would have to start in on a new job with machinery perhaps new to him, whereas he knew all about his present power equipment.

TIME AND AGAIN he asked himself the question: *"How can I make myself more valuable to my employers and in turn get more pay for increased efficiency?"* He had been reading many articles on how engineers increased the efficiency of their plants and decided that perhaps it was possible for him to do likewise. It was true that his engines always ran well and none had better care, the firm often remarking on the low cost of repairs.

The power plant consisted of one 600-hp. cross-compound Corliss engine and a 250-hp. single-cylinder Corliss, each noncondensing and belted to separate lineshafts. There was also a 600-ft. steam-driven air compressor of old design, which was always considered a "steam hog." Air pressure was 80 lb. and steam pressure on boilers 125 lb. gage.

Tim purchased a book on engine testing and learned how to figure steam consumption from indicator cards, because he wished to make a test and ascertain if his plant was as efficient as it should be.

He had no means of measuring steam because his plant was noncondensing and to "rig up" would cost too much for equipment—more, he knew, than his firm would allow—therefore steam consumption from indicator cards was the nearest he could approach true conditions.

While he was making elaborate preparations for indicating the different units, he became so enthusiastic that he even gave the office boy a package of cigarettes for spreading the news around the office that great "doings" for increased efficiency were going on in the power plant.

THE CARDS from the cross-compound were very good, showing good distribution of steam and figured 20½ lb. of steam per indicated horsepower-hour, which was relatively close to the engine builder's guarantee.

The single-cylinder engine's cards, while showing good valve setting, figured 29 lb. of steam per i.hp.-hr., which was very much higher than builder's guarantee. This was accounted for by the early cutoff shown on the cards, proving that this engine was considerably underloaded and therefore wasteful accordingly.

The air-compressor cards figured an average of 37 lb. steam per i.hp.-hr. and showed a cutoff of about 75 per cent. of the stroke, which meant that the work done by the expansion of steam was practically nothing.

Summing up the steam consumption for the three units, 20½ lb. + 29 lb. + 37 lb. = 86½ lb. of steam per i.hp.-hr., and as the coal had an evaporation value of one pound of coal per 7½ lb. of steam, it was no wonder the firm was complaining about the monthly coal cost.

This convinced Tim that, while for fifteen years he thought he had an economical plant, he was only fooling himself and incidentally throwing his firm's money into the boilers, as he termed it.

After a couple of days' thought, he asked permission to make a few changes that he believed would increase the efficiency of the power plant with very small expenditure of money, stating that he could do the work himself at "odd" times. The superintendent gave him permission to do anything within reason that would reduce the coal consumption.

TIM REASONED THUS: "The cross-compound is the only economical unit, and I'll leave it alone; the single-cylinder is underloaded, and I'll have to build up a load somehow; the air compressor is overloaded and playing h— with the coal pile."

On the air compressor there were two balance wheels, each wide enough for a belt to drive it and so located that it could easily be belted to the lineshaft driven by the single-cylinder engine.

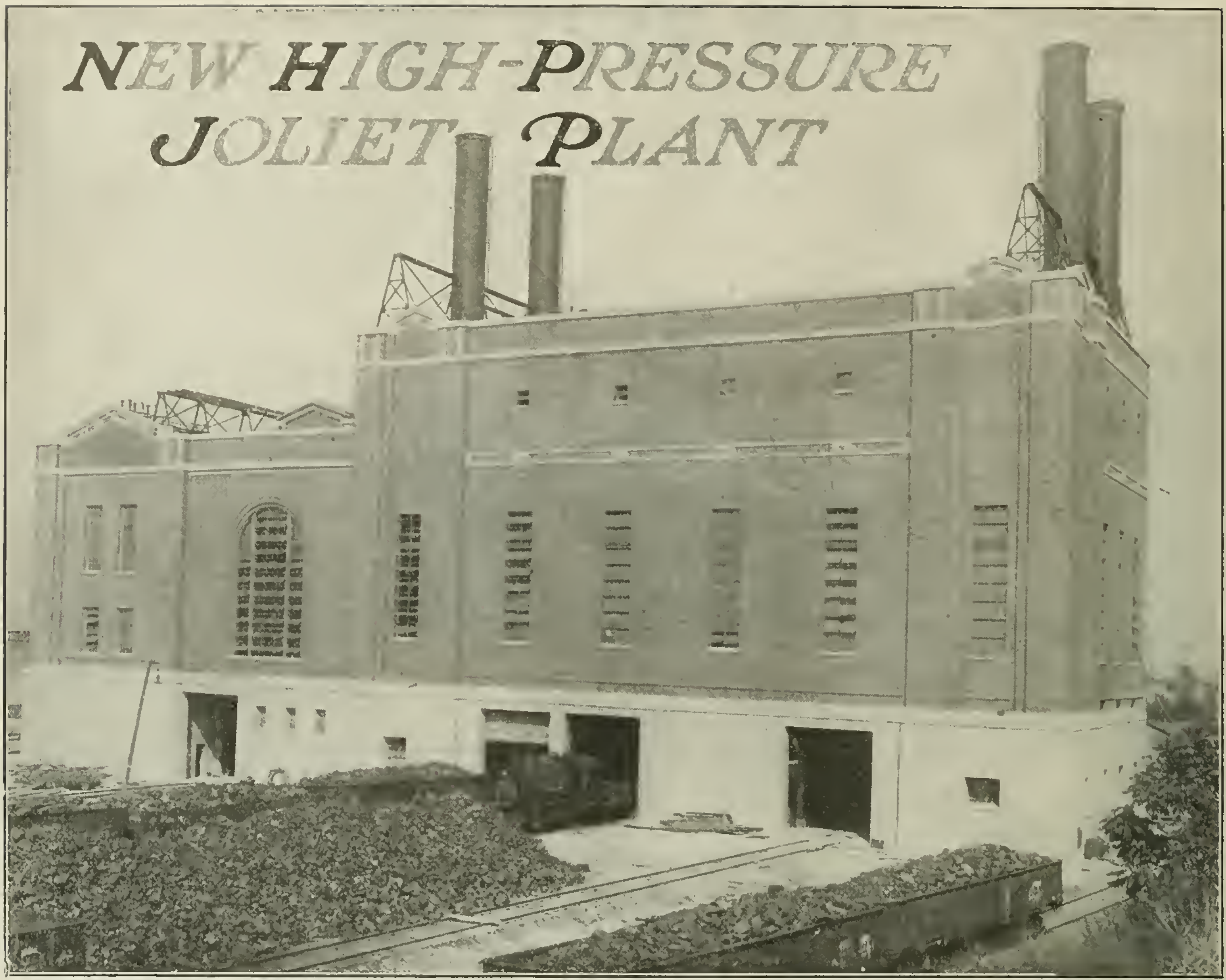
This seemed like an inspiration. He took the steam piston out of the air compressor and turned it down with a groove to hold babbitt and babbitted the lower circumference one-third the way around so as to act as a tail-rod crosshead, using the steam cylinder with heads removed as a tail-rod guide. He then procured a pulley of suitable size and mounted it on the lineshaft driven by single-cylinder engine, belted up the air compressor and shut off its steam line, letting the single-cylinder Corliss drive the belted air compressor.

His new set of indicator cards from the single-cylinder unit, while showing a slight overload, figured a fairly economical steam consumption and good distribution of steam and the 37 lb. per i.hp.-hr. of the air compressor was a thing of ancient history. Tim was the happiest man in North Carolina. Why?

ABOUT A WEEK after the change was completed, the manager sent for him. Tim was surprised at his offering him a cigar, and more so when he showed him a chart of coal consumption, week by week, covering year after year, and what the saving had been during the past week.

"Tim," said he, "you asked for a raise of pay a while ago, and we could not afford it, although we would willingly have granted it if conditions warranted it. We have been keenly interested in what you have been doing since, and the results are a revelation to us. You have initiative and can think for yourself. We are not going to give you a raise of pay as chief engineer." Tim began to feel sick at heart. After all his trouble, no raise! "No, not as chief engineer. At a directors' meeting this afternoon we appointed you general superintendent of this plant, your duties to begin at once, and you have free rein to use your best judgment in increasing the efficiency of any and every department according to your own ideas. You are the efficiency expert we have been advertising for and could not locate."

NEW HIGH-PRESSURE JOLIET PLANT



Boilers designed for 350 lb. pressure will deliver steam to the turbines at 300 lb. gage and 225 deg. F. of superheat. An all-steel horizontal-tube economizer is placed above and integral with each boiler. Extra-heavy piping, special welded joints and steel fittings are employed. First 10,000-kw. unit is now in operation and second under erection.

TO CARE for a rapidly increasing load in a territory covering thirteen counties, the Public Service Co. of Northern Illinois is adding the new Joliet plant, shown in the headpiece, to its list of generating stations. It is situated about three miles south of the city on the Des Plaines River, on 40 acres of land between the Atchison, Topeka & Santa Fe and the Chicago & Alton railroads. This location is adjacent to two railroads tapping the coal fields of Illinois and has at hand an abundant supply of water. A property plat is shown in Fig. 1. The initial portion of the station is to contain two 10,000-kw. generating units. Later, as the load demands, the building will be extended to accommodate additional and larger units.

In the new plant the outstanding feature is the high steam pressure—300 lb. at the turbine and approximately 325 lb. at the boiler, superheated 225 deg. This is about 75 lb. higher than common in modern stationary practice and is a notable step in the recent movement to improve economy by raising the upper limits of the cycle. It seems generally agreed that in the condenser there is little more to be gained. Higher steam temperatures to widen the operating range up to the limitations of the metal employed and the construction of the equipment offer the greater opportunity.

Although the boilers are of the standard Babcock & Wilcox cross-drum type, they are built heavy to withstand the high pressure. The plates in the boiler drum are $1\frac{5}{16}$ in. thick, the longitudinal seam being a butt and double cover strap quadruple-riveted joint. The heads are secured by two rows of rivets. Tubes of No. 7 gage, as compared to No. 10 for 200-lb. pressure, are used. All high-pressure steam piping is extra-heavy and of relatively small diameter owing to the density of the steam. With steam at a temperature of 650 deg. rigid construction was avoided. The length of straight runs has been limited, and numerous long-radius bends are employed to provide for expansion. All fittings are of steel, the manifolds used in connection with the boiler leads having been cast and the smaller fittings forged. On pipes above 4-in. diameter a special bolted joint with a welded seal at the periphery is used.

A notable feature is the installation of individual all-steel horizontal-tube economizers, the first of their kind in this country. The economizer is placed above and integral with the boiler. The economizer tubes have a 5-deg. slope. With no dampers between, so that the gases pass directly from one to the other, it is really one stage of the boiler unit. See Fig. 3. Furnace gases pass from the economizer at such low temperatures as to permit unlined steel stacks, the latter being coated with an asphaltic paint adapted to high temperatures.

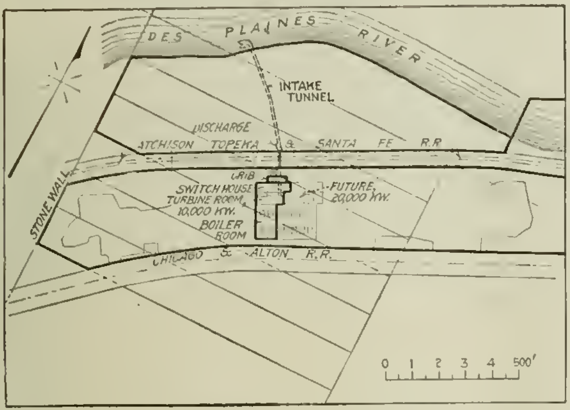


FIG. 1. PROPERTY PLAT, JOLIET STATION

Another feature of the plant is a basement entirely above ground, the main operating floor being the second story of the building. A solid rock footing was already available and excavation would have been costly. Besides, the construction gives headroom for the coal and ash cars operating at the ground level and eliminates ash conveyors. There is gravity flow from the overhead coal bunker to the stokers, and the ashes are delivered directly from the hoppers under the stokers to railway cars.

Outside of the small stoker engines held as reserves for motor drives, there is no reciprocating machinery in the station. All pumps are of the centrifugal type and motor-driven with the exception of the boiler-feed and one service pump operated by turbines. With little exhaust steam available to heat the feed water, provision is made to bleed steam under thermostatic control from the fourth stage of the main turbine, where the pressure is sufficient for this purpose. Another feature is to utilize the condenser for drawing boiler makeup from the fresh-water reservoir. The water enters the condenser and with the aid of the condensate pump is passed in the usual way to the heater.

With the compact arrangement of boiler and economizer and the steel casing over all, radiation and air leakage should be reduced to a minimum. An exceptionally high boiler efficiency should be maintained.

Architecturally, the building is substantial and of pleasing design, as the headpiece of this article shows. A skeleton steel frame supports walls of vitrified brick resting on concrete base walls. Floors are of reinforced concrete. In the turbine room the walls are lined with white glazed tile with a 5-ft. dado of dark-green tile. In plan the building is irregular with maximum dimensions of 134 x 244 ft. As the entire plant is above the ground level, the height is greater than usual. The basement floor is about six inches above ground level, the boiler-room floor is 28 ft. higher and to the top of the monitor roof an additional 60 ft. Under the turbine room is a 22-ft. basement. The height from the main floor to the crane rail is 30 ft., and the clear space to the bottom of the roof girders measures 40 ft. At one end of the building are temporary walls so that the station may be extended easily for additional equipment.

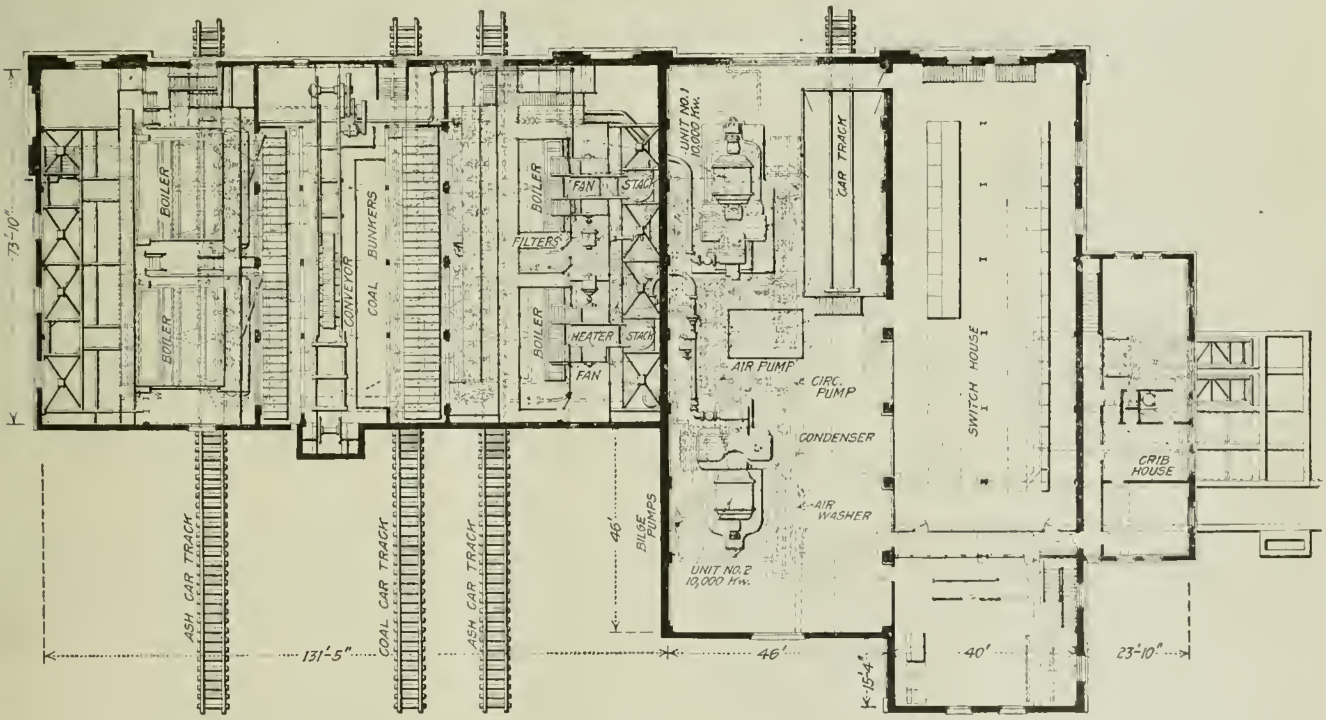


FIG. 2. GENERAL PLAN OF STATION

The station is arranged on the unit plan. For each 10,000-kw. generating unit there will be two cross-drum water-tube boilers, each having 9919 sq.ft. of steam-making surface, a built-in superheater with 3100 sq.ft.

and an economizer containing 6730 sq.ft. of surface. There are now three boilers in the plant, but when the second generating unit is installed, a fourth boiler will be added. Under ordinary conditions when a good grade of Illinois coal is available, it is the intention to use three boilers to carry the two generating units, leaving one boiler in reserve. With inferior coal the four boilers will probably be needed.

With three boilers serving two generators there will be 1.49 sq.ft. of active steam-making surface per kilowatt of generating capacity, or on the basis of 10 sq.ft., one boiler-horsepower will serve 7.67 kw. This does not take into account the economizer. Each boiler, with its steel casing, masonry setting and retreating back, covers at the floor line an area of 294 sq.ft., or 0.296 sq.ft. per horsepower (10 sq.ft.) of rating. Including the overhang the area increases to 0.472 sq.ft. per horsepower, and to the stoker fronts the floor space covered is 585 sq.ft., or 0.59 sq.ft. per horsepower. From the boiler-room floor to the center of the cross-drum the height is 26 ft. 6 in., and 42 ft. from the floor to the top of the economizer.

A very interesting feature is the stoker installation. Two chain grates are placed side by side in a common furnace, each being 8 ft. wide, 14 ft. 6 in. long and containing 116 sq.ft. of active grate area. Double this area bears a ratio to the steam-making surface in the boiler of 1 to 43. The stokers are motor-driven through reduction gears and belt, with vertical engines in reserve. The general design of the setting and the positions of the economizer and induced-draft motor-driven fan are shown in Fig. 3. Rising 65 ft. above the fan, or 125 ft. above the grate, is an individual self-supporting steel stack of 7 ft. diameter. Owing to the low temperature of the flue gases leaving the economizer (probably 350 deg. F.), the stack is unlined, an asphaltic paint on the interior surface protecting the metal.

Being the first of its kind in this country, the economizer is of special interest. The construction is similar to that of a B. & W. type boiler without the drum. The headers are of wrought steel and the tubes, which are 4 in. diameter and 16 ft. long, of drawn steel $\frac{1}{4}$ in. thick. As low temperatures are expected, the tubes are galvanized inside and out to guard against corrosion. The economizer is vertically baffled for three passes, the gases from the boiler entering at the front and from the third pass rising vertically through the induced-draft fan to the stack. The fan has capacity to handle 75,000 cu.ft. per min. of gas at 350 deg. F. At this rating the power required is 94 hp. To give plenty of reserve capacity for contingencies and to reduce upkeep to a minimum, a 150-hp. motor was installed. In general this policy of using motors of liberal capacity for the work has been adopted all through the station. Water to the economizer enters at the bottom of the rear header and passes through 396 four-inch tubes to leave at the top of the front heater. The relative flow of gas and water is thus counter-current.

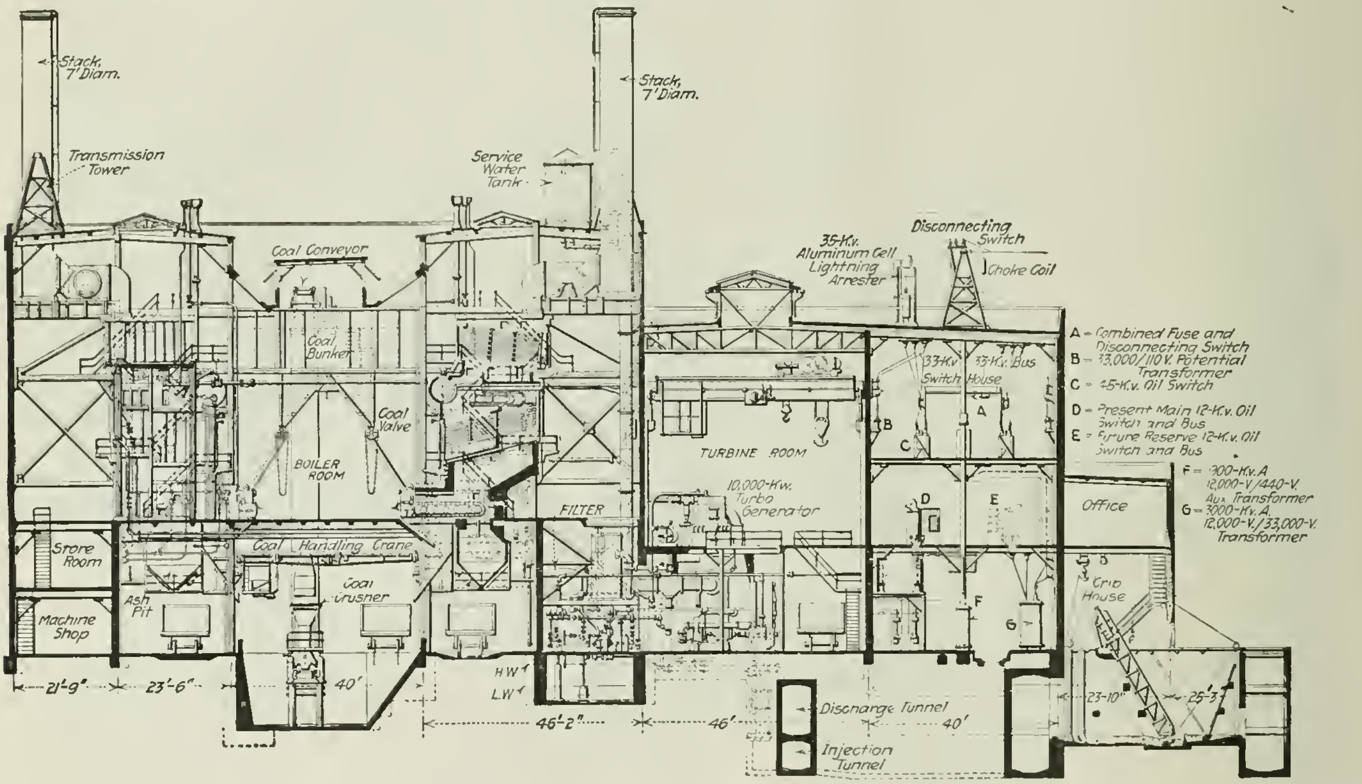


FIG. 3 SECTIONAL ELEVATION THROUGH PLANT

Reviewing the foregoing data, it will be seen that each 1000 sq.ft. of boiler-heating surface has 23.4 sq.ft. of grate, 313 sq.ft. of superheating surface, 678 sq.ft. of economizer and 3.88 sq.ft. of stack.

Feed water for the boilers is mainly condensate which has been delivered through a preheater at the top of the condenser, containing 1000 sq.ft. of surface to the heater by either one of two motor-driven condensate pumps, the duplication tending to insure continuity of service. The heater is of the open type, having capacity to serve the two boilers of the unit. Either of two four-stage turbine-driven centrifugal pumps designed

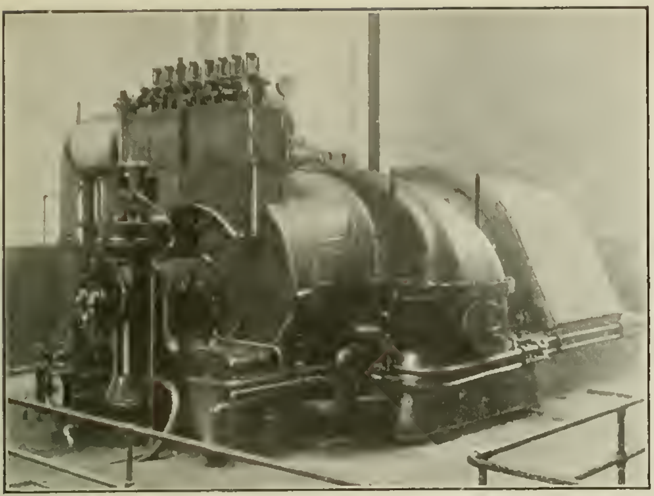


FIG. 4. TURBO-GENERATOR NOW IN OPERATION

to deliver 300 gal. per min. against a head of 375 to 400 lb., feeds the water to the boilers. The turbines are rated at 126 hp. and operate under full boiler pressure, their output being controlled by pressure-regulating valves. The water passes through the economizer and enters the boiler at both ends of the cross-drum.

The makeup water comes from a fresh-water reservoir which collects the steam-header drips, heater over flow and other other available condensation. Under float control it is also supplied with filtered service water. The house-service water supply is drawn from the condenser intake tunnel by two 600-gal. pumps, one driven by a turbine and the other by a motor. It is delivered to a service tank on the roof. From the pump discharge line several taps are taken off for transformer cooling and for various services where raw water can be used. Return water from the tank passes through duplicate pressure filters, each of which has capacity to filter 150 gal. per min. Upon leaving the filter the water supply divides, part going to cool bearings and to the lavatory system, and the balance as needed to the hot-water reservoir. The vacuum on the main unit is utilized to draw the makeup water from the reservoir into the condenser, the amount being regulated by a float in the heater. It is removed by the condensate pump in the usual way and delivered to the heater.

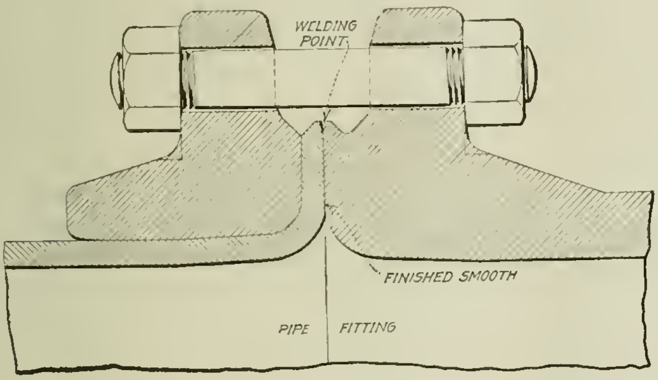


FIG. 5. CONSTRUCTION OF SPECIAL WELDED JOINT

With the exhaust steam available the water temperature in the heater under average load conditions will probably range from 100 to 120 deg. F. To maintain the temperature within this range a bleeder connection under thermostatic control has been made to the fourth stage of the turbine.

Coal for the plant, Illinois lump and screenings, is brought in over the company's siding from the Chicago & Alton tracks at Plaines, about three-quarters of a mile distant. The company has its own locomotive and coal cars and at the plant a yard containing five tracks. No. 1 is a storage track running past the south side of the building, Nos. 2 and 4 are ash tracks serving the two rows of boilers, No. 3 is the coal track, and No. 5 serves the turbine room. Between these tracks there is space to store about 10,000 tons of coal. Track No. 3, centering on the firing aisle, leads into the boiler-room basement over a concrete pit capable of storing 800 tons of coal. By a four-motor traveling crane with a 2-yd. grab bucket the coal is unloaded into a four-roll traveling crusher, driven by a 50-hp. induction motor, which discharges to a bucket conveyor delivering into the overhead bunker. The latter has capacity to hold 450 tons, or 112 tons per boiler. The bunker is made up of steel plates, concrete lined, and is divided up into four compartments with double chutes from each leading to the two stokers under their respective boiler.

Screenings are handled in the same way with the exception that the rolls of the crusher are spread to allow the coal to pass through to the conveyor. On both sides of the crusher are bypass chutes to the storage pit. The coal may be unloaded into the pit or into the outdoor storage space. In the latter case a locomotive crane unloads the coal and loads it again when it is desired to remove it to the plant.

Under each boiler furnace are ash and fine-coal hoppers. The former is brick lined and is equipped with a sprinkling system to wet down the ashes. Through a sliding gate operated by a handwheel, the ashes are passed directly to railway cars, thus obviating the need of ash-handling apparatus, always hard to maintain. Farther forward, under the stoker, is the fine-coal hopper, which delivers its contents to the con-

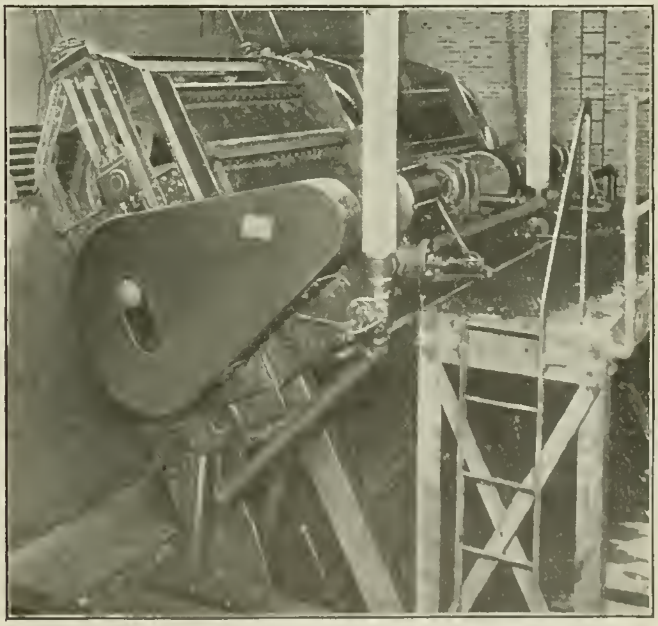


FIG. 6. TRAVELING SCREENS FOR COOLING-WATER INTAKE

crete storage pit. The outlet is controlled by a sliding gate operated from the boiler-room floor.

As previously explained, all high-pressure piping is extra-heavy, with fittings of cast or forged steel. On pipes above 4 in. diameter the special-welded joint shown in Fig. 5, is used. The pipe is extended through the flange and is belled out to form the face of the joint. The face is finished smooth, and the edge beveled off to form a V-shaped groove to receive the welding metal. On fittings a facing boss of extra thickness to form a welding surface similar to that on the pipe flange is provided. The weld is intended only to seal the joint, the bolts through the flange taking the stress. In the plan view, Fig. 2, the numerous bends in the piping to care for expansion may be noticed. From each end of the superheater there is a steam outlet, the leads from the superheater being joined by special steel manifolds at the boiler-room wall. Two boilers per turbine will be provided, but there are cross-connections between the two units so that three boilers may be used to carry the two 10,000-kw. machines. The fourth boiler provides a reserve needed at times of cleaning or inspection.

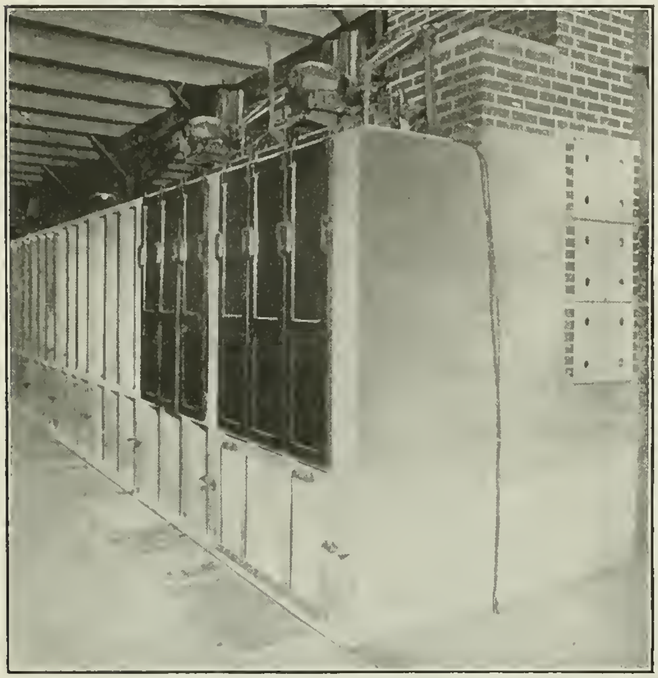


FIG. 7. OIL SWITCHES AND BUS COMPARTMENT

The main generating units of the present installation are rated at 10,000 kw. at 80 per cent. power factor. One of these is shown in Fig. 4. At the turbine the working pressure is 300-lb. gage. The speed is 1800 r.p.m. The generators are three-phase 60-cycle machines delivering current at 12,000 volts, which is standard in the company's newer plants. In the electrical end of the plant no radical departures from standard practice have been made. Distribution will be at 12,000 and 33,000 volts. A double bus system is employed throughout the station. Each generator may feed through either of two oil switches to a set of sectionalized 12,000-volt double busses. From these busses two kinds of leads are taken off; one class being the 12,000-volt feeders and the other leading to the low-tension side of water-cooled transformers, stepping up the voltage to 33,000. Fig. 7 shows oil switches and the bus compartment.

Control of all electrical equipment except auxiliary power is effected from an operating room in the switch-house located on the turbine-room floor and separated from it by a glass partition. Generator control is centered in a benchboard, and outgoing feeders are controlled by vertical boards arranged with the bench-board in the form of a hollow square. Auxiliary 440-volt power has remote mechanical control from a vertical board in the turbine room. The generator circuits are equipped with overload relays, ordinarily connected in circuit only during synchronizing, and each outgoing line has a polyphase watt-hour meter. Of the latter liberal use has been made throughout the station. Excitation is effected by 100-kw. 250-volt shunt-wound exciters mounted on the generator shafts and a 100-kw. turbine-driven reserve exciter.

Over all the main unit is 33 ft. 6 in. long and 13 ft. 3 in. wide, requiring a floor space of 444 sq.ft., or 0.0444 sq.ft. per kilowatt of rating. The height of the unit is 12 ft. above the floor line. The turbine is served by a two-pass condenser containing in 3600 one-inch tubes 20,000 sq.ft. of surface. From the foregoing figures there is 2 sq.ft. of surface per kilowatt of generating rating.

Circulating water is supplied by a centrifugal pump having capacity to deliver 18,000 gal. per min. In conjunction with the Leblanc air pump it is driven by a 200-hp. slip-ring induction motor. Duplicate condensate pumps are used, each rated to care for 360 gal. of condensate per minute and driven by a 25-hp. motor.

Cooling water for the condensers is drawn from the Des Plaines River through a concrete tunnel, the intake being 570 ft. distant from the center line of the tunnel in the turbine room. In its course to the plant the tunnel passes under the Santa Fe tracks to the screenhouse, its dimensions to the river side of the railway being 10 ft. wide by 8 ft. high. From this point on to the plant it is 8 x 8 ft. in section. Water from the tunnel enters the forebay in the screenhouse, Fig. 6, where it first passes through an iron grid of ¼ x 4-in. bars designed to keep back driftwood which may have escaped the log boom at the intake. Revolving screens are then encountered, which measure 26 ft. 9 in. between centers of the driving sprockets and 5 ft. 2 in. wide between roller centers. Through reduction gearing each screen is driven by a 5-hp. induction motor. Provision is made to swing the screens to a horizontal position for inspection or repairs. Cleaning is done during operation. Water from slotted pipes is forced at high velocity through the mesh, discharging against splashboards and draining down into a trough leading to the discharge tunnel.

Back of the traveling screens are double sets of stationary screens having ½-in. mesh to catch fibrous material, small fish or débris of any character remaining in the water. These screens are made up in sections 5 ft. 10 in. wide by 4 ft. 6 in. high. For cleaning they are removed by a hand-operated beam trolley. The discharge tunnel, 8 x 8 ft. in section, travels on top of the injection tunnel as far as the river side of the railway. Here it turns downstream and discharges into a swampy tract bordering on the river. At the turn a 2-ft. 8-in. by 3-ft. 8-in. tunnel leads from the main discharge to the intake, where during the winter season the warm water will keep down the ice. A sluice-gate valve determines the amount of water drawn off for this purpose.

Safety of the employees and congenial surroundings were features given special prominence in the design of the station. The engineer has a large roomy office, shower baths and locker rooms were provided for the help and excellent drinking water is piped from a near-by spring. In addition to the usual equipment, the station contains a machine shop, storeroom and a fuel engineer's office in which coal, the big factor in power-plant operation, will receive close attention. The station was designed by Sargent & Lundy, consulting engineers, and Von Holst & Fyfe were employed as architects. Of the operating company Samuel Insull is president; F. J. Baker, vice president in charge of operation and construction; George H. Lukes, general superintendent, and J. L. Hecht, mechanical engineer.

IMPORTANT DATA OF JOLIET STATION

Boiler Room

Type of boiler	B. & W. cross-drum water-tube
Setting	Masonry and steel casing
Number now installed	3
Steam-making surface, sq.ft	9,919
Steam-making surface installed per kw., sq.ft	2
Pressure for which boilers are designed, lb. per sq.in	350
Operating pressure, lb. per sq.in	325
Superheat, deg. F	225
Steam temperature, deg. F	650
Number of boilers per unit	2
Number of tubes per boiler	429
Length of tubes, ft	20
Diameter of tubes, in	4
Length of drum, ft.-in	23–10
Diameter of drum, ft	5
Stokers per boiler	2
Type of stoker	B. & W. chain-grate
Active area of two stokers, sq.ft	232
Ratio grate area to boiler-heating surface	1 to 43
Superheater surface (B. & W.), sq.ft	3,100
Floor space occupied by boiler, sq ft	468
Floor space per 10 sq.ft. heating surface	0 472
Floor space by boiler and stoker	585
Floor space per 10 sq.ft. of heating surface	0 59
Height of boiler from floor to center line of drum, ft	26.5
Height of boiler from floor to top of economizer, ft	42
Capacity boiler, normal, lb. steam per hr	60,000
Capacity boiler, maximum, lb. steam per hr	94,000
Per 1,000 sq.ft. boiler-heating surface:	
Connected grate area, sq ft	23 4
Stack area, sq.ft	3 88
Economizer surface, sq.ft	678
Superheating surface, sq.ft	313
Economizer	All-steel B. & W. horizontal
Number of economizers	One per boiler
Number of tubes	396
Length of tubes, ft	16
Diameter of tubes, in	4
Economizer surface, sq.ft	6,730
Induced-draft fan	Sturtevant multivane
Capacity of fan, cu.ft. gas per min	75,000
Horsepower of motor	150
Stack	Unlined steel, one per boiler
Stack diameter, ft	7
Height stack above fan, ft	65
Height stack above grate, ft	125
Coal	Illinois run-of-mine and screenings
Coal bunker	Steel, concrete lined
Capacity bunker, tons	450
Concrete pit storage, tons	800
Yard storage, tons	10,000
Locomotive crane	Browning
Traveling crane	Whiting, 2-yd. bucket, 150 tons per hour
Traveling crusher	Orton & Steinbrenner
Crusher capacity, tons per hour	125
Coal conveyor	Link-Belt continuous-bucket
Conveyor capacity at 45 ft. per min., tons per hour	120
Boiler-feed pumps	Worthington 4-stage, 3-in. centrifugal
Number of pumps	Two per unit
Horsepower of turbine drive	126
Pump capacity, gal. per min	300
Pump speed, r.p.m	2,550
Feed-water heater	Warren Webster open type
Heater capacity, lb. per hour	150,000
Number of heaters	One per unit
Pressure filters	2 per unit, New York "Jewel"
Capacity each filter, gal. per min	150
Service pumps, two, one turbine, one motor-driven, gal. per min., each	600

Turbines

Maker	General Electric Co.
Type	Horizontal Curtis
Capacity, kw	10,000
R.p.m	1,800
Steam pressure, lb. gage	300
Superheat, deg. F	225
Floor space covered by unit, sq.ft	444
Floor space per kilowatt, sq.ft	0 0444

Condenser

Maker	Westinghouse
Number of tubes	3,600
Size of tubes, in. O.D	1
Surface in condensers, sq ft	20,000
Surface per kw. gen. rating, sq.ft	2
Preheater top of condenser, surface, sq.ft	1,000
Circulating pump	Westinghouse centrifugal
Capacity circulating pump, gal. per min	18,000
Speed, r.p.m	690
Drive, induction-motor, hp	200
Air pump	Leblanc, driven by circ. pump motor
Condensate pumps	Motor-driven centrifugal
Number	2 per condenser
Capacity, gal. per min	360
Motor drive, hp	25
Screens	2 sets stationary and 2 traveling per unit
Traveling screens	Link-Belt Co.
Length, c. to c. of driving sprockets, ft.-in	26–9
Width c. to c. of rollers, ft.-in	5–2¼
Drive, G.E. induction motor, hp	5

Generator

Maker	General Electric Co.
Capacity, 80 per cent. power factor, kw	10,000
Voltage	12,000
Cycles	60
Phases	3
Field poles	4
Speed, r.p.m	1,800
Exciter mounted on shaft	100 kw., 250 volt
Exciter, turbine-driven, reserve unit, kw	100
Crane, turbine room, Whiting, tons	75

Electrical

Oil switch equipment, 12,000 volt	General Electric
Oil switch equipment, 33,000 volt	Westinghouse
Switchboard	Westinghouse
Lightning arresters	General Electric

Size of Neutral Wire for a Three-Wire System

BY T. A. NASH

While it is the practice in some localities to invariably make the neutral of a three-wire system the same cross-sectional area as the outside wires, this procedure is not always followed. Where there is likely at periods to be excessive unbalance on the three-wire system—that is, where practically all the load will come on one side of the system with no load on the other side—the neutral wire then carries the same current as the outside wire. Hence if the condition just outlined is likely to occur, the neutral wire should be made the same size as either one of the outside wires.

Some engineers specify that where outside wires are No. 6 or smaller, the neutral wire shall be of the same cross-sectional area as the outside wires, but when the outside wires are larger than No. 6, the neutral may have two-thirds of the cross-sectional area of either of the outside wires. In some cases it is permissible to make the cross-sectional area of the neutral one-half that of either of the outside wires.

Obviously, when the neutral is of smaller cross-sectional area than the outside wires, it must be protected by a fuse of correspondingly small capacity, in which case if the unbalance of the load on the two sides of the circuit becomes excessive, the fuse is likely to melt and thereby all the lights, assuming that the load is all on one side of the circuit, will be extinguished. It is for this reason that some engineers adhere to the practice of specifying the neutral of the same cross-sectional area as the outside wires. There is no reason, however, why the neutral, provided it is properly fused, should not be smaller than the outside conductors.

One of the tendencies of today is to overdo the stop-watch and the watch-dog method. Efficiency of product does not lie in that direction. It is not right to imagine that the men have no other interest in the success of the work than to watch the hands of the clock go round.

Heavy-Duty, Diesel-Type Oil Engines for Marine Work

The McIntosh & Seymour Corp., of Auburn, N. Y., has built a number of 500-hp. heavy-duty, marine-type Diesel oil engines, for use on the Pacific Coast, one of which is shown in the illustrations. The engine has six cylinders and is of the four-cycle type, single-acting and is directly reversible.

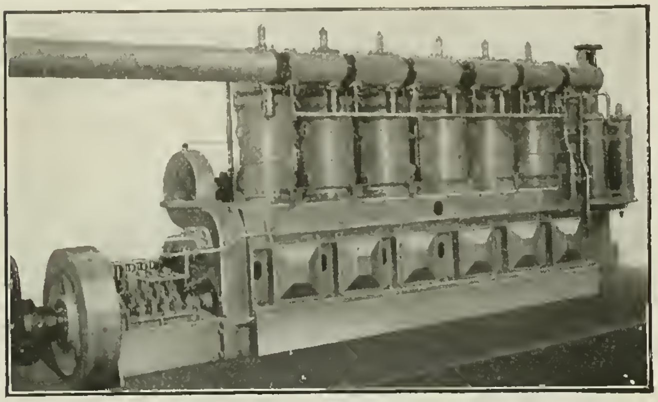


FIG. 1. ASSEMBLY OF ENGINE SHOWING CYLINDERS AND OVERHUNG FLYWHEEL

The air for atomizing the fuel for the working cylinders, also that required for maneuvering, is furnished by a three-stage compressor located at the forward end of the engine and directly driven from the engine. The compressor is built with intercoolers and aftercoolers. The valves and cages are all accessible and removable as a unit, making their removal and renewal a simple matter.

The thrust bearing, which may be of either the standard horseshoe-marine or Kingsbury type, is carried in a base bolted securely and doweled to the engine base, and contains a large bearing at its after end, making it possible to carry the flywheel overhung, as indicated in Fig. 1. The main working cylinders are bolted to the top of the engine frame and are of a simple design provided with removable liners. The heads are separate from the cylinders, each containing an inlet, an exhaust, a fuel and a starting valve. The gear for operating these valves is clearly shown in Fig. 2.

The camshaft, as can readily be seen, is carried in the housing bolted to the engine frame, and is driven by spur gears from the end of the crankshaft. From the forward end of the crankshaft a fuel pump and speed-limiting governor are driven.

The maneuvering gear, as can be seen, is at the forward end of the engine. The maneuvering is done in the proper sequence due to the interlocking feature of this device, thereby preventing the operator from damaging the equipment through a misunderstanding of its functions. The supply of oil, and consequently the control of the ship, is accomplished by one single lever. There is arranged a control lever within easy reach of the operator, which is devised to relieve the cylinder of any pressure, and when brought into operation, it automatically shuts off the atomizing air when the release valves are open.

The lubrication for the working cylinders, piston pins and compressor is effected by the use of a Richardson-Phenix force-feed lubricator driven by gears and suitably timed, so that the lubricating oil is delivered to the various parts during that portion of the cycle that is most beneficial. The oil for the crankpins, main bearings and other journals is supplied from a gravity system through gang oilers conveniently located. As the engine is entirely inclosed, the base having a bottom casting, the oil is all collected in the base from where it is pumped through a filter and then returned by gravity to the bearings. A small pump driven from the camshaft is arranged to automatically handle the oil and return it to the system.

The cooling system of this engine is so arranged that salt water can be used for cooling purposes without coming in contact with the steel studs or any part likely to be affected by it. It has the same effective cooling, however, as on stationary engines and the same even flow and proper circulation through the cylinder heads.

The average time consumed from full-speed ahead to full-speed astern for fifty maneuvers was eight seconds. Very likely this time can be somewhat reduced when the engines have become fairly limbered up and the operators are perfectly skilled in handling the equipment.

The fuel consumption of these engines is slightly over 0.4 lb. of fuel oil per horsepower-hour when operated at rated speed and load. It has been demonstrated that these engines are capable of a reduction in speed of 60 per cent. The air tanks supplied with the engine, which carry 300-lb. pressure, are of sufficient size to start the engine 44 times, the minimum starting pressure being 80 lb.

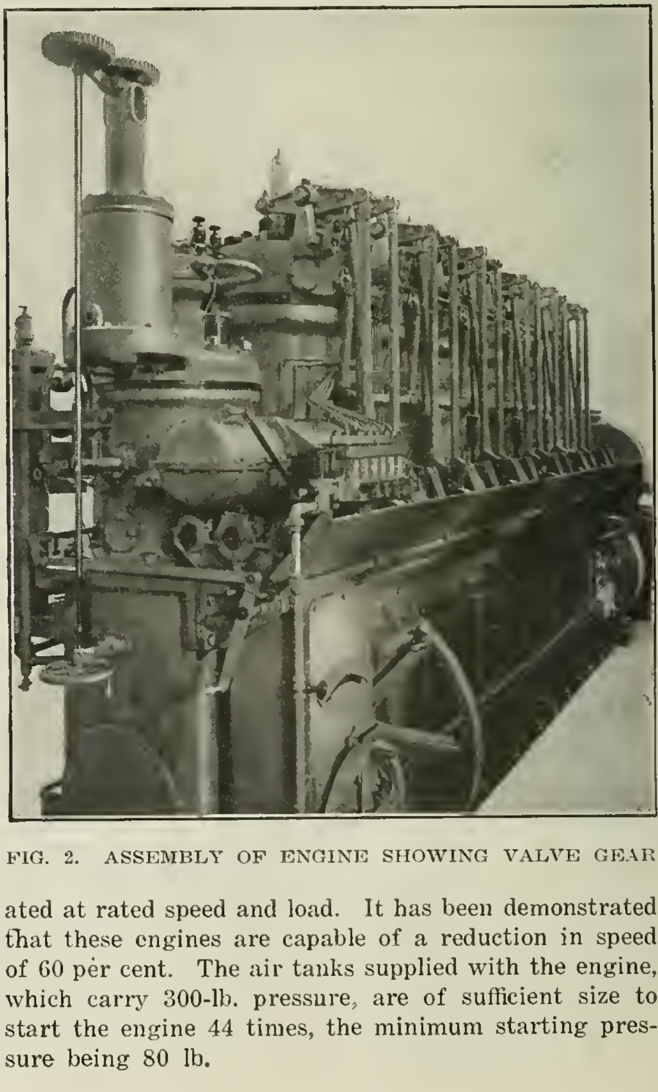


FIG. 2. ASSEMBLY OF ENGINE SHOWING VALVE GEAR

Fuel Consumption Control by the Government

By J. W. HENDERSON
Chief, Bureau Smoke Regulation, Pittsburgh, Penn.

The author proposes that the Federal Government assume absolute control not only of coal and its distribution, but of its consumption so as to conserve the supply. He believes the stoker should be adopted by most plants that the lower grades of coal may be burned. The Fuel Administration should be continued after the war, and the Bureau of Mines act as engineer for it. Specific cases of saving by better combustion methods are cited.

THE materials embraced by the term "Fuel" in this article are: Coal and its byproducts; wood and its distillates; oil; gas. The possible savings are conservatively estimated at $1,000,000,000 annually. The purpose is to offer evidence and argument in support of a recommendation that the Federal Government extend its work of conservation to include fuel consumption control and smoke regulation, and to suggest how this may be done. The proposition is that the Government shall go one step farther than is the case at present. It now regulates the production, distribution and price of fuel. There is equal or greater necessity for regulation of the methods of consumption.

The results of this work under Governmental control will be such as to (1) save fuel and (2) release men from nonproductive labor for productive effort; (3) increase the number of men available for war activities without interference with production in the industries; (4) increase the available freight-car tonnage without adding to the number of cars; (5) establish standards for fuel usage according to quality and applicability; (6) develop the coal-tar and other byproduct industries; (7) provide gas to replace the natural-gas shortage; (8) add to the supply of fuel for internal-combustion engines; (9) promote the production of fruits and vegetables; (10) protect the material welfare of the people; (11) conserve the health of the people.

All these things are possible and their attainment practicable and within the sphere of the powers of the Federal Government. In fact, no other authority in this country is available for undertaking this task with the consistency and permanency called for by the conditions. This is true in peace times as well as during the war. The reader's attention is called to quotations from a recent opinion of a Supreme Court Justice and a message to Congress of a former President as follows:

The Adamson Case, Wilson vs. New: Justice McKenna, concurring, "And submission to regulation is the condition which attaches to one who enters into or accepts employment in a business in which the public has an interest."

Special Message of President Roosevelt, Jan. 22, 1909: "The conservation of our resources is the fundamental question before this nation, and that our first and greatest task is to set our house in order and begin to live within our means. I do urge, where the facts are known, where the public interest is clear, that neither indifference and inertia, nor adverse private interests, shall be allowed to stand in the way of the public good. The freedom of the individual should be limited only by the present and future rights, interests and needs of the other individuals who make up the community. When necessary, the private right must yield, under due process of law and with proper compensation, to the welfare of the commonwealth. All this is simply good common sense. The underlying principle of conservation has been described as the application of common sense to common problems for the common good."

At this time not only the success of the war, but also the "permanent welfare of the people," is at stake. The "facts are known"; the "public interest is clear"; "adverse private interests" are ready and willing to yield to the necessities created by the war in which the country is involved; there is an awakened public consciousness to the need of conservation, and there is at hand the machinery of government capable of accomplishing the results outlined in the eleven items mentioned above.

1. SAVE FUEL

There are a number of ways in which fuel saving can be promoted. Upon the extent of fuel-consumption control and smoke regulation and the methods employed, will depend the accomplishing of the other items in the list of results. The work can be started immediately by compelling temporary changes to furnaces, pending further changes of fuel and equipment for permanent efficiency.

Emission of black smoke from stacks is a sure indication of waste. Prohibiting this smoke will result in proper firing methods, which alone will reduce the waste of fuel. The demand should be to stop hand-firing of boiler furnaces and other furnaces where capacity is beyond one-man-power. Mechanical appliances should be ordered at once, especially where the waste of fuel is most flagrant. Some governmental authority should also insist upon their proper use.

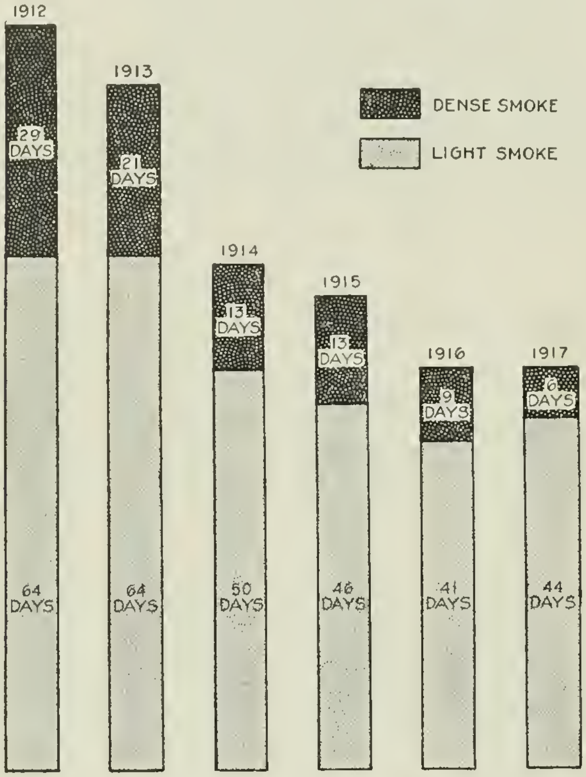
Smoke regulation and fuel-consumption control cannot be separated. Properly conducted, both lead to conservation in its broadest sense. A wider application of the term "smoke" would include zinc dust, ore dust and other destructive and wasteful materials now being emitted from stacks country-wide.

A mandate from the proper Government source having absolute power of control can cut the waste as indicated by "smoke" fully 50 per cent. almost immediately. This is a safe assertion because it merely requires personal attention with more frequent firing of small quantities of fuel to secure this result. Later, this dependence upon the man can be minimized by mechanical means with still greater economies and an increase of output from furnaces and mills.

Laboring men and their organizations need not fear the displacement of labor by mechanical appliances; first, because the great war is causing a shortage of labor and, second, following the recommendations outlined in this paper will mean raising the standard of laboring men and training them along lines that will mean increased rates of wages.

Proof of these claims will be found in the experiences referred to later where specific cases are cited showing only partially what has been accomplished and what may be expected under the plan herein proposed.

Some of the more important things that can be done almost at the outset, to save fuel by mandate of the Government in control of fuel consumption, are as follows:



SMOKE-ABATEMENT PROGRESS IN PITTSBURGH

a. Use bone coal in place of commercial bituminous and anthracite coals. This will be equivalent to increasing the visible coal supply by bringing into the market the millions of tons of bone coal piled nearly mountain high in the mining districts.

b. Use anthracite culm to replace commercial anthracite or bituminous coals. Remarks under (a) apply here.

c. Use coke breeze under boiler furnaces, thus applying what has heretofore been considered only fit for yard filling around manufacturing plants. A further saving of standard commercial coal.

Note: There are stokers now on the market and applied to furnaces efficiently burning these fuels.

d. Secure more complete combustion of all fuel, thus stopping waste in the processes of consumption.

Note: Examples are cited among the cases listed on another page.

e. Restrict the production of beehive coke, replacing it with byproduct coke.

f. Compel the application of waste-heat boilers to openhearth and other large furnaces.

g. Establish standards for fuel usage as outlined later.

h. Promote the development and use of substitutes for coal, coke and oil.

i. Maintain the gas supply for private residences where coal cannot be burned economically.

j. Increase the supply of fuel for internal-combustion engines. This may be accomplished as stated later.

k. Reduce the demand for artificial light by adoption of the daylight-saving plan, which has proven successful in Europe and as proposed to Congress by the Chamber of Commerce of the United States.

RESULTS NO. 2 AND NO. 3

Release men from nonproductive labor for productive effort, or increase the number of men available for war activities without interfering with production in the industries.

Hand-firing of furnaces is generally considered nonproductive labor. There are many cases where the application of mechanical devices for doing such work not only accomplishes fuel saving and increased output of better product, but does away with keeping men at such employment. These results will be further promoted by other labor-saving equipment such as installing ash-handling appliances in connection with furnaces now requiring several men for this work.

Instances are mentioned among the list of cases cited later in this paper. Most of them have been the result of an effort to comply with the laws regulating the production and emission of smoke from stacks. Under Government control of fuel consumption and of smoke regulation, the results can be multiplied almost immediately and continuously and kept up to whatever standard may be set by the Government.

4. INCREASE THE AVAILABLE FREIGHT-CAR TONNAGE WITHOUT ADDING TO THE NUMBER OF CARS

This will be brought about by reducing the quantity of coal required in the industries, for the same or greater output, and thereby relieve the railroads from the necessity of furnishing the equivalent tonnage for coal transportation.

A quotation on another page gives a concise statement of this phase of the problem.

5. ESTABLISH STANDARDS FOR FUEL USAGE ACCORDING TO QUALITY AND APPLICABILITY

This heading carries its own argument. The country might be divided into fuel zones. Anthracite coal and natural gas should be saved to the people for use in the homes. Anthracite coal should not be permitted as fuel for boiler or other furnaces wherever other fuel, except natural gas, is available at the same cost or less, per unit of output. Such requirement might also be applied to the gas from byproduct coke ovens.

Low-volatile bituminous coals should be conserved for special uses where other bituminous coals cannot be used without excessive smoke, but where for other reasons, such as furnace construction, bituminous coals are the logical fuel. These include locomotives at terminals and in switching service, vertical and stationary boilers of the locomotive type.

It just happens that the experience with low-volatile bituminous coal in locomotive practice has been found more economical in the way of fuel saving for the same service, as compared with high-volatile bituminous coal.

6. Develop the Coal-Tar and Other Byproduct Industries

Here is opportunity for launching new industries which need fostering in this country. These industries are directly related not only to fuel saving, but also to all the results enumerated in the first part of this paper. If restrictions are placed upon the waste of coal in coke production, the industries incidental to the byproduct-coke processes will be placed on a footing to compete with foreign countries.

The coal tar that will be recovered from byproduct coke making and wood distillation can be used as a substitute for coal, oil and gas, in many types of furnaces. A wide range of products may be produced by these processes, among which may be mentioned gas, paraffin, tar, resin, benzol, creosote, ammonium sulphate, alcohol, charcoal, pyroligneous acid, toluol.

As an example of how these products run into values in dollars and cents, figure on the possibilities in regard to gas from byproduct coke. Available statistics show coke produced during 1916, in the following amounts, in tons: Total coke, 51,544,447; beehive coke, 35,464,224; byproduct coke, 16,080,223. Allowing 8000 cu.ft. of gas per ton of coke produced, if the beehive coke had been made by the byproduct process, it would have amounted to 283,713,792,000 cu.ft. of gas. On the basis of one-half the heat value of natural gas, this is equivalent to 141,856,896,000 cu.ft. The commercial value figured on the consumers' rate (net) for natural gas in the United States is: 141,856,896,000 × 28.63c. per 1000 cu.ft. = $40,613,629.

Reference is made merely to the gas that might have been recovered should the quantity of beehive-oven coke have been made in byproduct ovens and without considering the gas that may have resulted from the coke produced in 1916 by this latter process. The 283,713,792,000 cu.ft. of byproduct oven gas as estimated according to its equivalent heat value in terms of natural gas, and based on the natural-gas consumption in the United States, would supply the demand for residence uses to the extent of 1,420,000 homes, satisfying the needs of about 10,000,000 people.

If it were used in melting steel by the openhearth process, the output from such furnaces would be in excess of 7,000,000 tons.

So much for the gas from the source indicated. The other products are of equal value in many ways. Incidental to the proposed discarding of beehive ovens is the elimination of smoke from such ovens and its ill-effects upon health and property.

7. Provide Gas To Replace the Natural-Gas Shortage

This is one of the incidental possibilities from coke making by the byproduct process. It should not necessarily follow that all the gas recovered in coke making shall be diverted to private-residence purposes, but this may be done where such use of it will be of more value to the country than when otherwise consumed.

If the total coke production for 1916, of 51,544,447 tons, had been from byproduct ovens, the gas that might have been recovered would have been equal in heat value to about 27½ per cent. of the total quantity of natural gas consumed in the United States that year.

Byproduct ovens can be operated primarily for gas production and at the same time give a soft coke comparatively high in volatile, suitable for private-residence furnaces, and produce the valuable chemicals already mentioned.

8. Add to the Supply of Fuel for Internal-Combustion Engines

Referring to the materials resulting from byproduct coke making, it is to be noted that benzol is among the number. As to the possibilities of accomplishing the purpose mentioned here, the reader is to note the following:

> Commercial alcohol and gasoline are not miscible. Alcohol and benzol are miscible and make a most efficient fuel, and further, after the addition of benzol to alcohol, the mixture will carry a high proportion of gasoline. The future may see benzol as the tie between gasoline and alcohol, permitting a piecing out of the gasoline supply and an introduction of alcohol as a commercial motor fuel.—*Journal of the American Society of Mechanical Engineers, June, 1917, p. 497.*

As smoke and its evil effects cannot be confined within political boundary lines set up by government, and as its prevention saves fuel and labor, improves products and increases output, and for other reasons which naturally follow, smoke regulation should be in the hands of the Federal Government.

In the following, Dr. Arthur A. Hamerschlag, director, Carnegie Institute of Technology, Pittsburgh, Penn., voices the opinion of many men:

> The Government has undertaken, for the benefit of the nation, to regulate and fix the price of fuel. It has also been interested in distribution, governing the car supply and determining the volume of fuel to be shipped to various centers. But it has neglected what is an equally essential element in fuel conservation, the consumption of fuel in efficient appliances. This has been left to the individual industry and consumer. It ought to be under the supervision and control of a centralized government agency, coöperating through state and municipal agents, that would compel the elimination of waste by demanding more efficient methods of securing heat from fuel.
>
> Until the Government recognizes this element of the situation, at least 25 per cent. more fuel will have to be produced at the mines than is needed in order to develop the energy required for the service of the nation.
>
> If we could increase the car supply 25 per cent., the labor supply 25 per cent., the output from the mines 25 per cent., or reduce the price of fuel to the consumer 25 per cent., we would consider that a great economic and patriotic movement was in progress.
>
> Since it seems impossible to increase in this ratio either the labor or car supply, why not attack the problem from the other end, accomplishing an equally satisfactory result?

This brings us to the "Cases" referred to several times in the preceding pages. What has been done in most of these instances has been brought about through pressure incident to enforcing the ordinances regulating the production and emission of smoke from stacks in cities.

From a Large Steel Corporation, Pittsburgh Plant: "To do away with the smoke evil, to save labor and make the fuel consumption more effective, we have endeavored to put into use such mechanical devices as will produce the best steam economies. Here we have scrapped an old plant of 55 boilers located on valuable land leased by your company for many years, in which boilers the insurance companies would allow a pressure of but 85 lb. and have replaced them with eight 600-hp. units, having double the steam pressure of the old boilers, and with mechanical stokers. These eight boilers cost, with boiler house, coal- and ash-handling apparatus, including every mechanism known to produce an up-to-date plant, but $130,000. This new installation is saving $1500 per month in payroll and .$3500 per month in coal, equal to $60,000 per annum, or 6 per cent. on $1,000,000. In addition, it has increased the capacity of the whole mill through a greater steam supply."

An Office Building in Pittsburgh: "In the winter of 1903 we installed four stokers under four 200-hp. boilers at a cost of between $4000 and $5000, including automatic control, air piping, blower engine and blower. Our average cost of upkeep to and including December, 1914, covering all repairs and replacements in connection with the stoking system, has been 2.79 per cent. on the original cost of installation. During the fiscal year preceding the installation of our stokers, our coal consumption was 171,010 bu., while in the year following, with the same steam requirements, it was 141,901 bu., a saving of 1106 tons, or 17 per cent."

A Bank Building in Pittsburgh: "We installed stokers, and the cost of coal and labor incident therewith was $6082.53. Assuming that we would have burned gas in that year, at the new rates the cost would have been $9254.25. Comparing these figures with those of the coal consumption, we have saved $3171.72, or practically more than the cost of the stokers."

An Independent Steel Company, Pittsburgh: "The boiler plant has 17 boiler furnaces. When stokers were applied to 9 boilers, they were producing as much power as they had been getting from the 17 boilers and replaced 23 men who had been used as firemen. This installation was made during the great demand on the plant for output and within a year beginning November, 1915."

A Manufacturing Company, Ohio: "After having stokers under three 150-hp. boilers for the past twenty months, I can issue the following information from practical experience: They have reduced our fuel bill 30 per cent. and a saving of $998 on labor for one year has been noticed."

A Manufacturing Company, Buffalo, N. Y.: "The four stokers installed have given the best of satisfaction, having done better than the guarantee. The saving in coal is equal to 16 per cent., and maintenance has been only an average of 0.01½ per cent. of the investment. The operation is very satisfactory, and boiler output can be controlled to the greatest possible economy."

A Tin-Plate Company, West Virginia: "The application of stokers to hot mill furnaces shows two things: First, that the coal consumption is reduced 20 per cent. to 25 per cent. and maybe more in some instances; second, because the air necessary to burn the coal is under control this gives absolute control of the flame and heat, which in turn enables the operator to heat his iron without scale. This, we find, is a great advantage to hot mill furnace work, and unless gas is obtainable at a very low price, the stoker-fired furnaces would be much more preferable. We have, in fact, installed in another of our plants stoker-fired furnaces to replace gas-fired."

A Foundry Company, Buffalo, N. Y.: This refers to a powdered-coal installation. "We have just completed dumping the castings in our No. 4 oven, and I have never seen iron in quality and uniformity to equal it. Every piece has been perfectly annealed, and they are 25 per cent. tougher than anything we have ever had from our other furnaces equipped with the old burners. The saving in coal will be around 30 per cent. Just as soon as we have run through two more ovens under favorable conditions, I will give you the exact figures showing number of pounds of coal per ton of castings."

The case mentioned as having experienced the greatest economies has not reached its maximum in this direction. Even this case is not as exceptional as some might imagine. All those shown herein indicate the possibilities for savings in the use of coal.

What the plants were doing previous to the changes leaves no doubt as to the necessity for taking action toward more efficient operation. Further economies in this direction, and in other ways as indicated in this paper, depend upon action by the Federal Government.

Van. H. Manning places the loss last year at $500,000,000, due to inefficient use of coal. Intimate acquaintance with plant operations, as a result of being connected with the Bureau of Smoke Regulation, Pittsburgh, Penn., makes it possible to testify that Mr. Manning's total figure is a conservative one.

The Working Plan Outlined

The machinery of government at hand is in the Fuel Administration and the Bureau of Mines. The foundation is already laid. It only remains for the Fuel Administration to broaden the scope of its activities and continue its existence and aims after peace shall be declared. The function of the Bureau of Mines should be to furnish information to be used as the basis for action on the part of the Fuel Administrator.

Example: The Fuel Administrator might desire data in regard to the practices and methods of a certain concern. Upon advice to this effect, the Bureau of Mines would make a thorough survey and report the results to the Fuel Administrator for such action as the conditions might warrant. For instance, if the concern should be using, say, 1000 tons of coal a day for a given production when a competitor is using but 750 tons per day for the same amount of output, the former may be compelled to take action leading to the efficiency of the latter.

It must be conceded that everything points to the plan proposed being feasible and practical and in line with a statement of the President in an address to Congress, Apr. 8, 1913, as follows: "We must . . . put our business men and producers under the stimulation of a constant necessity to be efficient, economical and enterprising, masters of competitive supremacy, better workers and merchants than any in the world."

Attention is called to an error in the article published on page 16 of the Jan. 1, 1918, issue of *Power* wherein the title should have read Tyler Condensation Meter instead of Taylor, and the manufacturer's name should have read Tyler Underground Heating System instead of Taylor, as published.—Editor.

Fires in Turbo-Generators

By M. A. WALKER

The possibilities of fires in large turbine-driven alternating-current generators are discussed and some of the possible means of combating these fires, should they happen to start, are suggested.

IN LARGE power-stations two goals are sought—one, economy of operation; the other, reliability of service. For large turbo-generators the former is accomplished by operating them at high load factors. Reliability is obtained by first-class construction methods and ample precautions. These generators are rarely if ever tied in to the station bus by automatic circuit-breakers, but instead must be disconnected by hand. Generator reactances, may, however, be installed to limit the current from or to the individual generators. Bus-tie reactances are likewise often employed for sectionalizing busses and limiting the energy transfer from one section to another. Many generators are controlled automatically, however, by means of balanced relays, so that the generator may be automatically disconnected from the station bus when it short-circuits internally, thus isolating the machine and preventing the flow of current from the station into the machine in trouble. This is a very necessary precaution because of the enormous magnetic stresses and heating involved, due to the current delivered into the defective machine from other units on the system. The modern turbo-generator may be capable of generating a current as high as twenty times normal on short-circuit and for the first few cycles.

Combustible Materials in Turbo-Generators

It is often stated that the modern turbo-generator contains nothing that will burn or support combustion. Practice refutes this, however. The cambric insulation impregnated with varnish makes an inflammable material, combustible in still air and quick-burning in an air current, such as the cooling air passing through the turbo-generator. The various tapes and cording on the end turns are likewise inflammable. The wooden wedges and spacers are also combustible, though some makers employ fiber wedges and spacers, a practice thought inadvisable since fiber warps and shrinks and absorbs moisture and oil. Other manufacturers employ wedges of brass, which is perhaps the best practice of all. Dust and dirt become embedded in the stator windings and likewise in the rotor, in an intensely dry condition, although portions are oil and grease soaked. It is possible that when an all-mica insulation is used, with noncombustible spacers and wedges and nothing to give off inflammable gas, the turbo-generator may be claimed to be fireproof. Even where air filters and washers are employed, as they are for the largest machines, dirt and dust gradually collect and make conditions favorable for fire.

The amount of air used by turbo-generators for cooling purposes depends on the efficiency of the machine. For a unit of about 25,000 kw. an average value would be about 2.5 cu.ft. per kilowatt, or a total of around 60,000 cu.ft. per minute. As the air ducts through the core and windings are restricted, this enormous quantity of air passes through the machine at a high velocity, probably between 5000 and 10,000 ft. per minute. If, now, a flame or arc starts, it is obvious that this high-velocity air fans the flame into an intense heat, burning very much like a blow-torch, which destroys everything within its reach—copper conductors, iron laminations and everything else. This high-velocity air thus causes not only more intense damage, but likewise more extensive, instead of somewhat localized as might be expected to be the case where the air is stagnant.

Most Favorable Place for a Fire

The most favorable place for a fire to start seems to be around the end of the winding and usually close to where the coils emerge from the slots. It is here that coil movement is most likely to occur, also the dielectric strains are the greatest and the accumulation of dust and dirt finds a ready resting place.

A fire started in varnish-impregnated cambric with a rapid supply of oxygen from the air may persist for an hour or more, although voltage and current no longer exist. Apart from the amount of combustible material, its combustibility is increased by the formation of gases from the impregnating compounds employed. The difficulties of fighting the fire are very real—it is out of sight and difficult to get at. Usually the casing of the generator has become so hot before help arrives that the covers cannot be touched for removal, while smoke and the noise from within do their part to interfere. In a severe fire the generator cannot be opened until the fire has burnt itself out and the outer casing has been cooled off with water. Perhaps this is really just as well, for combustion cannot exist without air, and it is probable that the fire extinguishes itself more rapidly by being inclosed than if the burning parts were thrown open to the air.

Extinguishing Fires in Turbo-Generators

As scientific methods are employed in the design, installation, operation and maintenance of a turbo-generator, it would seem that such might well be extended to fire fighting should the emergency arrive. Flooding the interior with water in a haphazard way will probably do more harm than good. To fight a fire scientifically in the present instance, it must be fought by methods thought of before the emergency happens and not by any or all methods that suggest themselves at the time. To the writer it appears, for the same reasons advanced in the article entitled "Transformer Fires," which appeared in the issue of *Power* of Sept. 18, that no effort should be made to open the cover of the generator. To do so permits the ingress of air and the escape of the gases of combustion, which, if confined, assist in extinguishing the fire.

To extinguish a fire rapidly, safely and with a minimum of damage the following precautions appear to warrant consideration: (1) When an internal short-circuit occurs in a generator, whether between phases or from one phase to ground, the automatic control should disconnect the generator from the system and thus prevent the rush of current from the station bus into the fault. In addition to this—which is being done quite widely—the excitation of the generator should be killed simultaneously, by control from the same source as the main circuit-breakers. (2) Simultaneously with isolation of the defective generator the air supply should be shut off. The air inlet and outlets should have doors, normally open, but arranged to close by gravity, held open by a solenoid-controlled or motor-operated latch, in turn controlled by the balanced-relay protective circuit. Thus when an internal short-circuit occurs, which, as already pointed out, may be followed by a fire, not only would the generator be isolated from the system, but its voltage is killed and the supply of forced air for fanning the flame is cut off. The confinement of the gases of combustion within the machine will assist in extinguishing the fire. Should a fire start, there is less chance of its obtaining headway, while its effect should be local instead of distributed. (3) The shutting off of air is a radical and effective step toward preventing and limiting the fire. However, more heroic steps need be taken in quenching a fire once it starts. Therefore why not, as part of the installation, connect at two or more different locations of the generator casing inlets for fire-fighting fluid, so arranged that a fire in any portion of the windings can be reached? These inlets may be connected to water hydrants, storage tanks containing water, carbon tetrachloride or even carbon dioxide. The behavior and disadvantages of water are well known; it is, however, the most inexpensive. Carbon tetrachloride and carbon dioxide are both powerful fire extinguishers. They probably would smother a fire more rapidly than water, especially when used in the gaseous form. Carbon tetrachloride is an efficient solvent for rubber, which is, however, little used in modern generators, cambric and mica having taken its place. Tetrachloride is a rather rapid anæsthetic when admixed with air, while carbon dioxide is poisonous. Both these hazards should be borne in mind, although in stations where ventilation is good and the roofs high the danger is small. Where inlets are installed in the generator casing, the valves controlling them should not, as with the other safeguards, be automatic, since every short-circuit does not necessarily cause a fire, therefore does not require turning on the fire extinguisher.

OBJECTIONS TO THE DIFFERENT METHODS

There are objections to all the foregoing suggestions: An automatically closing air inlet and outlet may close accidentally and thus cause overheating by interrupting the ventilation. Killing the excitation when the machine protective circuit operates accidentally, as it sometimes does for unexplained reasons, makes for delay in placing the machine back on the system. Every complication adds to the possibility of service interruptions. All precautions cost money, and in the present case are taken against a contingency that admittedly may never occur. Perhaps the cheapest precaution and the one that is least likely to cause trouble is that of installing inlets into the generator for water or other fire-extinguishing agency.

It must be realized that when turbo-generators of 70,000 kw. come into use, with boilers and auxiliaries, an integral part of the whole, taking one out of service means a big loss in capacity and also in the station's earnings, for the interest upon the investment still goes on.

No attempt has been made to cover the matter of generator fires fully in any one respect. Rather has effort been made to show that fires may occur; that the ventilating air adds much to the havoc wrought by the fire, and may even be the only means of permitting it to persist; and possible ways of extinguishing a fire as quickly as possible. What every operating engineer should realize is that a turbo-generator is not fireproof, that a fire may start and persist with great tenacity under the influence of the ventilating air drawn in by the machine as long as it revolves. Moreover, once fully started, a fire is rarely quenched until it has burned itself out, by which time the electrical end is practically destroyed. With the increasing use of turbo-generators and with increasing capacities, this subject is becoming of more and more importance. Experience is the best teacher, but it is preferable to gain experience of this sort second-hand. It is hoped, therefore, that this article in surveying conditions as the writer has found them may tempt others to enter the discussion and thus make available their ideas and the interchange of experiences.

Adjusting Marine-Engine Bearings

By William M. McRobert

One of the most important of the many duties of a marine engineer is the adjustment of the main engine bearings. To engineers who have operated on lake or river steamers it might be said that running an engine on the ocean is a little different from operating on inland waters, for it is the practice on fresh water to allow a stream of water to flow continuously on most of the bearings to avoid overheating and to reduce the amount of lubricating oil used. This cannot be done at sea, as the salt and other solid matter in the water would ruin the bearing in a short time, so that dependence is on oil alone.

When an engineer joins a ship with which he is unfamiliar, he should, in order to avoid trouble while on a voyage, examine and adjust all the main bearings and the crank and crosshead brasses. When proceeding to adjust a bearing and before taking off the nuts, they should be marked so that their respective positions may be known and the amount, if any, taken up in adjustment determined. To make the nuts readily distinguishable, they should be typed *P* for port and *S* for starboard, together with the number of the particular bearing to which they belong. The nuts on No. 1 bearing would therefore be designated as, *P*1 *S*1, for when looking toward the bow of the vessel the side to the left is known as port and to the right is starboard.

A simple and permanent method of marking the nuts so that mistakes in adjustments are practically eliminated is shown in Fig. 1. Prior to slackening back a nut, cut an arrow on the bolt with a thin, sharp chisel and make a light mark on the nut to coincide with it. Next remove the nut to the vise and graduate off somewhat as shown, using the mark already made for the zero or starting point. A piece of wood is necessary as a center for the nut when laying off the graduations with a pair of compasses and a sharp flat chisel.

The arrow on the bolt will be used as the base from which all readings are taken, and a record of the position of each nut should be kept for reference in a manner similar to the following:

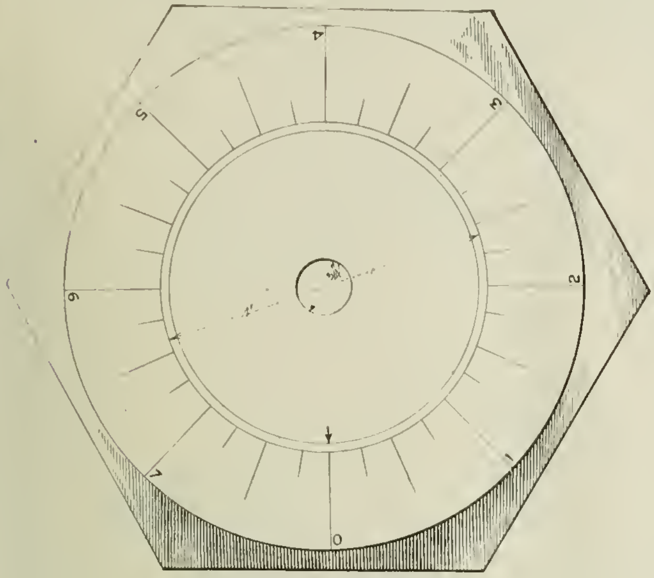


FIG. 1. NUT MARKED TO FACILITATE ADJUSTMENT

S. S At Port of Date.

MAIN BEARINGS

	Port Nuts		Starboard Nuts	
No. 1	Before Adjustment 4½	After 4¾	Before Adjustment 6¼	After 6½
No. 2	Before Adjustment 5	After 5½	Before Adjustment 2½	After 3
No. 3	Before Adjustment 6	After 6¼	Before Adjustment 3¾	After 4¼
No. 4	Before Adjustment 1½	After 1⅝	Before Adjustment 5¼	After 5⅞
No. 5	Before Adjustment 3¼	After 3¾	Before Adjustment 4½	After 5
No. 6	Before Adjustment 2½	After 2¾	Before Adjustment 6½	After 7

All bearings including the crank bearings should have the same kind of record.

Having marked and removed the nuts from the bolts on one of the main bearings, for example, the engineer lifts the cap clear of the journal, by means of a chain or rope block, then lifts off the liners, noting down their number and description so as to replace them after cleaning thoroughly. In marine work soft lead wire is generally used to ascertain the clearance between the wearing surfaces. To do this, take two pieces of wire and place one, circumferentially, on each end of the journal within two or three inches of the ends of the bearing surface. On a large engine three "leads" should be used, the additional one at the center of the bearing. Care must be taken that the wire is a little shorter than the exposed part of the shaft or the ends will get on top of the liners when the cap is put on. Making sure the leads are in their proper positions (a little soap or grease will keep them in place), lower the bearing cap, put the nuts on and tighten them simultaneously until they are at their respective marks or perhaps a little past them, until the cap is "solid" on its liners. Notice particularly whether the cap is solidly down on the liners; if not, insert an extra liner to make it so. Again mark and slack off the nuts and lift the bearing cap and gage the leads for thickness and the uniformity to which they are squeezed out. Any desired adjustments may be made by removing or adding liners as occasion demands. Next comes the connecting-rod alignment and the adjustment of crank and crosshead bearings, referring to Fig. 2.

Every steamship engine is equipped with either a steam- or hand-operated turning engine for the purpose of setting the engine in any required position to effect repairs. Prior to moving the engine, take a look over the stern of the ship to see that there are no boats or ropes near the propeller, and also be sure that the engine itself is clear of obstructions; then by means of the turning engine put the high-pressure crank on the top center. On the face of the crosshead-shoe guide will be found two tapped holes, to which a piece of plate or a casting may be attached to support the piston and connecting-rod when the rod is disconnected from its crankpin. After this "guide plate," as it is called, is securely bolted in place, attach to each side of the crosshead a differential chain block. Mark the position of the crank-bolt nuts, as in the case of the main bearings, then slacken them back after screwing an eye-bolt firmly into the threaded holes in the ends of each of the connecting-rod bolts and pulling up slightly with the two chain blocks; next lower the bottom half of the bearing gently on both tackles until it rests in the crank pit. The eye-bolts and also the hooks on the chain block are small enough to pass through the bolt holes so the lower half can be lowered into the crank pit, or in case of small engines a rope sling may be used from the eye-bolt to the hook. A rope sling is sometimes used in place of the eyebolts to support the chain blocks at the crosshead. With the turning engine, turn the crank slightly ahead until the crankpin is just clear of the top half of the bearing, first making sure that the latter is held in place with a capscrew passed through each of the flanges. Keep the bearing off the crankpin, and with a pair of inside calipers measure to see if the end of the connecting-rod is hanging central between the webs of the crank. In order to obtain smooth running, this condition must be realized.

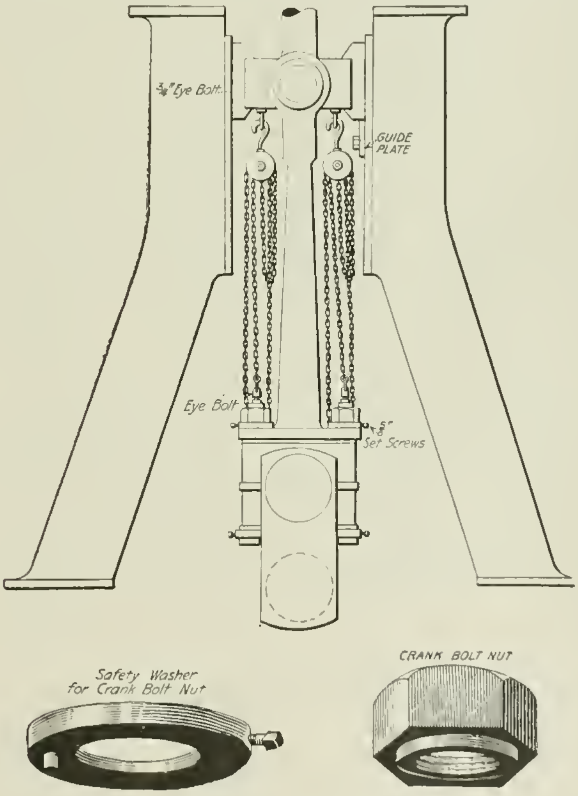


FIG. 2. UNSHIPPING A CRANKPIN BEARING

Should the connecting-rod be out of alignment, it may be corrected by inserting a thin liner between the lower crosshead brass and the top end of the connecting-rod. Pounding might be overcome in many engines if the rods were put in line. It is sometimes necessary to scrape the babbitt metal of the bearings in order to get a true alignment, but no matter what is called for, the engineer can rest assured that continual trouble will ensue as long as the conneting-rod is out of alignment.

On a 12,000-hp. quadruple-expansion engine the writer sailed with, he spent many a hard day in tropical climates scraping the bearings to put the high-pressure rod in line; in fact, on every available opportunity the chief had him on this job, but eventually success and comfort were the reward.

If the rod is found to be in line, turn the engine back until the crank is on its exact top center and take off the guide plate and remove the cap bolts from the top half of the connecting-rod bearing, then raise the lower bearing out of the crank pit until the bolts have just entered the holes, then carefully place two or three pieces of lead wire circumferentially at equal intervals along the surface as described for the main bearing, then pull the bearing or cap up into position and tighten the nuts to their previously located marks. Again slacken back the nuts and lower the bottom half of the bearing just so the leads can be removed. If they are the right thickness, clean the bearing thoroughly and pour a little clean oil on the surface, then heave up and pull the nuts solidly up to their marks, using a hammer on the wrench and being certain as before that the bearing is up solid on the liners. The intermediate-pressure and low-pressure engines are adjusted in turn in the same manner as described.

The foregoing is intended as a mere outline on the subject of the adjustment of marine-engine bearings, all of which is familiar to seagoing engineers, but there are three important points to be remembered, which should be emphasized; namely, before turning the engine, see that the propeller is clear, that the guide plate is off and that all other obstructions are removed.

Morris Improved Tube Beader

To properly expand and bead a boiler tube requires considerable experience and expertness when the common expander and beading tool are employed. An inexperienced workman is more than likely to thin the tube end by excessive rolling, as in Fig. 1, thus reducing its strength where it is needed. In beading the tube ends by the hand tool they may be bulged, as shown in Fig. 2, thus forming a pocket between the tube and the tube head, which would increase the possibility of the tube burning out at that point.

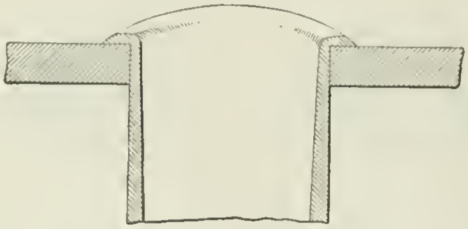


FIG. 1. RESULT OF EXCESSIVE ROLLING

A machine that has been designed to strike a blow on the beading tool at the right position and to expand and bead a boiler tube at one operation, at the same time eliminating the defective results shown in Figs. 1 and 2, has been developed by the Wallace Manufacturing Co., 1319 West 42nd St., Kansas City, Mo. This device, Fig. 3, known as the Morris beading tool, consists of a lever-operated 6-lb. hammer *A*, the striking blow of which is governed by the propelling springs *B*, the strength of which is adjustable by the bolt *C*.

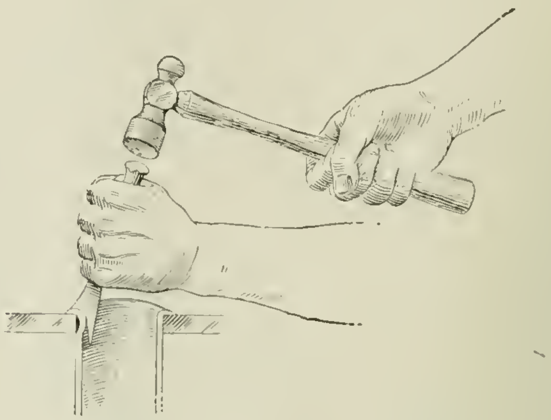


FIG. 2. BULGED TUBE IN TUBE SHEET

A beading tool *D*, which beads and expands a tube in one operation, is at one end of the frame holding the hammer. It is rotated in the tube by a ratchet movement *E* actuated by the hand lever *F* which operates a camwheel *G* which is rotated by the two pawls *H* to lift the hammer and trip it into action. The tool is held in place at a boiler head by an adjustable supporting block *I* containing wedge bolts, which are expanded after the supporting block is placed in a tube, by the bolt *J*. A head block *K* holds and guides the beading tool in place, and the dotted line *L* shows the angle the tool is driven on for expansion of the tube.

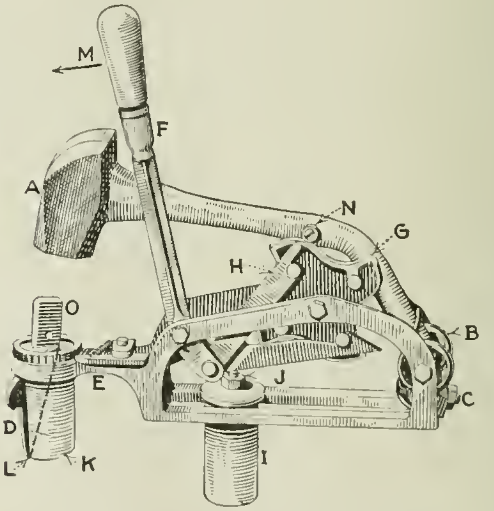


FIG. 3. MORRIS TUBE BEADER

The application and operation of the tool are simple and it can as easily be worked at one part of the tube sheet as at another. When about to use, the head block of the beading tool is placed in the tube to be secured in the tube sheet. the supporting block being placed in any other tube already in place, within the scope of the tool. With the tool in place the operator pulls or pushes the lever in the direction of the arrow *M*. This movement rotates the camwheel *G* to the right, and as the roller *N* reaches the edge of the camwheel, the weight of the hammer *A* and the tension of the springs *B* produce a sharp blow on the head block *O*. Each time the lever is operated for a hammer stroke, the ratchet is rotated two notches. Fig. 4 shows how the beader enters a tube and also the kind of joint it produces between the tube and the head, there being no thinning of the tube end or forming of a pocket between the tube and the head.

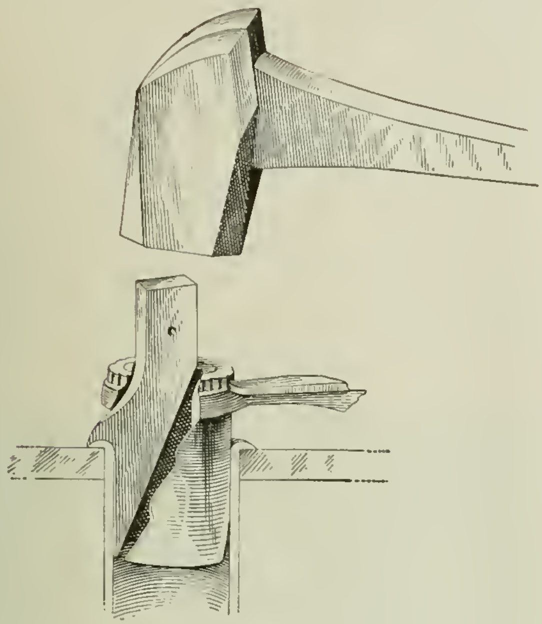


FIG. 4. HOW THE BEADER FITS IN THE TUBE

Calculating the Contents of Oil Tanks

By R. T. Strohm

The increasing use of liquid fuels has brought about the storage of large quantities of oil, gasoline and similar products. The usual type of storage tank is a cylindrical steel shell with bumped heads, placed in a horizontal position and ordinarily buried in the earth as a matter of safety. The calculation of the amount of oil in a tank of this kind, when the oil stands at a certain level, is a problem that seems to cause operating engineers considerable difficulty, largely because of the use of bumped heads. If the heads were flat, the problem would be greatly simplified.

The depth of the oil is commonly measured in inches above the bottom of the tank, this distance being determined by a measuring rod inserted through the manhole or by some form of registering gage. The known data, therefore, are the length and diameter of the cylindrical part of the tank, the radius of curvature of the heads, and the depth of oil in the tank, and from these the quantity of oil must be calculated.

Since the amount of oil on hand at any given time is information that must be quickly available whenever it is called for, the best thing the engineer can do is to make up a table showing the cubic contents of the tank for every inch of depth. Then, by measuring the depth of oil, he can quickly refer to the table and so determine the quantity of oil on hand.

If a reliable meter is available, the quickest way to compile the table is to use the arrangement shown in Fig. 1. Connect the meter *a* to the filling pipe *b* and have a shutoff cock *c* in the oil-supply pipe *d*. Insert a measuring rod *e*, graduated in inches from the bottom end, through the open manhole. Then run oil into the tank until the measuring rod shows a depth of one inch, and read the meter. The quantity of oil run in will be the quantity corresponding to a depth of one inch. Mark this down in the table, run in oil until the depth is two inches as indicated by the rod *e*, and read the meter again. If the meter is set at zero at the start, the second reading will be the quantity of oil at a depth of two inches, and so on for each additional inch.

If no meter is available and no similar method of measuring the quantity of oil run in for each inch of depth can be used conveniently, the table may be compiled by a series of calculations that are not difficult to make, though they are numerous and therefore apt to be tedious.

Assume, for example, that the tank in question is 28 ft. long and 8 ft. in diameter and that the ends are parts of spherical surfaces, with a rise of 10 in. at the center line of the shell. Make a scale drawing of the tank, as shown in Fig. 2, using as large a scale as possible, to obtain accuracy. On the center line *ab* find by trial a center *c* for a circle that will pass through the points *d*, *e* and *f*, and draw the circle *defg*, which will represent the sphere of which the bumped head is a part. The small circle *xyz* is a cross-section of the cylindrical shell.

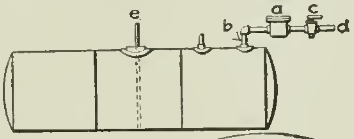


FIG. 1

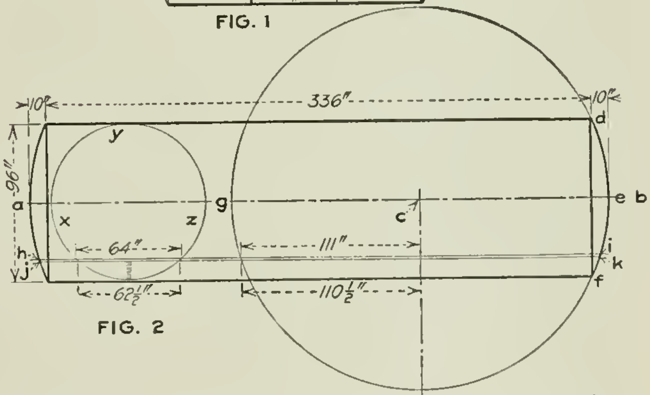


FIG. 2

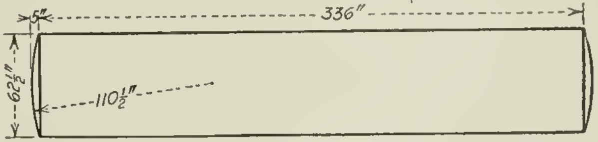


FIG. 3

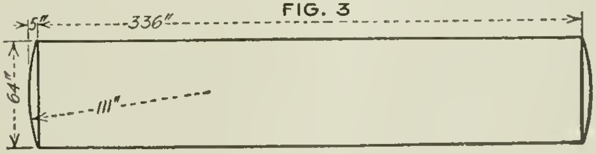


FIG. 4

METHODS OF OBTAINING MEASUREMENTS

Beginning at the bottom of the shell, draw lines parallel to the axis *ab* and one inch apart. These will divide the entire tank into 96 layers, each one inch thick, and the problem then resolves itself into finding the cubic contents of each layer. To illustrate the method to be followed, let the layer between the twelfth and thirteenth inches be taken.

First, draw two lines *hi* and *jk* at these two points. The lower surface of the layer will then have the shape and dimensions shown in Fig. 3 and the upper surface the shape and dimensions shown in Fig. 4. The sizes of both these sections are obtained directly from Fig. 2, as may be seen from the corresponding dimensions. As both sections are drawn to scale, the rise of the segmental end can be scaled. It will be found to be practically 5 in. in each case.

The area of the section in Fig. 3 consists of a rectangle 62½ x 336 in. and two segments whose diameter is 2 × 110½ in. and whose rise is 5 in. The area of a segment is found by the formula,

$$A = \tfrac{4}{3}H^2\sqrt{\frac{D}{H} - 0.608}$$

in which *A* is the area in square inches, *H* the height of the segment in inches and *D* the diameter of the circle of which the segment is a part. In this particular case

$$A = \tfrac{4}{3} \times 25\sqrt{\frac{221}{5} - 0.608} = 220\ sq.in.$$

and the area of both segments is 440 sq.in. The rectangular part has an area of 336 × 62½ = 21,000 sq.in. and so the total area of the section is 21,440 square inches.

By a similar procedure, the area of the segmental end in Fig. 4 is found to be 220 sq.in.—the difference between this and the end in Fig. 3 is so slight as to make no appreciable change in the area. The total area of the section in Fig. 4 is therefore 336 × 64 + 440 = 21,944 sq.in. Now, with sufficient accuracy for all practical purposes, the volume of the layer between *hi* and *jk*, Fig. 2, may be taken as the average of the areas of the upper and lower faces multiplied by the thickness of the layer, which is one inch; hence, the volume of the layer is ½(21,440 + 21,944) × 1 = 21,692 cu.in., or about 94 gallons.

The volume of each layer from the bottom to the center line should be calculated in this way. Since the layers between the center line and the top are of exactly the same size and shape as those between the bottom and the center line, but in the reverse order, the calculations will need to be made for only 48 different layers.

In calculating the volume of the first layer at the bottom—which is the same as the first one at the top—the area of one surface is zero; hence, the average area of the two faces of the layer is simply half of the area of the one surface whose area is calculated.

In making these calculations, extreme accuracy is a waste of time. If the areas are determined to the nearest ten square inches, the table will be quite accurate enough, for the diameter of the tank is not the same throughout because of overlapping plates and the graduated measuring rod cannot be read to small fractions of an inch. If the table values are worked out to the nearest five gallons, they will meet all ordinary demands.

It should be noted that the volume added by the bumped heads is 440 cu.in., while the total volume included by the layer is 21,692 cu.in. Thus the bumped heads contain 440 ÷ 21,692 = 0.02, or practically 2 per cent. of the total volume; in other words, if the heads were neglected altogether and considered to be flat, the error would be only 2 per cent. at the section shown in Fig. 2. At the level of the center line of the tank, where the head has its greatest projection, the error is still within 4 per cent. of the total volume.

Steel-Jacketed Electric Heater

The steel-jacketed electric heater unit indicated by the arrow in the figure has been put to innumerable uses in all kinds of industrial plants. Besides such applications as in crane cabs, valve, pump and meter houses, there have been scores of miscellaneous applications. The ease of conducting electric current to remote corners, to moving-crane cabs, etc., makes the use of electric heaters simpler than any other. The heater unit shown is of 500-watt capacity, can be connected in multiple to any alternating- or direct-current circuit where the voltage is not in excess of 250. Only as many as are actually required need be installed, and additions made when required as easily as adding electric lamps. Just as lamps are placed singly or in groups in locations where light is needed, so also are these units mounted singly or in groups in places where heat is required.

HEATER INSTALLED IN GAS-VALVE HOUSE

The units are flat like an ordinary meter, the dimensions being $\frac{3}{16}$ x 1½ x 23¾ in. All parts are inclosed, and no porcelain, cement, asbestos or molded insulation material used. The installation in the figure shows one of these units installed in a gas-valve house. These heaters are designed and manufactured by the Cutler-Hammer Manufacturing Co., Milwaukee, Wisconsin.

In offering "War-Savings Stamps" to the public the Government has made immediately available for every man, woman and child in the country a profitable, simple, and secure investment.

Editorials

Developing the Water Power

THE agitation for the development of the water powers has culminated in the submission to the President by the Secretaries of War, Interior and Agriculture, jointly, the draft of a proposed bill which embodies the fundamental principles of several bills now pending in Congress and seeks to avoid or cure their defects. The letter of transmittal, which will be found on page 135, outlines its principal features. A commission composed of the Secretary of War, the Secretary of the Interior and the Secretary of Agriculture, and having an executive officer who shall be appointed by the President, is to make investigations and to collect and record data concerning the power industry and its relation to other industries, and concerning the location, capacity, development, cost and relation to markets of power sites; to make public from time to time such portions of the information secured as it shall deem expedient in the public interest, and to issue licenses to citizens of the United States, or to any association of such citizens, or to any corporation, state or municipality, for the purpose of constructing, operating and maintaining dams, water conduits, reservoirs, power houses, transmission lines or other project work necessary or convenient for the development and improvement of navigation and for the development, transmission and utilization of power. The licenses are to be granted for definite periods not exceeding fifty years, and are irrevocable inside of that period, except for cause. Upon or after the expiration of the lease the United States shall have the right, upon not less than two years' notice, to take over any project covered in whole or in part by the license, upon paying a fair value, not to exceed the actual cost of the property taken, plus such reasonable severance damages, if any, as may be caused by the separation of said property from property valuable, serviceable and dependent not taken.

It would seem that under such a provision the Government would be powerless to exercise the right of eminent domain, no matter how badly the property might be needed, within the term of the lease, although there is provision that the Government may commandeer the plant temporarily in case the safety of the United States demands, for the purpose of manufacturing nitrates, explosives or munitions of war, or for any other purpose involving the safety of the United States, paying to the party, or parties, entitled thereto such just and fair compensation for the use of the property as may be fixed by the commission, on the basis of a reasonable profit in time of peace. It is not clear who shall exercise the right of recapture at the end of license period, on behalf of the United States, or who shall question or decide whether such recapture is advisable.

Inasmuch as the fifty-year license is insisted upon, in order that the licensee may get back his investment within the term of the license, it is not fair that the Government, at the time of recapture, should be expected to pay anything like the full cost of the project. A "fair value" is an indefinite and indeterminable quantity. It would be much preferable to retain the right to recapture at any time upon the restitution to the licensee of all that had been expended upon the property, less what had been retired in depreciation and discharged indebtedness.

The regulation of the issue of securities, the control of expenditures, and the fixing of rates, are left altogether to the public utilities commissions of such states as have such bodies, the newly created commission having the right to exercise these functions in states where no such bodies exist, but being obliged to surrender them to such bodies when created. We should have preferred to see such control unified and systematized in the Federal Commission, and to see, as one of the terms of the license, that the price of current should be fixed at cost plus a fair and stipulated profit. The commission may, in its discretion, give preference to applications for licenses by states and municipalities for developing power "for state and municipal purposes," but apparently not for the general use of its inhabitants.

An annual rental of not less than ten cents per horsepower is to be charged. Fifty per cent. of the charges arising from licenses for the occupancy and use of national forests is to be expended in the survey, construction and maintenance of roads and trails within such national forests. Fifty per cent. of the charges arising from licenses for the occupancy and use of public lands, national parks, national monuments and power sites reserved outside of national forests shall be paid into the Reclamation Fund. All proceeds from any Indian reservation shall be placed to the credit of the Indians on such reservations, and fifty per cent. of the charges arising from all other licenses is reserved as a special fund to be expended in the maintenance and operation of dams and other navigation structures owned by the United States, or in the construction, maintenance or operation of headwater improvements on navigable rivers of the United States. This rental will, of course, be an item in the rate-fixing charges and the users of the current will thus be taxed for the purposes named.

The licensee is required to furnish, free of cost to the United States, power for the operation of navigation facilities connected with the project, whether constructed by the licensee or by the United States. The licensee must commence the construction of the project work within the time fixed in the license, thereafter in good faith and with due diligence prosecute such construction and, within the time fixed in the license, complete and put into operation such part of the ultimate development as the commission shall deem necessary to supply the reasonable needs of the then available market. Should he fail to do so, the Attorney General, upon the request of the commission, shall institute proceedings in the District Court of the United States for the district in which any part of the project is situated, for the revocation of such license, the sale of the works constructed and such other equitable relief as the case may demand.

The time to fix definite terms is when one is making a bargain. The terms of the proposed license do not enable one to judge with sufficient accuracy how the price of the service rendered by the licensee is likely to compare with what it would cost if rendered by the Government itself.

The first step toward the passage of the foregoing bill was taken by the House of Representatives on January eleventh, by the adoption of a resolution providing for the appointment of a special committee of eighteen members to which shall be referred all bills and resolutions introduced during the Sixty-fifth Congress (except those touching foreign affairs), which deal with water-power matters. The committee, which will be named by the Speaker, will serve only during the present Congress.

The adoption of this resolution discharges the committee on Interstate and Foreign Commerce and the committee on Public Lands from further consideration of the various bills that have been before the House for some years, and these bills are to go to the new committee. The proposed legislation in regard to water power at Niagara Falls is left in the hands of the House Committee on Foreign Affairs.

A bill introduced in the House on January ninth is intended to give the President power to take posession and assume control of any water-power projects using the waters of Niagara River for manufacturing purposes. The bill further empowers the President to retain possession, management and control of these projects for such time as may appear necessary to him during the period of the war, and then to restore them to their original owners, who are to be paid a fair and just compensation for the use of their property, as determined by an impartial agency. The basis of this compensation is a reasonable profit in times of peace, to which must be added the cost of restoring the property to as good condition as existed at the time it was taken over, less the value of improvements made thereto by the United States during its tenure.

In connection with the question of Government control of water powers, it is significant to note that Governor Whitman, of New York, in his message to the Legislature, advocated the idea that the state should undertake to develop some of its unused water power, a large amount of which has been created by the construction of the new barge canal. After developing the projects, the state might either operate them itself or lease the plants to others.

The present activity in regard to water-power utilization indicates an acute appreciation of the urgent need of tapping sources of power as yet untouched, to relieve the pressure on the fuel industries and the transportation systems; and under the spur of necessity it is probable that the long delay will be succeeded by prompt, equitable and conclusive action.

Coal

COAL continues to be the principal concern of the power-plant owner and engineer. To the extra quantity required to meet the normal growth of the country has been added that required by the speeding up of industry and the increased activity of the railroads. Even if the mines could produce the additional quantity needed, the railroads cannot transport it, and the demand, the difficulty of transportation and the suffering due to the lack of fuel have been enhanced by unusually long periods of exceptionally cold weather.

Industries have been shut down, hotels and hospitals and homes without coal, street-car lines stopped, public utilities hampered, commutation service deranged, and all the habits and activities of the people overset because of the shortage of fuel.

All this has resulted in a wild scramble for coal, not only on the part of individuals, but of localities. Local officials and administrators have commandeered coal passing through their territories en route to other sections. New England and New York are contesting for priority. There is not coal enough for all. Some must get along without—but who?

Obviously, provision must first be made for the absolute essentials. Homes, hospitals, hotels and places where people are obliged to work must be kept warm, the people must be transported to and from their work, food must be prepared, distributed and cooked. There are many things for which coal is burned that might be spared temporarily, and there has been much talk of cutting off the fuel supply to nonessential industries, but this would throw thousands out of employment and be productive of widespread suffering.

The United States Fuel Administration made public on January eighth its "budget plan" of allotting the available coal supply.

Committees representing the large industries not engaged in war work—more than one hundred in all—will be called into conference with the officials of the Fuel Administration. They will be shown the amount of coal available for all purposes, the amount required for war purposes and domestic consumers and the total curtailment of the use of coal which must be effected to satisfy these demands.

They will be asked on patriotic grounds as well as for their own future interests to volunteer in behalf of their industry a reduction of the coal consumption for the year 1918. They will be asked to show the Fuel Administration the best method of accomplishing this curtailment. They will also be asked to advise the Fuel Administration as to how to arrange these restrictions so as to affect only the less essential portions of their own business if possible.

When an agreement is thus reached as to the quantity of coal to be conserved in each industry, the Fuel Administration order will be issued, making this agreement effective as regards the total industry involved.

The voluntary annual saving shown by the first dozen industries called into conference promises to be between fifteen and twenty million tons. The total offering, from all nonwar industries will be between thirty-six and fifty million tons for the year 1918.

Fuel needed in 1918 for Army and Navy purposes, for munition works, for public utilities, for domestic consumers, and for factories working on war material is scheduled in the budget for one hundred per cent. fulfillment. With this figure and the estimated production of coal during 1918 as a basis, a subtraction shows the amount of fuel left for nonwar industries.

All the large American industries which have so far met with the Fuel Administration have shown a willingness to go voluntarily just as far as necessary in curtailing their activity. The Fuel Administration asks that other industries affected get in touch with Washington without waiting for formal notice.

In the meantime the situation has become so acute that Fuel Administrator Garfield has ordered all manufacturing plants to shut down immediately for five days, and thereafter on every Monday up to and including March twenty-fifth. Certain exceptions are made in favor of plants that must be operated continuously seven days a week, those engaged in manufacturing perishable foods, and printers and publishers of papers and periodicals; also, fuel may be burned on Mondays to prevent damage to property from freezing. The situation will continue acute until a sufficient spell of moderate weather uncripples transportation, and the congestion which hampers the movement of freight can be relieved. All that the individual can do is to put up good-naturedly with disarranged service, and save, *save*, SAVE. Save fuel directly in every possible way—save it by burning fewer lights, by heating fewer rooms; save it indirectly and lessen the burden upon the transportation facilities by traveling as little as possible and buying nothing that you can get along without; for there is nothing that does not require coal and transportation in its production and delivery to you.

The Joliet Plant

ON OTHER pages of this issue is a description of the new Joliet plant of the Public Service Company of northern Illinois. Among stationary plants in this country it is one of the first to reach an operating steam temperature of six hundred and fifty degrees. At the Buffalo General Electric plant recently placed in operation the steam temperature is six hundred and eighty-nine degrees, obtained from a steam pressure of two hundred and seventy-five degrees. In the present case the superheat is less by fifty degrees but the pressure is greater, being three hundred pounds at the turbine and enough higher at the boiler, to insure the above density. It is probable that the boiler pressure will approximate three hundred and twenty-five pounds, the design still allowing an additional twenty-five pounds.

There appears to be some difference of opinion as to the choice of pressure or superheat in making up the total steam temperature. Theoretically, the advantage is on the side of higher pressures, but here mechanical difficulties place restrictions. To obtain a temperature range such as exists in the plant under discussion, a compromise is necessary. Pressure up to the present mechanical limits is employed and then superheat to increase the initial temperature and add to the efficiency. Other factors influencing the degree of superheat are steam density and condensation during expansion. Superheat reduces the density and lessens friction. It also tends to prevent liquefaction in the turbine and should increase with the pressure. It is evident, then, that pressure and superheat must go hand in hand, the ratio to be determined by existing conditions and the results obtained from practice.

While little trouble is expected in the turbine, as up to a certain point it is merely a case of using heavier construction at the first stage and perhaps additional stages to cover the wider range, it is different with boilers and fittings. At Joliet the limit in pressure has been reached for the standard design of large boiler. Experimental work is being conducted to develop boilers for the higher pressures, but some time must naturally elapse before any new design is ready for practical application.

While the arrangement of boiler and economizer at Joliet has been used for several years in some of the leading stations in Europe, it is new to this country, as is the use of the all-steel horizontal economizer. To withstand the high pressure, steel is more reliable than cast iron, but it is more subject to corrosion from low-temperature flue gases. Galvanizing the tubes should neutralize this action.

The design of the unit calls for height in the building, but not so much as for the individual detached vertical-tube economizer placed in the same location. The above-ground basement is another factor adding to the height, but this is counterbalanced to some extent by small overhead bunker capacity calling for no additional height and minimizing the steel requirements. One great advantage of this arrangement is the elimination of ash-handling equipment. Another feature is the economical use of floor space. With backs retreating to the rear of the bridge-wall, the boilers require less than three-tenths square foot per nominal horsepower based on ten square feet of heating surface. The figure given omits the overhang at the rear.

No comprehensive tests have been conducted at the plant, so that the increase in efficiency over average present practice is open only to estimate. Owing to the favorable conditions it is quite probable that the over-all boiler efficiency may exceed eighty per cent., a gain of, say, five per cent. over good average practice. Theoretically, the one hundred pounds pressure additional to that commonly employed in the larger plants makes possible a gain of between six and seven per cent. in the turbine, giving a steam consumption that will compare favorably with the best from the largest units. It would not be unreasonable to expect a net production of one kilowatt-hour on eighteen to nineteen thousand British thermal units.

Against this increase in economy must be charged the additional investment. It has been estimated that boilers for this high pressure cost about twenty per cent. more than those designed for pressures close to two hundred pounds. The piping, valves and fittings are also more expensive, but small diameters help limit the cost. An analysis of actual figures should show a net advantage to the plant well worth while.

An appeal has been made by the Machine Tool Section of the War Industries Board, Council of National Defense, to the machine-building industry to relinquish a large number of heavy machine tools which are urgently and immediately needed for making heavy guns. There is no time to have them built. They must be taken from shops that already have them in use. To their owners is given the opportunity of doing something for the service of mankind—something that will save thousands of lives and prevent hundreds from being crippled. In modern warfare big guns are a paramount necessity. Without heavy artillery to clear the way, the loss of life in assaulting columns runs up to forty and sixty per cent. With adequate artillery preparation the loss is reduced to three to five per cent. The sacrifice asked is small compared with that of the thousands of boys over there who are making the supreme sacrifice—all they've got.

Correspondence

High Speed of Steam Turbines

In the Oct. 2 issue of *Power* W. F. Shaphorst discusses the subject of high speed of steam turbines. I have also noticed C. H. Watson's comments on the same subject in the issue of Nov. 6.

Mr. Watson points out that an 80 per cent. overspeed test will be highly objectionable from the designer's point of view. In this he is, of course, entirely correct. For a given power not only would a more expensive and a less efficient machine result, but turbines of as high power rating as are now manufactured could hardly be produced with any materials available at the present time.

Neither of the writers, however, seems to have considered that an 80 per cent. overspeed test, in the majority of cases, would be far from conclusive evidence that the various parts would be able to withstand the stresses occasioned by such overspeed as the turbine may be put to as a result of the failure of its safety appliances to perform their functions. I believe it can safely be said that 75 per cent. of all the turbines manufactured in the United States today, if unleashed from the reins of their speed regulators and unloaded, would assume a speed in excess of 180 per cent. of the operating speed.

As is commonly known, the speed that a certain turbine will assume under these conditions depends upon several factors. The main factor is the relation between the steam and blade velocities. In the Rateau turbine this relation is, for the best efficiencies, commonly taken as 2.3, while the theoretical figure for small nozzle angles is 2. If the windage losses in the turbine were entirely neglected and the theoretical figure used, when the blade velocity had increased to such an extent as to equal the steam velocity there would no longer be a force component in the direction of rotation, and consequently the speed of the turbine would be twice the normal operating speed.

Using the practical figure of 2.3 and still neglecting the windage losses, the overspeed to which the turbine would be theoretically put would be 130 per cent. However, if the turbine has a low horsepower rating, the windage losses for this overspeed will amount to so much that the machine will be self-loading before it reaches this point. It is true that the steam would impinge on the back of the blades long before this point was reached, but the blade losses as a result of this would be only about twice as great as if the angle of entrance into the blade row were the same number of degrees smaller than the blade-inlet angle, as it is greater in the present instance.

Furthermore, a well-designed Rateau turbine has a bucket-entrance angle sufficiently wide to take care of a steam velocity corresponding, approximately, to 70 per cent. load, rather than full load, without shock on the back of the blades. For a Curtis turbine with two rows of moving blades, the ratio between steam velocity and blade velocity would be about 4.5, practically, and as a consequence, the theoretical speed at which a turbine of this kind would be self-loading would be 350 per cent. above normal. The Parsons turbine would theoretically become self-loading at 100 per cent. overspeed. Here, as well as for the straight Rateau turbine, it is true that windage and blade losses would make the turbines of ideal condition self-loading long before reaching the theoretical point.

While the foregoing figures are those for the ideal conditions, a very small percentage of turbines are manufactured, in which such relations between steam and blade velocities actually exist. The figures are almost always greater. The reason for this, as is easily understood, is the fact that the frames required to make turbines commercial for small capacities will ordinarily be smaller than the frames at which they would give their best steam rate.

While high speed for steam turbines of larger type is a relatively new practice, as Mr. Shaphorst points out, in the field of small turbines, on the contrary, the last decade has shown a falling off in popularity of extremely high speeds. Instead of using single-stage units of 30,000 to 40,000 r.p.m., we are now generally employing 5000- to 7000-r.p.m. geared machines, and from 1000- to 4000-r.p.m. direct-connected.

There is no reason why a well-designed and intelligently operated high-speed turbine should not be as safe as a lower-speed machine. In some instances the drive is of such a nature as to render unnecessary any governor or overspeed device. For instance, in case of a blower or fan the additional resistance experienced for overspeeds is so great as to keep the unit from increasing its speed unless the runner on the fan should break for some reason or other. It would, therefore, generally be safe to leave off all governor mechanisms for a blower unit.

With the centrifugal pump it is generally considered allowable to leave off the governor and run the turbine with an emergency governor alone. This is also true of turbines used for ship propulsion.

For a generator unit, as Mr. Watson points out, there are always supplied the main governor and an emergency trip governor, these two safety devices being entirely independent of each other. The main governor is sometimes operating the steam-admission valve directly through a lever or a linkage, and in some instances the valve is handled by oil or steam pressure, regulated by a pilot actuated by the governor. The design of linkage and pilot-valve arrangement offers opportunities to guard against accidents. For instance, if any part of a properly designed governor mechanism should break, the valve should always close. If the pilot spindle should unscrew or be broken off, its motion should always be such as to admit oil or steam on the side of the operating piston, which would make the valve close. Furthermore, a spring or a small steam cylinder should be arranged over the valve so that in case the oil pressure failed the turbine would shut down. On low-pressure turbines, operated at, say, 2 lb. back pressure and 28 in. vacuum, it is generally considered good practice to install a vacuum breaker actuated by an emergency governor, in addition to the trip valve in the inlet of the turbine. In fact, the trip valve is often left off entirely and the vacuum breaker depended on to keep the turbine from running away, and this is generally safe.

In high-speed turbines there are certain characteristics that may give rise to trouble if design is not properly made. The one most commonly talked of is the flexibility of the shaft. As Mr. Watson says, impulse-type turbines are generally made to run somewhat above their first critical speed. This is also, I believe, a good practice. A turbine rotor will generally run with less vibration after it has gone through its first critical speed than before this point has been passed. This is a fact commonly known and recognized by all turbine builders, and contrary to Mr. Watson's supposition, the larger of the reaction turbines for land work also have flexible spindles and run through their first critical speed before coming up to operating speed. For marine turbines this condition is, of course, not allowable, since a marine turbine will be called upon to operate at any speed below its maximum running speed.

A turbine of any kind can generally be made to operate the best between the first and second critical speeds, but if the shaft is so flexible that the turbine is allowed to pass through the second critical speed before reaching the operating speed, if these critical speeds do not come more than 3000 r.p.m. apart, and unless the turbine is in perfect balance, it is often difficult to obtain smooth running at operating speed.

The bearings for high-speed turbines have occasioned a certain amount of difficulty in the past, when the theory regarding the proper way of admitting the lubricant to the bearing was still obscure. The more recent practice for high-speed bearings is to use only a part of the available bearing surface at the top and bottom of the bearing and use the remaining space to build up the oil film under the journal. Bearings made in this manner generally permit of the use of far higher surface speeds and pressure intensities than those of the older type.

J. Y. DAHLSTRAND,
Chief Eng., Kerr Turbine Co.
Wellsville, N. Y.

Piston Packing Burns Out

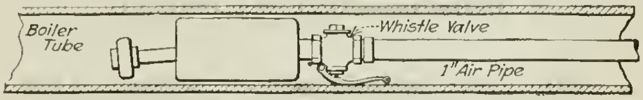
I am up against a puzzling problem. We have two Ideal engines 9 x 10 in., making 205 r.p.m. with 100 lb steam pressure and direct-connected to generators. They sometimes run for several weeks without giving trouble, then, presto! the piston rod gets so hot that the packing in the box is burned out. We use a good grade of cylinder oil fed by automatic force-feed pumps. The packing is of a good grade, costing $1.50 per pound, and is kept in A-1 condition. Sometimes the heating occurs shortly after repacking and at other times not for some weeks.

I have asked different engineers, including the experts from the engine shop, and no one seems able to explain the cause. Recently, we spent $1000 having the engines overhauled and put into good condition by the makers, but still the rod will occasionally heat and burn the packing. The piston and rod are properly centered, and the load is never excessive. I have never heard of a similar case, but some readers may have been troubled in this way and solved the problem.

Portsmouth, Ont., Canada. JAMES E. NOBLE.

Air Control for Tube Cleaner

In removing scale from a fire-tube boiler, we use a compressed-air tube cleaner that is attached to a 14-ft. length of 1-in. pipe. In operating this cleaner it required one man to open and close the air valve every time the cleaner was changed from one tube to another. I found an old whistle valve and screwed it to one end of the tube cleaner, attached the pipe to the valve and left the valve on the air line open. When the cleaner enters the boiler tube, the lever on the whistle bears against the tube and opens the valve, thus admitting air to the cleaner. When the cleaner is withdrawn from the tube, the spring closes the valve. This arrangement is shown in the accompanying sketch and is repeated each time the cleaner is pushed into the tube.



WHISTLE VALVE ATTACHED TO TUBE CLEANER

JOSEPH MCCUMBER.
Grinnell, Iowa.

Fuel-Saving Suggestions

In *Power* of Dec. 11, Mr. Bromley gives directions for saving coal in power plants. The article is very good, and with a comment on the method advocated of cleaning fires I would give it approval. "Jumping" ash and clinkers over clean fuel is impractical and results after hard work in only half-clean fires. It is not done so "in our set this season." I also believe Mr. Bromley overlooked the great advantages of shaking grates in furnaces. Now, above all times, it is opportune to recommend the shaking grate, as it is without doubt a valuable asset to fuel saving.

The shaking grate is not new. It was introduced many years ago, and the principle was recognized at once as sound and logical. The very desirability of some such device induced many makers to go into the business of turning shaking grates out as fast as possible.

The result was that many of the grates were not strong enough for the hard usage encountered in many of the installations, and the shaking grate got a "black eye" from which it has not yet recovered, notwithstanding the great improvements made.

In every instance where a stationary grate is used, a large saving of fuel would be made if a shaking grate were substituted, and I believe Mr. Bromley will agree that every effort should be made to induce engineers to use all their influence to have this style installed, instead of the original and old-fashioned stationary grate.

Somerville, Mass. JOHN M. COLEMAN.

["Jumping" the fire was considered because of the very extensive use of the stationary grate. The shaking grate is desirable.—Editor.]

Static Electricity from Gasoline

The following experiment will show that gasoline will create enough electricity in flowing from a spigot to ignite itself. Insulate a can from the ground and draw gasoline into it from a spigot near to but not touching the can, and the composition of the gasoline is such that it will create static electricity in the can and discharge in sparks when it gets up to the neck of the can, so that it can jump across and an explosion will occur. This has happened in several instances, and even if the spigot is grounded, electricity will still be generated in the can. The only way to prevent the explosion is to ground the can to carry it off.

This is a new one on me, and it seems to be the composition of the gasoline that causes it, as other liquids have been tried with no such results. D. R. HIBBS.

New York City.

Controlling Smoking Chimneys

The smoke-preventing system described on page 718 of the Nov. 27 issue of *Power* is very good for a large power plant, but it would be rather expensive for a small one. Following are a couple of methods that may be employed to watch the smoke and assist in keeping it down to the proper density and that can be used by almost any plant, no matter how small. Some of the small plants have more trouble with smoke than the large ones, as they do not have as efficient methods of operation; and there is more complaint in a small place, as many of the homes are owned by the tenants.

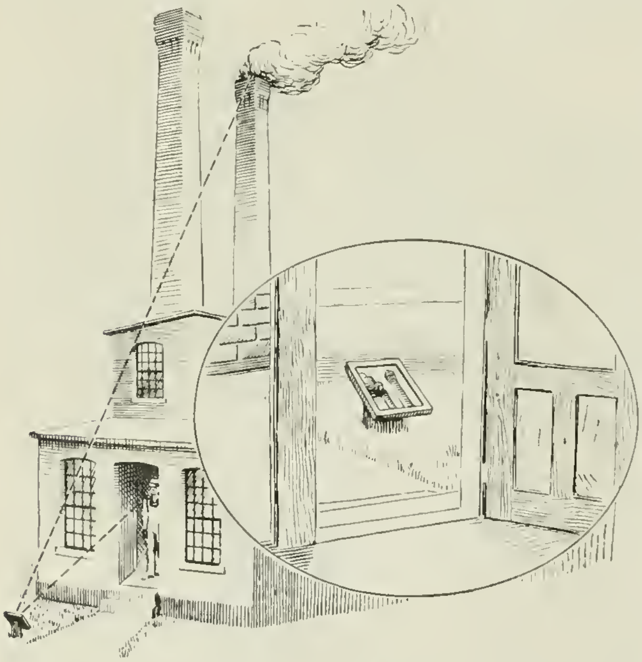


FIG. 1. SMOKE OBSERVATION MIRROR IN THE YARD

One method of smoke observation is to place a post in the boiler-house yard with a mirror attached to it and set at such an angle as will enable the boiler attendant when standing in the doorway (see Fig. 1) to easily observe whether his chimney is smoking or not. If it is, he can remedy the cause.

The other method can be used only in boiler plants in which the chimney rests on the top of the boiler. A 2-in. pipe is put through the stack at such an angle that the fireman can see through it from the floor. The pipe has several large holes drilled through it to admit the smoke, but not large enough to affect the draft. An electric light is hung at the top end of the pipe, as shown in Fig. 2. When the fireman looks through the pipe, he can see at a glance whether the light is clearly visible or not. The clearness with which the light can be seen, of course, indicates the smoke condition. D. R. HIBBS.

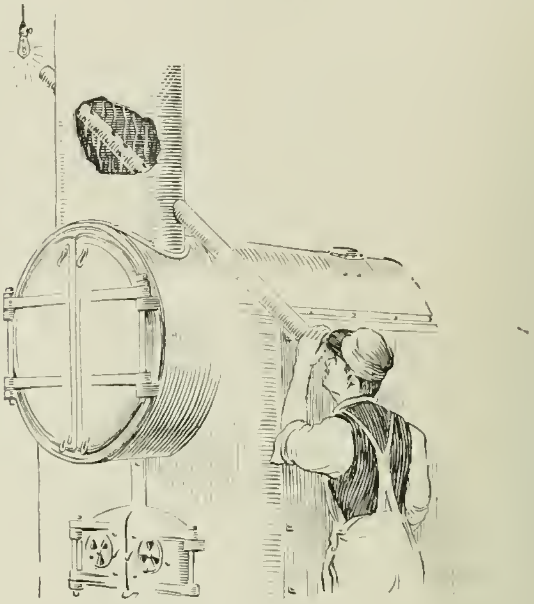


FIG. 2. SMOKE OBSERVATION PIPE IN STACK

New York City.

Unsatisfactory Plant Conditions

When I took charge of this plant, which comprises three generating units of medium size, I found that the governors on two of them were so badly corroded and sticky that with the least fluctuation of steam pressure or load they would race badly or slow down. The governors were immediately cleaned and put in order, and no further trouble has ever developed. The smallest of the three engines would remind one more of a trip-hammer than a steam engine. The former chief informed me that the knock was born in the small unit and that no means could be found to remove it, but I can truthfully say now that I never saw a more quiet running engine, and a coin will stand on edge on different parts of the engine and bedplate.

A great deal has been said on the coal question, and most writers hold to the point that the engineers are the ones charged with the saving of coal. To a certain extent this may be true, but assuming that one has done all in one's power to cut down on coal, such as cleaning boilers, stopping leaks in boiler walls and cleaning stacks, and is getting the best results possible under existing conditions, but is still burning more coal than should be consumed, with black smoke belching from the chimney continuously, and after satisfying oneself that an investment of a few hundred dollars would cut that coal bill, the owner should refuse to make the investment, what should one do? I think I know the answer most engineers would make. M. E. WEBBER.

Syracuse, N. Y.

Sandpapering Brushes

In sandpapering the brushes of modern motors, I have found that, where the brushes fit well in the holders, it does not make much difference whether the sandpaper is drawn in one direction only or back and forth. In up-to-date machines the brushes usually make a good fit in the brush-holders. In the older machines the brushes often fitted loosely in the holders, and then difficulty was likely to be encountered unless the sandpaper was pulled only in the direction of rotation of the machine. However, it is safe always to pull the sandpaper in one direction; that is, in the direction of the rotation of the machine. T. A. NASH.

New York City.

Warning of Impending Danger

Some readers of *Power* no doubt have had experience with flywheel explosions and are "alive to tell of them." There surely must have been some warning or a series of warning incidents, if properly interpreted, preceding the explosion. From experience we recognize the sound when valves "grind" for want of better lubrication or when water is heard in the cylinders. If all strange sounds are immediately investigated, there is a remedy for such things if applied in time. While alone on watch, I have often wondered what incident would occur? What sound would be heard which would be a sign of impending disaster—that the flywheel was on the point of rupture? How many readers could describe the series of events leading up to a flywheel explosion? Would not such a discussion be of great value?

A young man walked into our station one night, introduced himself as an engineer and asked to look around. I showed him around, answering his questions and in turn asking some. We stopped in front of the 300-kw. unit which was running at the time, and he asked if I had had any experience with flywheel explosions. My answer was in the negative, but in reply to the same question to him, he said that he had and told the following:

Several years previously he was working in a certain manufacturing plant as a sort of wiper and making himself generally useful about the place. There were two units, duplicates. The flywheel of each weighed approximately 14 tons and operated at 100 r.p.m. One day toward noon he walked into the engine room to help fill cups, etc., during the shutdown. Suddenly a "whistling" sound came from the flywheel—something that had never been heard before. An old timer at engineering urged an immediate shutdown of the engine as a flywheel explosion was impending. The whistling increased while the throttle was being closed, and the men "scattered for the open air." The whistling continued as the engine gradually slowed down, then the flywheel suddenly went to pieces; but the damage was comparatively slight, for which everyone felt grateful to the old timer.

According to the young man's narrative, then, if an engineer heard a whistling or other unusual noise coming from a revolving flywheel, he would be justified in shutting down and investigating. Anyway, by so doing he would be playing on the safe side. I hope there will be a discussion that will give a clue in regard to such explosions, and surely there are many engineers who will appreciate it. THOMAS M. GRAY.

Middletown, N. Y.

United States Navy Service Flag

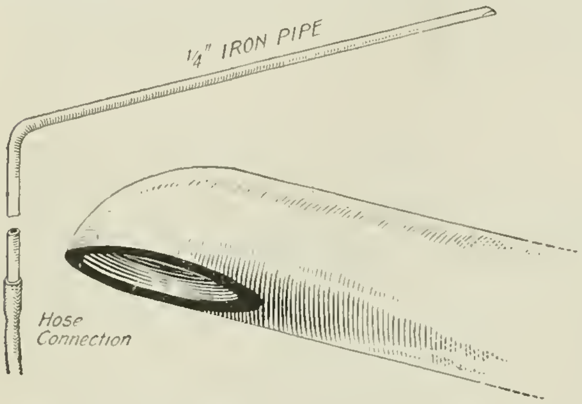
With the usual service flag there is no way of distinguishing the particular branch of service represented. Being in the Naval service, I took occasion to make a service flag for my own home and decided that anybody who should see it would recognize the branch of service represented. I took a white line and made some of the most attractive navy knots and placed the cord in a continuous line around the white panel. At the top and bottom there is a double Carrick bend and on each side, at equal intervals, a figure-of-eight and a square knot. Since sending the flag home, I have heard that it is considered not only attractive, but leaves no doubt as to which branch of the service I am in.

SERVICE FLAG TO DESIGNATE THE SERVICE

New York City. M. M. CLEMENT.

Cleaning Turbo-Alternators

The importance of keeping the windings and air passages of turbo-alternators free from dirt is well known and cannot be overstated, and it is not a difficult job with some types of generators at least. We use compressed air through a ¼-in. iron pipe, bent as shown in the illustration, for blowing out 5000-kw. generators.



BLOWPIPE FOR CLEANING GENERATORS AND MOTORS

The lance is long enough to reach halfway through the generator, and from the long-radius bend to the hose connection is about two feet; this serves as a handle, and it also indicates the direction of the blast when the lance is in the generator. With the end shields off the generator the lance may be inserted between the field and armature, and the powerful blast of air, issuing at right angles to the pipe, blows through the windings and laminations, effectually removing the accumulated dirt. It takes four men from eight to ten hours to do the whole job and get the machine ready for service again. H. W. MORREALL.

Utica, N. Y.

Preventing Lamps Burning Out

Recently, I had several flood lights to install on a 220-volt circuit, therefore the lamps were wired two in series. After the lights were put in service, considerable trouble was experienced with the lamps burning out, owing to voltage surges in the line serving the property.

I have been able to reduce our lamp loss from this cause by connecting, in series in the line, about a thousand feet of No. 8 wire, leaving the wire in the form of a coil, which seems to act as a choke coil. Since doing this I have lost only two lamps in two weeks. Previous to the installation of the coil the loss was two or more every night. C. W. YOUNG.

Tulsa, Okla.

[The experience related is no doubt a case of operating the lamp on too high a voltage. This could have been remedied by finding out the correct voltage and installing the proper lamps.—Editor.]

Regulation of Feed Pumps

A large number of plants using steam heating or drying coils, and draining the condensate and drips back to an open heater to save the heat as well as the water itself, lose a large part of the returns through the heater overflow because of the limited storage space and improper operation of the feed pump.

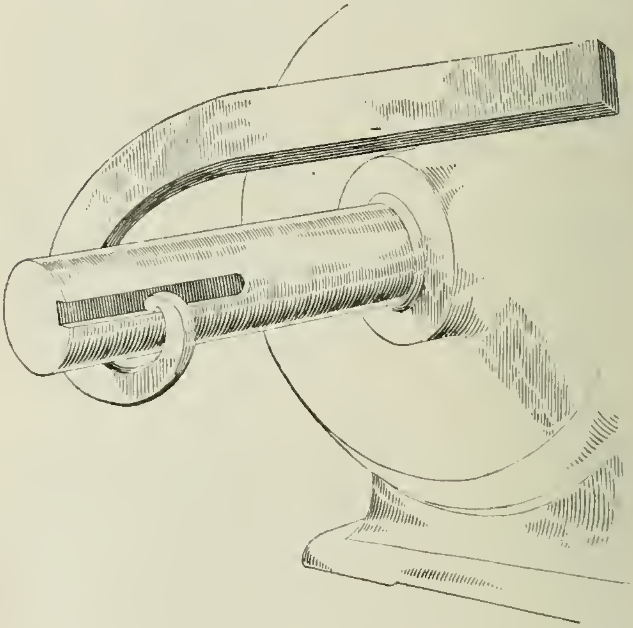
Frequently, the pump is speeded up and the boilers filled with water during times when the volume of returns is not sufficient to make up the feed supply and cold water is automatically supplied. The pump is then shut down, and the returns fill the storage space of the heater and overflow, carrying away valuable heat. The pump should be so adjusted as to deliver the return water continuously to the boiler at the rate at which it is coming back, and as a result none will be wasted at the overflow.

Such regulation of the feed pump in one plant cut down the use of makeup water by one-third and gave an even feed temperature of 210 deg. F.

Philadelphia, Penn. M. A. SALLER.

Spanner Wrench for Finished Shafts

The illustration shows a spanner wrench for shafts, which has proved so useful that I want others to know of it. It is made of 1 x ½-in. steel, and the same wrench can be used on shafts from one to six inches in diameter without damaging the keyway. The shape of the tool is the result of something like two years' evolution. It is christened the "Twister" and is used for rotating (by hand) armatures and the like during the process of erection, repairing and inspection, and of course it works equally well on other similar things. The need of something of the kind is shown by the condition of keyways on shafts so frequently found damaged by the use of monkey wrenches and pipe wrenches.



WRENCH TO ROTATE A SHAFT

Brooklyn, N. Y. A. J. CAHEN.

A point about the arrangement of blowoff piping, which is often overlooked and may lead to a serious accident, is failure to see that the pipe system drains thoroughly by gravity to the discharge point. A pipe that remains partly filled with water, that becomes cold between the times, is likely to cause severe water-hammer that may break the fittings and may scald the operator.

Inquiries of General Interest

Collapsing vs. Bursting Pressure of Tubes—Will a flue or tube of a boiler resist a greater internal or external pressure? L. L. S.

On account of the impossibility of constructing flues or tubes of true circular form, or of their maintaining circular form when subjected to external pressure, they fail by collapsing from less pressure applied externally than the internally applied pressure required for bursting them.

Theoretically Maximum Percentage of CO_2—What is the theoretically maximum percentage of CO_2 in boiler-flue gases resulting from complete combustion of a pound of carbon? J. H. K.

With complete combustion, and only enough air present to burn the carbon, the flue gas would show only CO_2 and N, as all of the oxygen would be combined with the carbon. As air consists by volume of oxygen 0.207 part and nitrogen 0.793 part, the flue gas would show 20.7 per cent. of CO_2 and 79.3 per cent. of nitrogen, because CO_2 occupies the same volume as the oxygen from which it is formed.

Advantages of Subdivided Steam-Heating Surfaces—For warming a room by steam heat, what advantages are to be obtained by employing two direct radiators in place of one? C. C. P.

For the same amount of heat given out there will be the same amount of steam required, but when appropriately located, two or more radiators may be so placed as to give more uniform distribution of the heat throughout the space that is to be warmed and thereby effect a saving by not requiring overheating of a portion of the space to obtain sufficient warmth throughout the whole space. Another advantage is that with the heating surface divided the amount of surface used can be better adapted to requirements of weather.

Troublesome Radiator—In a low-pressure two-pipe gravity-return steam-heating apparatus fitted with direct radiators, one of the radiators fills up with water and will not circulate properly. What would remedy the trouble? A. W. F.

The radiator may not have large enough steam supply to maintain sufficient pressure for discharging the water against the pressure in the return main. This trouble is likely to occur when drips or other radiators at a higher level or more active radiators on the same level are connected into the same dry return line. If the troublesome radiator has ample steam supply, it should be made to return as well as others on the same level by giving it a separate return connected to the return main well below the water line of the boiler.

Variation of Power Required for Vacuum Pump—Is more power required for driving a vacuum pump with a high or a low vacuum? T. C. E.

The energy required depends on the net pressure or difference of pressure on each side of the piston. Hence with a single-acting air pump or any type of vacuum pump working at constant speed against atmospheric pressure, the higher the vacuum the greater the power required for its operation. But with a double-acting vacuum pump, operated at constant speed, the higher the vacuum the less the power required, as the average pressure on the discharging side becomes less the higher the vacuum in the condenser. With a perfect vacuum the difference of pressure would be 0 and the power required for operation of the pump would be only that required for overcoming friction.

"Lead" or Clearance of Large Bearings—What is a practical method of determining the setting that should be given to the boxes of a large crankshaft? F. M. F.

For stationary engines the amount of "lead," or radial clearance, is commonly adjusted by setting the capscrews or nuts down hard and then backing them off such a fraction of one turn as to permit a clearance between the journal and bearing that has been determined to be suitable for the special conditions. For large bearings having good working surfaces, radial clearance of 0.008 to about 0.014 in. usually will be found satisfactory. The actual amount of clearance obtained by "setting down hard and backing off" may be approximately estimated by multiplying the pitch of the screw threads by the fraction of a complete turn backed off; thus with screws having 7 threads per inch, backed off "one-half of one flat" of a hexagonal nut or bolt head, or $^1/_{12}$ of a complete turn, the approximate clearance would be $^1/_7 \times {}^1/_{12} = {}^1/_{84}$, or about 0.012 in.

Check Marks on Drawings—What are the advantages and disadvantages of leaving check marks on mechanical drawings? J. A. P.

The purposes of mechanical drawings are better served by omission of any lines or markings that do not add to exactness of interpretation. There can be no objection, however, in leaving check marks on private copies of drawings in hands of the makers as information for what it may be worth, to indicate that the dimensions or other features check-marked have been criticized or have received special consideration. But the presence of such marks detracts from general clearness of representation and from concentration of the reader, and it is better to omit them from drawings intended only to impart information of design or construction, unless the marks are used sparingly and for attracting special attention.

Computing Power of Compound Engine—What is the formula for computing the indicated horsepower of a compound engine? R. D. B.

The power developed in each cylinder may be estimated separately as a simple engine by the usual formula

$$I.hp. = \frac{P\,L\,A\,N}{33{,}000}$$

in which

P = Mean effective pressure, lb. per square inch;
L = Length of stroke, in feet;
A = Area of piston in square inches;
N = Number of single strokes per minute.

Then, adding together the number of indicated horsepower for each cylinder gives the total power developed.

When, as is generally the case, there is the same length and number of strokes in each cylinder, a more convenient method of computing the gross power of the engine is to assume that the m.e.p. of both cylinders are combined and referred to one of the cylinders (as the low-pressure cylinder) and assume that the whole power is developed in the cylinder thus referred to. If d = diameter of the high-pressure cylinder, D = diameter of the low-pressure cylinder, M = m.e.p. of the high-pressure cylinder, m = m.e.p. of the low-pressure cylinder, then the m.e.p. of the high-pressure cylinder referred to the low-pressure cylinder would be $M \times d^2 \div D^2$; the combined m.e.p. referred to the low-pressure cylinder would be $\frac{Md^2}{D^2} + m$, and the gross power of the engine would be given by the formula

$$I.hp. = \frac{\left(\frac{Md^2}{D^2} + m\right) \times L \times 0.7854D^2 \times N}{33{,}000}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Effects of War Conditions on Cost of Electric Service

Owing to the number of requests for regular institute meetings by the different sections of the American Institute of Electrical Engineers, it was decided to hold intersectional meetings, in which nearly simultaneous sessions are held in two or more cities, to consider the same papers. In accordance with this plan the 336th meeting of the institute was held in Boston, Jan. 8; in New York City, at the Engineering Societies Building, Jan. 11, and in Chicago, Jan. 14. The same paper was presented and discussed at all three places.

The success of these meetings, especially at this time, when the engineers of the country are overtaxed with the duties involved as an outcome of the war, thoroughly justifies these intersectional meetings. A record number was in attendance at all three meetings. One paper, "Effects of War Conditions on Cost and Quality of Electric Service," by Lynn S. Goodman and William B. Jackson, was presented at all three meetings. Mr. Jackson presented the paper at Boston and New York. I. M. Cushing, secretary of the Boston section, presided at the Boston meeting, and President E. W. Rice at New York City.

Mr. Jackson, as an introductory to the presentation of the paper in New York, gave a brief outline of the war situation for the past year, pointing out that when viewed in a narrow way the outlook was not very promising, but viewed with a broad range of vision the outlook for the United States and her allies could be nothing else but optimistic, and that the outcome would be of material benefit to this country. Likewise in the power industry, when viewed in a small way, the outlook creates pessimism, but when considered from the larger angle there is every reason to believe that the situation will be successfully met.

The paper deals more particularly with the effect of war conditions upon electric-light and power service, but the principles relate in their broad application to every kind of public-utility service.

DIRECTIONS IN WHICH THE EFFECTS APPEAR

The principal directions in which the effects of war conditions on electric service appear are:

1. In relation to operating: (a) In increased salaries and wages paid for operating; (b) in difficulty of retaining trained operatives and, conversely, the need to operate with partly trained forces; (c) in increased cost and difficulty of obtaining fuel and in reduction of its uniformity and quality; (d) in increased cost of other supplies and materials for operation and maintenance; (e) in the need for protecting the properties against enemy agents; (f) in increased taxes; (g) in possible decrease of consumption of electric power by ordinary customers; (h) in possible changes of load factor.

2. In relation to extensions of plant: (a) In the necessity in many cases for quickly caring for large accessions of permanent and temporary business; (b) in increased cost over normal for plant required to care for additional business; (c) in high cost for money and difficulty of obtaining it at any rate considered reasonable in normal times; (d) in the difficulty of obtaining equipment in reasonable times of delivery.

The effects of the war conditions are being manifested not only in the matter of heavy increases in operating costs, but also in the matter of extraordinary increases in cost for new plant required to care for added business. These conditions have already increased the operating expenses of the electric companies of this country to the extent of over $116,000,000 per year, as hereafter shown. This points to the necessity of readjustment to the new conditions without delay, while at the same time requiring readjustment to abnormal labor conditions.

An analysis of the United States Census statistics shows that the increase in the average wages paid per employee (exclusive of general officers, managers and superintendents) during the ten years from 1902 to 1912 was 11 per cent. During the war period thus far, salaries of officers, managers and general superintendents have in general not greatly increased, but increases in wages in the operating departments have ranged from 15 to 50 per cent., and it is the opinion that 25 per cent. may be taken as the average increase thus far occasioned by the war.

Under normal growth from 1912, at the rate indicated by the growth during the previous ten years, we find that the salary and wage disbursements of electric companies in the year 1917, had there been no unusual disturbance, should have amounted to $90,000,000, of which one-seventh would have been for general officers', managers' and superintendents' salaries and six-sevenths for wages. From this it is seen that the increase in wages of 25 per cent. means an outlay on the part of the electric companies of $19,000,000 for the year.

INCREASED FUEL COST TO ELECTRIC COMPANIES

Estimates based upon the United States Census reports show that the fuel cost for all the electric companies in the United States would have reached $50,000,000 for the year 1917, under normal conditions of the country, and would have amounted to about 60 to 65 per cent. of the normal generating expense. Definite information as to the amount of increase in fuel cost for the whole country is not available, but from information obtained from various sections of the country the conclusion is arrived at that the average cost per ton of coal to electric companies has increased a little more than 100 per cent. on account of war conditions, and that 100 per cent. is not far from correct. On this basis the increase in total cost due to the enhanced price per ton of fuel is $50,000,000. A conservative figure for the increase in tonnage due to lower quality and non-uniformity of grade is 10 per cent., which means an added increase of $10,000,000, making the total increase $60,000,000.

An estimate of the output from steam-driven electric central stations which might have been expected for 1917 under normal conditions shows 13,000,000,000 kw.-hr., and an average requirement of three pounds of coal per kilowatt-hour of output shows that the fuel requirements would amount to not over 20,000,000 net tons, which is approximately 3 per cent. of the estimated output from the mines for 1917. It is thus seen that a relatively large reserve supply of coal in the hands of every electric company would tie up but a very small part of the coal supply of the country and this supply would be widely distributed and to a certain extent would be in proportion to the populations and industrial importance of the several sections of the country.

The indications are that the cost of materials and supplies other than fuel, which is estimated as a little over 15 per cent. of the total operating expense, has increased as much as 75 per cent. Such an advance in this expense means an increase in expenditures in the neighborhood of $30,000,000.

INCREASED TAXES PAID BY ELECTRIC COMPANIES

Estimates based on the United States Census returns indicate that the 1917 taxes paid by electric companies might normally have reached $25,000,000. The proportion of gross revenue required for taxes has apparently been increasing year by year, having been slightly over 3 per cent. in 1902, a little over 3.5 per cent. in 1907, and nearly 4.5 per cent. in 1912. An estimate of the amount of the expense which may be expected to be added to the cost of electric service throughout the country from increased taxes is difficult of determination, but we may hazard a guess that the increase over normal expense will lie between $5,000,000 and $10,000,000 for the year 1917.

Summing up the foregoing amounts shows that the extra expenses now imposed on the electric companies on account of war conditions amounts to the immense aggregate per year, as follows:

Increased salaries and wages chargeable to operating	$19,000,000
Increased cost of fuel	60,000,000
Increased cost of other materials and supplies	30,000,000
Increased taxes	7,500,000
	$116,500,000

This amounts to a quarter of the normal estimated gross revenue for 1917 of all the electric companies, and it wipes out two-thirds of the sum that would have been available for interest, dividends and surplus. It does not include additional expenses caused by the difficulty of retaining trained operatives and the cost of protecting the properties against malicious interference, the magnitude of which we are unable to estimate. It puts the electric companies in a critical position, which is rendered more ominous by the impossibility of foretelling how much larger these extra expenses may become in future months.

Effect of War Prices on Power Industry

The effect of war prices on the electric-light and power business may be shown in the aggregate. The United States Census of central stations shows that the total revenue received from operation and other sources by all central electric-light and power systems (including both hydraulic and steam stations) in 1912 was in round figures $302,000,000 and the total operating expenses, including taxes and renewals and replacement expense, but not including interest on debt, was $184,500,000, leaving a total income of $117,500,000. The reported cost of construction and equipment was $2,176,000,000. Extension of these totals to the year 1917 shows that under normal growth the total revenues in 1917 would have reached $475,000,000 and the operating expenses, including taxes and renewals and replacement expense, would have reached $290,000,000, making the total income before deducting interest on debt, $185,000,000. Estimating the reported cost for construction and equipment would have grown to $3,500,000,000, an increase of 60 per cent. in five years, the income mentioned would represent 5.3 per cent. of this cost of construction and equipment. If no other factors entered into the problem besides increases in cost of operation, and assuming these increases effective over the whole year, the fuel expense, as before pointed out, would increase $60,000,000 for 1917, other supplies $30,000,000, labor expense $19,000,000 and taxes $7,500,000, representing an aggregate increase of operating expenses for these items of $116,500,000. This is an increase of 40 per cent. in operating expenses, and it reduces the divisible income to $68,500,000, which amount is equivalent to less than 2 per cent. on the cost of construction and equipment. This percentage is still lower in the case of the steam-electric systems of the country taken alone, and additional expenses for training new employees and the lowered efficiency of such employees, the cost of special policing, etc., reduce the amount still further.

What has been pointed out in the foregoing regarding the effect of war conditions on central-station electric service is also applicable to the cost of power produced by private power plants. The immensity of this field is seen by reference to the United States Census of Manufacturers for 1914, in which the total primary power reported as used in this field aggregated 22,500,000 hp. (exclusive of isolated electric plants for office buildings, hotels, etc.), of which 15,700,000 hp. was comprised of steam-driven equipment and only 3,900,000 hp. was in the form of purchased electric power. The central-station steam and water-driven electric generating capacity in 1912 was only 7,500,000 hp., with a probable 9,000,000 hp. in 1914.

Power Output of Industrial Plants

Considering the output of power by the industrial plants using steam power, which do not now purchase electric current, estimated on the basis of the capacity of equipment as reported for 1914, operating at the equivalent of full load for a sixth of the time, the total horsepower output would amount to 23,000,000,000 hp.-hr. It is safe to say that at least three-quarters of this is such that the exhaust steam cannot be effectively used for heating purposes and there would be a possible saving of at least 1.5 lb. of coal per horsepower-hour through service of this three-quarters from central steam-driven electric stations, making a total saving in fuel of 13,000,000 tons of coal per year under the industrial plant output for the year 1914. The saving would be much greater when considering only the more modern and economical central stations. The same considerations apply to the field of isolated building and hotel electric plants where conservation of coal amounting to millions of tons could unquestionably be effected.

The result of the increased cost of producing electric power in England, and also the curtailment of certain classes of service not yet experienced in this country, has been quite a universal increase in rates, in some cases flat percentage increases of the same amount for light and power, in other cases differing percentage increases for light and power, and in still others increases depending upon changes in cost of fuel. These flat percentage increases have varied from less than 10 per cent. to as high as 50 per cent. over the rates in effect prior to the war, London rates having been increased 50 per cent., according to the London *Electrical Review*.

The authors in the paper also point out that the economical central power-generating station is the proper medium for the supply of the large-power requirements arising on account of the war, and the many advantages of this means of producing and distributing power. These advantages, they say, are so large that it is advisable for the Government to use every reasonable means to encourage the central-station companies and discourage individual power plants during the period of the war. Certain operating economies and changes which might be adopted by the central-station companies, if forced to it by war conditions, are also considered.

The paper brought forth a vast amount of discussion. Among the opinions expressed was that when the exhaust steam could be used for heating and manufacturing purposes, power could be produced just as cheaply, in the isolated plant, if not at less cost, as in the central station.

H. M. Hobart, who had recently returned from England, called attention to the 50 per cent. increase in the rates for electric service in London being an exceptional case, as it was doubtful if there had been any increase in the rates in many localities in that country. He also pointed out that the increased cost of each item entering into the production of power should not be considered as directly affecting the cost of power, since the output of the central station has also greatly increased.

The pooling of power of both central and private plants, and if necessary the commandeering of private plants, was suggested as a means to help supply power to the essential industries for carrying on the war.

In Re Proposed Water-Power Legislation

"Joint letter" from the Secretary of War, Secretary of the Interior and Secretary of Agriculture, addressed to the President, regarding the proposed water-power bill.

My Dear Mr. President: We transmit herewith for your consideration draft of a proposed bill for the development of the water powers of the United States upon navigable streams, public lands and national forests. The measure was prepared under our direction by members of our departments who have had most to do with the water-power problem, and we believe it will be likely to secure extensive development of this resource, with due regard to the public interests as well as those of the developers.

It embodies the fundamental principles of several bills now pending in Congress, and an effort has been made to avoid or cure their defects. The principal features of the proposed bill are as follows:

Administration

By a commission composed of the Secretaries of War, Interior and Agriculture.

The Shields bill (navigable waters), by the Secretary of War.

The Ferris bill (public lands), by the Secretary of the Interior.

Period of Lease

The bill proposes to lease the water-power privilege for a period of not exceeding 50 years. At the end of that time the project may be (a) taken over by the United States; (b) re-leased to the original lessee; (c) leased to a new lessee.

The Ferris and Shields bills also provide for leasehold periods of not exceeding 50 years.

The attached bill proposes that at the end of the leasehold period the project may be taken over as follows: All property owned and held by the licensee then valuable and serviceable in the development or distribution of power, together with any locks or other aids to navigation constructed by the lessee, upon payment of "the fair value, not to exceed actual cost of the property taken, plus such reasonable severance damages, if any, as may be caused by the separation of said property from property valuable, serviceable and dependent as above set forth, but not taken," such value not to include any rights granted by the United States, good will, going value or prospective revenues. Further, the values allowed are not to exceed the actual reasonable cost of the property at the date of its acquisition by the lessee.

The Ferris bill provides that the United States may take over at the end of the leasehold period all property in the project to the point of distribution, upon payment of actual cost of water rights, lands and interests therein, and the reasonable value of all other property taken over, but not including franchise value, good will or other intangible elements.

The Shields bill provides that the United States may take over all the property of the grantee which constitutes part of the plant or is dependent in whole or in part upon it, upon paying to the grantee just compensation for said property, together with the cost to the grantee of the locks or other aids to navigation, no value being allowed for the rights granted by the United States for good will or anticipated profits.

REGULATION OF SERVICE AND CHARGES

The attached bill provides for regulation by the Federal Water-Power Commission of interstate power; also of power in any states where no state regulation is had. Intrastate power is to be regulated by state utility commissions, where same exist.

The Ferris bill provides for regulation of service and charges and of stock and bond issues where there is interstate transmission or in states having no commission by the Secretary of the Interior.

The Shields bill provides for the regulation of interstate power by the Interstate Commerce Commission, other power developed to be regulated by the state in which the service is rendered. No provision is made for control in those states where there is no public-service commissio

CHARGES

The bill proposes that the lessee must pay the United States reasonable annual charges, to be fixed by the water-power commission and specified in the lease, in no case to be less than 10 cents per horsepower per annum. No maximum is fixed. Where the lessee builds, maintains and operates locks or other aids to navigation, the commission may take that fact into consideration in fixing charges, also assessing against the lessee any benefits he may obtain from the construction, operation and maintenance by the United States of headwater improvements or navigation structures.

The Ferris bill provides that annual charges, measured by the power developed, shall be collected.

The Shields bill provides that payment shall be made for any lands of the United States used or occupied by the lessee, the charges to be based on the value of the lands as fixed by the Secretary of War, his discretion being limited by the requirement that the value must be ascertained by the rules in force in the state where the lands are located in proceedings where private property is sought to be taken for a public use. It also requires that the grantee shall pay the United States reasonable charges in consideration of the construction, operation and maintenance by the United States of headwater improvements.

DISPOSITION OF RECEIPTS

The attached bill provides that all receipts shall be placed in the Treasury of the United States; that 50 per cent. of the proceeds from national forests be expended in construction of roads therein; that 50 per cent. of receipts from public lands be placed in the reclamation fund; that 50 per cent. of receipts from navigable streams be expended in the maintenance and operation of dams and other navigation structures of the United States; and that all proceeds from Indian reservations shall be placed to the credit of the Indians.

The Ferris bill provides that all receipts from public lands shall be placed in the reclamation fund, and upon return to that fund, be divided equally between the United States and the states in which the development occurred.

The Shields bill provides that proceeds shall be set aside as a special fund for the maintenance of dams and headwater improvements.

We believe that some such legislation as is here proposed, if enacted, would mean the early development of a considerable portion of our water-power resources, with a resultant saving in fuel and a considerable lessening of the present demand on our transportation facilities caused by the moving of coal and other heavy fuels.

Cordially yours,

NEWTON D. BAKER.
FRANKLIN K. LANE.
D. F. HOUSTON.

THE PRESIDENT,
The White House.

Interpretations by the Boiler Code Committee

Following are the most recent interpretations by the Boiler Code Committee:

Case No. 177—Inquiry: Is the type of removable dome as shown in Fig. 13 of the Code for use on horizontal return-tubular boilers permissible under the rules of the Boiler Code, or is it necessary that this dome be attached direct to the shell with a double-riveted flange for pressures over 100 lb.?

Reply: The construction shown in Fig. 13 is considered as a steam-boiler drum and not a boiler dome, and therefore does not come under Par. 194 of the Boiler Code.

Case No. 178—Inquiry: An interpretation is requested of the application of Par. 253 to the drilling of rivet holes in crowfoot braces. Is it permissible to punch holes in the shell full size where the brace is fastened thereto?

Reply: It has been proposed to revise Par. 253 to read as follows:

253. Drilling of Holes. All rivet and stay-bolt holes, and holes in braces and lugs, shall be drilled full size or they may be punched not to exceeed ¼ in. less than full diameter for material over $\frac{5}{16}$ in. in thickness, and ⅛ in. less than full diameter for material not exceeding $\frac{5}{16}$ in. in thickness, and then drilled or reamed to full diameter.

Case No. 179—Inquiry: In the use of steel castings for the construction of locomotive boilers, what class of castings shall be used under the specifications for steel castings given in the Boiler Code?

Reply: It is the opinion of the committee that unless the Code specifically distinguishes between Class A and Class B, either class is permissible.

Case No. 180—Inquiry: Is it permissible when calculating the maximum allowable pressure on a furnace of a vertical tubular boiler, that is stay-bolted and less than 38 in. in diameter, to determine the pressure that would be allowed under Par. 239 for a plain furnace, then add the pressure which would be allowed according to Par. 199 for the supporting value of stay-bolts?

Reply: It is the opinion of the committee that individual cases and specific diameters of furnaces could be calculated either by Par. 199 or Par. 239; that is, the maximum allowable working pressure cannot be determined by a combination of the two paragraphs.

The A. S. M. E. Boiler Code is at present under revision and the committee will be glad to consider any constructive suggestions.

The following is from a reply to a communication from the Erie City Iron Works requesting the approval of the committee of a design of 148-hp. horizontal water-tube boiler:

Your inquiry of the 6th requesting the opinion of the Boiler Code Committee regarding your new 148-hp. horizontal water-tube boiler has been referred to the committee, and in reply I am directed to advise you that it has been a ruling of the committee for some time past that it will not express opinions on types of boilers, and it will therefore be impossible to comply with your request for an opinion. Yours truly, Calvin W. Rice, secretary.

Power Rate For Electrically Driven Ice Plants*

By Harry B. Joyce†

The increase in the operating cost of ice-manufacturing plants, particularly in the last year, caused by the continually rising fuel prices, the uncertainty of getting fuel at any price, together with unstable and unsatisfactory labor conditions, has forced a number of manufacturers to seek a cheaper source of adequate power and a method of eliminating, at least in part, some of their labor troubles. As electrical power supplied from central stations logically meets both of these conditions, a discussion of the various electrical rates in force in this section of the country, for the operation of these plants, seems opportune.

It is not the intention of this paper to go into the details of or explain the many advantages of electric drive for ice-manufacturing plants, but rather to attempt to present clearly the general principles and conditions of the power rates available.

PLANT MUST BE OPERATED TO FIT THE RATE

To secure the best or even a fair rate per kilowatt-hour for electrical power in most cases, it is impossible to operate the rate to fit the plant; the plant must be operated to fit the rate.

When an ice-plant owner or operator asks, "What is the rate for electrical power?" what he really wants to know is the rate per kilowatt-hour or the power cost per ton of ice. This question in the majority of cases can best be answered by "The best rate you can earn." This depends first on the way one can or will operate the plant; and secondly, on the kilowatt-hour consumption per ton of ice in the particular plant. Both of these items must be determined from the size or sizes of the compressors, the number of cans per ton, feet of pipe per ton, number and size of condensers, temperature of the condensing water, etc.

That it is possible to operate a plant so as to earn an adequate electrical rate per kilowatt-hour is proved by the many plants now operated by electricity.

Practically all the so-called refrigeration and ice-making rates are what is known as "high-tension, high-load factor, off-peak demand rates." That is, the power supplied is alternating current in excess of 2200 volts, the load factor is maintained above a certain definite value, only a limited amount of power can be demanded during certain hours of a day over a period of a year, and the cost is based either in part or wholly on the demand for power and not on the amount of power consumed. Let us therefore take up singly these various items and discuss principally the maximum demand and the electrical load factor, on which the cost of currrent per kilowatt-hour depends practically entirely when operating under this class of rate.

The United Electric Light and Power Co. defines the maximum demand, as do some of the other central stations operating in Greater New York, as the maximum fifteen-minute average demand measured during a period of one week from 12 o'clock midnight Saturday to 12 o'clock midnight the Saturday succeeding; that is, the average power demand is recorded every fifteen minutes, and the highest of these demands so recorded occurring in any week is the maximum demand for that week and on which the bill is rendered.

In other cities different methods of determining the maximum demand are in use, as are the periods of time over which the demands are effective. Buffalo, for instance, uses the highest average demand for two consecutive minutes to apply for a period of one month. In Chicago the maximum demand used is the highest thirty minutes' average demand for the off-peak rate and the highest three-minute average demand for the on-peak rate, both of these demands applying for a period of one month. This contract (Chicago), in addition to the demand charge, makes an energy charge of so much per kilowatt-hour consumed. It provides, however, that if the customer will operate his plant so as to maintain at least a 50 per cent. load factor (which will be defined later) at not less than a 200-kw. maximum demand, the cost of the current will not exceed one cent per kilowatt-hour.

The Public Service Electric Co. of New Jersey determines the maximum demand from inspection and defines it as either 70 per cent., 60 per cent. or 50 per cent. of the connected load, depending on whether this connected load is all in one motor, more than one motor under 50 hp., or more than one motor over 50 hp. Here, also, there is a service charge for each kilowatt-hour consumed and a deduction of 5 per cent. if the customer takes service at a voltage of 2400 volts or higher.

DETERMINING MAXIMUM DEMAND BY DEMAND FACTOR

This method of determining the maximum demand by what is known as the demand factor, or the ratio of the maximum demand to the connected load, is greatly to the ice manufacturer's advantage, as the demand charged is based on 50 per cent. of the connected load, while the actual maximum demand is usually greater than 80 per cent. of the connected load. I know of one plant where, during the hottest months of the year, this demand factor was as high as 135 per cent., which incidentally proves clearly the dependability of the electric motor to carry heavy overloads.

Time will not permit of discussing more of these electrical rates in detail; but practically all rates that apply to this class of service are similar in that they contain practically the same provisions and conditions.

The electrical load factor, which actually determines the cost of current per kilowatt-hour under the demand rate should not be confused with the yearly ice-load factor. The electrical load factor is the ratio of the actual kilowatt-hours consumed during the period of time over which the maximum demand is measured, to the kilowatt-hours the consumer would have used had this maximum demand been used continually during this period. That is, since the charge based on the maximum demand is the same whether or not this maximum demand is used continually, it is readily seen that the longer this demand is maintained during the period, the greater will be the consumption of current at the same cost and consequently the cheaper the current per kilowatt-hour; in other words, the higher the electrical load factor the less the cost of current per kilowatt-hour and consequently the cheaper the ice.

I might also mention that the shorter the period of time over which the maximum demand is measured, the more it is possible to maintain this higher electrical load factor. It is much easier to maintain a constant or nearly constant load, and consequently load factor, for a week than it is for a month, and it is easier to do this for a month than for a year. Central-station records show that in a properly designed and operated plant, a weekly load factor of from 85 to 93 per cent. is easily maintained; also that a monthly load factor of from 80 to 90 per cent. can be maintained during the summer months and from 60 to 80 per cent. during the winter months, while the yearly load factor will vary from 35 to 60 per cent.

Some of the central-station companies, in addition to the demand charge for this class of service, make an addition or reduction to adjust the primary rate according to the price of coal. For instance, the companies operating in Greater New York now make an additional charge or deduction of 0.035c. for each 10 per cent. increase or decrease in the price of coal above or below $3 per long ton f.o.b. New York Harbor. This additional coal charge, however, as far as I can learn, is made only by the companies who base their rates entirely on the maximum demand and make no additional charge for the energy consumed.

By the term "off-peak" as related to rates is meant that the rates are made with the provision that only a limited amount of power will be demanded during certain hours of

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*Paper read before the Eastern Ice Association, Atlantic City, November, 1917.

†Power engineer, United Electric Light and Power Co., New York City.

the day, over that portion of the year when the central stations are carrying their greatest load. This is usually either from 4 p.m. to 8 p.m. or from 4:30 p.m. to 8:30 p.m. during the months of November, December, January and February. The power demand during this time is limited usually to from 10 to 20 per cent. of the highest previous maximum demand of the year. These values, it has been found, are sufficiently high to permit the operation of the lights and auxiliaries, and even to provide the operation of a small compressor while the large machines are shut down.

Should this specified demand be exceeded during these hours, a penalty charge is made for each kilowatt of demand in excess of that specified or a special rate is put into effect.

As far as I can learn, all these rates, with the exception of the Chicago rates, are high-tension rates; that is, the power is supplied at a voltage of 2200 or higher, and the customer must furnish his own transformers where it is necessary to have a lower voltage for the operation of any or all of his motors and, of course, for his light.

Some of the central-station companies have incorporated in their contracts such provisions as a guaranteed load factor, a guaranteed demand factor, etc., while others make an addition or deduction if the line power factor is below or above a certain definite value. I think it has been shown that it works no hardship, but that the ice manufacturer must maintain as high an electrical load factor and demand factor as is possible to earn a reasonable rate. As for a reduction in rate for maintaining a high power factor, this can easily be done by the use of synchronous motors on the compressors, which will permit of maintaining practically any power factor desired.

SUMMARY

Let me summarize what I believe to be the safest and most accurate way to predetermine or estimate the power cost per ton of ice when it is decided to change to electric drive. First determine the number of kilowatt-hours necessary per ton of ice and what changes will be necessary to operate your plant at a constant or nearly constant load for the time over which the maximum demand will be measured. Then have the central-station representative of the district advise what the average load factor is for similar plants operating in the neighborhood, also the cost of current per kilowatt-hour at this load factor under the rate according to which your plant will operate.

I believe that many, particularly those who are operating plants in the larger cities where central-station electric power is available, will be figuring on this question within the next year or two. At this time last year, there was not an electrically operated ice-manufacturing plant on Manhattan Island. Today there is one in operation, five plants being changed over from either steam- or oil-engine drive, and one new plant in the course of erection.

If it is my privilege to attend this convention next year, I hope to be able to present some very interesting figures on the operation of these plants, all of which are different not only in capacity, but also in the number of cans used per ton, feet of pipe per ton, size and number of condensers, some using cooling towers, some wells, and others river water. I hope at that time to be able to show that although all these factors affect in one way or another the necessary kilowatt-hours per ton of ice, a high load factor and consequent low cost of current per kilowatt-hour can be maintained, under all of the foregoing conditions, if the plants are properly operated.

Message to German Business Men

The Chamber of Commerce of the United States has sent to its members a referendum which is designed to ascertain whether American business men desire to notify German business men that they will not trade with them after the war unless the German government is made responsible to the German people. The National Chamber announces that 500,000 American business men are now voting on this question through national commercial organizations that are members of the National Chamber.

The referendum is the suggestion of the Boston Chamber of Commerce, and if it is adopted by the members of the National Chamber, it is hoped to communicate its result to German business men through international chambers of commerce and through German business men who are now visiting Switzerland, Holland, Denmark, Sweden and other neutral countries. Announcement by the National Chamber in regard to the referendum says: "The message cannot fail of its purposes, as Germany cannot hope for years to come to reëstablish satisfactory trade relations with Great Britain, Italy or France."

The message on which the vote is being taken is as follows:

Whereas, The size of Germany's present armament and her militaristic attitude have been due to the fact that her government is a military autocracy, not responsible to the German people; and

Whereas, The size of the German armament after the war will be the measure of the greatness of the armament forced on all nations; and

Whereas, Careful analysis of economic conditions shows that the size of Germany's future armament will fundamentally depend on her after-war receipts of raw materials and profits from her foreign trade; and

Whereas, in our opinion the American people for the purpose of preventing an excessive armament will assuredly enter an economic combination against Germany if governmental conditions in Germany make it necessary for self-defense; and

Whereas, We believe the American people will not join in discrimination against German goods after the war if the danger of excessive armament has been removed by the fact that the German government has in reality become a responsible instrument controlled by the German people; therefore, be it

Resolved, That the Chamber of Commerce of the United States of America earnestly calls the attention of the business men of Germany to these conditions and urges them also to study this situation and to coöperate to the end that a disastrous economic war may be averted and that a lasting peace may be made more certain.

Economizer Explosion Kills One Man

By the explosion of an economizer at the Remington, N. Y., "Short Line" power plant, one man was killed and the electric power and lighting circuits supplied by the plant were put out of service. The accident occurred a little after 10 o'clock on the night of Dec. 28. According to the newspaper account, the cause of the explosion is not known. It is stated, however, that earlier in the evening the power was shut off at the plant for more than an hour because of a leak in a valve on the economizer. That was repaired and electric service was resumed, when shortly afterward the economizer exploded.

The man who was killed was a water tender, and it is assumed from the position in which he was found that he was quite close to the economizer when the explosion occurred, as he was buried beneath the wreckage. One of the firemen in the boiler room was taken to the hospital.

Two of the seven boilers were damaged. These boilers were housed in a wooden frame building, the end of which was blown out and the boiler house more or less wrecked. Details of the accident will be published as soon as the facts can be obtained.

Christopher W. Levalley

Christopher W. Levalley, founder and chairman of the board of directors of the Chain Belt Co., died suddenly of heart failure at his home in Milwaukee, on Friday, Jan. 4. He was born at Manchester, Conn., in April, 1835, receiving his education in the schools there. When 14 years old he moved to Hartford, Conn., where he served an apprenticeship in a machine shop. At the outbreak of the Civil War he enlisted in the army. Following the war he went to St. Paul as superintendent of the St. Paul Harvester Co., later becoming general manager. It was at this time that he saw the necessity of a positive drive for harvesting machinery, and in 1891 he moved to Milwaukee, where he established the Chain Belt Co. In 1907 Mr. Levalley conceived the idea of driving a concrete mixer with a steel chain and using a cast semisteel drum. These ideas were incorporated in what was known then as the Chain Belt Mixer, but which name has since been changed to Rex Mixer.

Mr. Levalley would have been 83 years old in April had he lived. From 1891 until 1916 he was president and general manager of the Chain Belt Co. In 1916 he was elected chairman of the board of directors and held this position up to the time of his death. He was also interested in the C. O. Bartlett & Snow Co., of Cleveland, and the Federal Malleable Co., of Milwaukee. He was a donor of many gifts to charitable institutions and only within the past year gave $100,000 to the Milwaukee Foundation.

Wartime Lubrication Economy

An example of lubrication economy is that of a large, well-equipped and well-managed plant in Boston. During the year preceding an investigation to cut the costs, the plant used 18,500 gal. of various oils with a total lubrication cost of $4425. Under the system used barrels of oil were distributed through the plant, and several were found to be leaking. The remedy was the construction of a central oilhouse containing metal tanks provided with key faucets. Much loss was also due to wiping up of engine frames and floors with waste, then thrown away or burned. To check this loss, an oil- and waste-saving machine was installed. This reclaimed considerable oil, and the waste could be reused many times. Cost of lubrication dropped from $4425 to $2570 within one year, a saving of almost 42 per cent.—*The Wall Street Journal Straws.*

What Power Did for a Dry Dock

To operate the dock of the New Orleans Dry Dock and Shipbuilding Co. by hand required the services of 64 men at an average cost of 25c. per hour per man, and the best time made was two hours for a small vessel. The dock has just been equipped by S. J. Stewart with eight motors, which make use of the old-style sucker pumps formerly operated by hand, by the use of which they are now able to make a lift in half an hour with the consumption of about $3 worth of current.

New Publications

THE DETERMINATION OF ABSOLUTE VISCOSITY BY SHORT-TUBE VISCOSIMETERS. Technologic paper, No. 100. Published by the Bureau of Standards, Washington, D. C. Size, 7 x 10 in.; 55 pages.

This publication reviews briefly the literature relating to the determination of viscosity and gives the results of further experimental work that has been done. The conclusion is reached that water is not a suitable liquid to use in finding the relation between the viscosity and the time of discharge for short-tube viscosimeters, and that Ubbelohde's equation and all others based on it are seriously in error. The paper is now ready for distribution, and those interested may obtain a copy by addressing a request to the Bureau.

Miscellaneous News

Regulation of Coal Exports during 1918 announced by the Fuel Administration limits shipments strictly to war uses.

A Boiler Flue Blew Out at the Barnet leather plant, at Little Falls, N. Y., on Dec. 31, severely scalding two men who were in the boiler room at the time of the accident.

The Boiler of a Pennsylvania R.R. engine attached to a freight car exploded at Metuchen, N. J., on Jan. 8, seriously injuring two men, one of whom died a few hours later in a hospital.

The Power House and Machinery of the municipal light and water plant at Marlington, W. Va., were destroyed by fire on Jan. 8. The fire was discovered over the boiler room. The cause is unknown.

A Boiler Explosion wrecked the Home Laundry at Delaware, Ohio, on Jan. 8 and decapitated the proprietor, T. E. Fox. The explosion occurred when Fox turned cold water into the empty tubes of the boiler, under which a hot fire was burning.

Flywheel Explosion at Hawarden, Iowa—Operation of the Hawarden, Iowa, municipal electric plant was interrupted for a time when the flywheel of one of the engines driving a generator exploded on the night of Jan. 2. Damage to the building was confined mostly to the walls opposite the flywheel and to the roof above it. It will cost about $4000 to repair the damage done to the engine and buildings. Temporary service was obtained from a reserve engine as soon as it could be put in running order. Fortunately, no one was injured.

Obituary

Malcolm Alexander, formerly superintendent of the old Brooklyn Union Gas Co., with which he was connected for thirty years, and later in the harbor transportation business, died at his home in Brooklyn on Jan. 11, at the age of 88 years. He was a native of Glasgow, Scotland.

Personals

E. B. Craft, W. F. Hendry and E. H. Colpitts have been appointed assistant engineers of the Western Electric Co.

Franklin T. Chapman, formerly connected with the Olympian Motors Co., of Pontiac, Mich., is now assistant general sales manager of E. F. Houghton & Co., Philadelphia, Penn.

Harry V. Hunt has resigned as superintendent of the Hooven, Owens, Rentschler Co., at Hamilton, Ohio, to accept the position of general superintendent of the Consolidated Press Co., at Hastings, Michigan.

J. S. Pandiani, formerly manager of the meter and supply department of the Italian Westinghouse Co., is now the Italian trade representative of the Esterline Co., of Indianapolis, Ind., with headquarters at Via Mario Pagano 27, Milano.

Russell T. Gray, formerly advertising manager of the Haynes Automobile Co., and more recently secretary of the Shuman Advertising Co., has opened an office in the First National Bank Building, Chicago, as an advertising engineer. Advertising service will be rendered a limited number of clients in the technical field. Technical advertising in trade papers and magazines as well as all forms of engineering catalogs and direct-by-mail advertising will be handled.

Engineering Affairs

The National Association of Stationary Engineers, No. 9, of Atlantic City, will hold its sixth annual banquet and entertainment at the Wiltshire Hotel, on Saturday evening, Jan. 26.

The Boston Section of the A. S. M. E. will give a reception to Charles T. Main, the new president of the American Society of Mechanical Engineers at the Engineers' Club, Boston, Mass., Tuesday evening, Jan. 22. This will be one of the big events of the Boston Section this season. Prof. Lionel S. Marks will speak briefly on the career of Mr. Main. H. C. Balch, of the Boston "Transcript," just back from France, will speak on "Engineering at the Front," as he saw it.

The Association of Iron and Steel Electrical Engineers has announced the following meetings: The Cleveland Section on Jan. 26, subject not yet announced. The Philadelphia Section on Feb. 2, at which H. G. Steele, of the Pittsburgh Transformer Co., will speak on "Mill Type Transformers." The Pittsburgh Section will meet on Feb. 16 at the Hotel Chatham, at which David L. Lindquist, chief engineer of the Otis Elevator Co., will present a paper on "A. C. and D. C. Skip by Hoists."

The Aldred Lectures at Johns Hopkins University—Through the generosity of J. E. Aldred there has been founded in the Department of Engineering of Johns Hopkins University, of Baltimore, a course of lectures on "Engineering Practice." The lectures will deal with the practical phases of engineering problems, rather than with theory, and will consist of three lectures each on general subjects in civil, electrical and mechanical engineering. They are given on Wednesday evenings at 8 o'clock, in the auditorium of the Civil Engineering Building. Those of particular interest to "Power" readers are "Steam-Electric Power Plant Design," given on Jan. 16 by A. S. Loizeaux, electrical engineer of the Consolidated Gas, Electric Light and Power Co., of Baltimore; and "Coal and Its Combustion in Boiler Furnaces," by E. G. Bailey, president of the Bailey Meter Co., Boston, to be given Mar. 13. The lectures are open to the public.

New York Engineers Granted Charter—The New York Chapter of the American Association of Engineers was established on Wednesday evening, Jan. 16, at the Hotel McAlpin, when the charter granted by the national organization was formally presented by President Edmund T. Perkins. The keynote of the meeting was sounded by Mr. Perkins, the principal speaker, with the subject, "The Engineer's Relation to Society." He urged the men to broaden their social and civic activities and to pay more attention to the human equation in engineering. Alexander Potter complimented the association on its national success with the problems relating to the human and business side of the engineering profession. A. H. Krom, general secretary of the A. A. E., gave a summary of the activities of the national organization and urged the members to promote the work and coöperate with all technical societies as well as to acquaint engineers with the fact that this is a business organization in a field of its own and which conflicts with none. E. J. Mehren, editor of the Engineering News-Record; S. J. Stone, A. C. Davis and others put forward valuable suggestions during the discussion. The New York office is at 220 West 42nd St., and the officers are: R. H. Vanderbrook, chairman; I. L. Birne, secretary.

Trade Catalogs

Link-Belt Silent Chain for Rubber Mill Machinery. Link-Belt Co., 39th St., Stewart Ave., Chicago, Ill. Book No. 299. Pp. 24; 6 x 9 in.; illustrated.

"Hydro" Gas Meters. Bacharach Instrument Co., Pittsburgh, Penn. Catalog E. Pp. 12; 6 x 9 in.; illustrated. This contains information on the various methods employed in the measuring of gases and shows the application of these meters to producer plants, gas works, etc.

How Anyone Can Make a Jointless, Gastight Furnace Lining is the title of a booklet issued by the Betson Plastic Fire Brick Co., Rome, N. Y., showing how "plastic fire-brick" made by this concern is used in forming one-piece linings for steel boiler furnaces. Pp. 16; 3½ x 6 in.; illustrated.

Smooth-On Instruction Book No. 16. Smooth-On Manufacturing Co., Jersey City, N. J. Pp. 16; 3½ x 6 in.; illustrated. This describes various cements for repairing breaks or leaks in iron pipes, castings, etc., and contains the standard sizes of Smooth-On coated corrugated gaskets for flanged pipes from 2 in. up to 26 inches.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows.

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago
Buckwheat	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago
Clearfields	....	$3.00	......	$4.25—5.00
Cambrias and Somersets	....	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4 as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60 †Water coal

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 17 1918	One Year Ago	Jan. 17, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.00—7.25
Buckwheat	4.30—5.00	2.75	5.50—6.00	6.50—7.00
Rice	3.75—3.95	2.20	4.50—5.00	4.50—5.00
Barley	3.25—3.50	1.95	3.50—4.00	3.25—3.50
Boiler	3.50—3.75	2.20	....	......

Bituminous smithing coal, $4.50—5.25 f.o.b.
Quotations at the upper ports are about 5c. higher

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Jan. 17, 1918	One Year Ago		Jan. 17, 1918	One Year Ago
Buckwheat	$3.15-3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65-3.65	1.25	3.65	2.15	3.35
Boiler	2.45-2.85	1.10	3.55	2.00	....
Barley	2.15-2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago	Jan. 17, 1918	One Year Ago
6-in. lump	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3-3.25	$2.65-2.80	$2.50-2.75
2-in. lump	2.65-2.80	......	2.65-2.80	......	2.65-2.80	2.25-2.50
Steam egg	2.65-2.80	....	2.65-2.80	3-3.25	2.65-2.80	2.25-2.50
Mine-run	2.40-2.55	3.00-3.25	2.40-2.55	3-3.25	2.40-2.55	2.25-2.50
No. 1 nut	3.65-2.80	......	2.65-2.80	......	2.65-2.80	......
2-in. screen	......	3.00-3.25	2.15-2.30	......	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75	2.15-2.30	....

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

PROPOSED CONSTRUCTION

Calif., Los Angeles—The Nevada-Calif. Power Co., Riverside, plans to build about 300 miles of voltage line. About $300,000. C. O. Poole, Riverside, Ch. Engr.

D. C., Wash.—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at various Navy Yards under Schedule No. 1653, 30 sets of motor generators.

Ga., Waynesboro—City plans extensive improvements to its electric-lighting plant, including the installation of one 200-hp. boiler, and one 100-kw., 3-phase, 60-cycle, 2300-volt generating unit directly connected with a switchboard, complete. J. C. Andrews, Supt.

Ill., Chicago—The Lincoln Park Commissioners plan to install a 500-kw., 3-phase, 2300-4000-volt turbo-generator for heating system. C. H. Shepherd, Electrical Engr.

Iowa, Emmetsburg—The Northern Iowa Gas and Electric Co. plans to extend its electric transmission line from here to Dickens. R. J. Mullins, Mgr.

Kan., Sabetha—The City Council plans to change the equipment of the entire electric-lighting plant from single to 3-phase system. C. A. Darby, City Engr.

Ky., Guthrie—The South Kentucky Power Co. plans to build an electric transmission line from here to Lebanon, Tenn. A. F Trimble, Mgr.

La., Kenner—City plans to issue $10,000 bonds for improvements to its electric-lighting plant. P. Felix, Mayor.

Md., Rising Sun—City has sold $8000 bonds and plans to improve its electric-lighting plant with the proceeds.

Mass., Cambridge—The Cambridge Electric Light Co. plans extensive improvements including the installation of a 12,500-kw. turbine, two 600-hp. boilers, an ash-handling system and the extension of its switchboard. W. E. Holmes, Newton, Gen. Mgr.

Mass., Gardiner—The Gardner Electric Light Co. plans to install an additional 1500-kw. bank of transformers. C. A. Ware, Mgr.

Mass., Hudson—The Town plans to install a new 600-kw. turbine with a condenser and an additional boiler in its electric-lighting plant. G. A. Brothers, Mgr.

Mass., Pittsfield—The Pittsfield Electric Co. plans to install a 2500-kw. General Electric turbo-generator and two 520-hp. Babcock & Wilcox boilers. W. A. Whittlesey, Supt.

Mich., Sturgis—The Board of Public Works plans to install a 500-kw. auxiliary generating unit. J. S. Flanders, Mgr.

Mo., Cameron—The City Council plans to improve its electric-lighting plant.

N. Y., New York—The Electric Reduction Co., 50 East 41st St., has increased its capital stock from $100,000 to $200,000; the proceeds will be used for additions and improvements.

N. C., Southern Pines—J. T. Patrick is in the market for second-hand electrical machinery in good condition, from about 25 to 50 hp., for water-power development.

Okla., Chandler—The Chandler Electric Co. plans to build a new power house and install equipment. H. G. Stettmund, Jr., Mgr.

Okla., Hooker—City plans to issue bonds for the erection of an electric-lighting plant to replace the one which was destroyed by fire. Loss, $22,000.

Wash., Seattle—The City Council plans to build a substation for the Light Department on B 166, Gilman Park addition. About $20,000. A. H. Dimock, City Engr.

Wis., Amherst—The Amherst Electric Service Co. recently incorporated, plans to build an electric-lighting plant. B. E. Dwinnell, interested.

Wis., Sheboygen—The Badger State Tanning Co. is having plans prepared by Juul & Sixta, Arch., 805 North 8th St., for the erection of an addition to its power house.

Wis., Stebbinsville—The Porter Electric Line Co. recently incorporated, plans to develop the water power and furnish electricity to the rural district here. F. Miller, Pres.

Ont., Port Colborne—A. E. Augustine, Box 116, is in the market for a 15-hp electric motor with starter.

Ont., Toronto—The Swift Canadian Co., Keele St., is in the market for a 50-hp. locomotive-type boiler.

Ont., Trenton—The Hydro-Electric Power Commission, Toronto, plans to build a transmisison line through the towns of Picton, Wellington and Bloomfield in Prince Edward County; also a 4000-volt transmission line from Bloomfield to Wellington, for which 2 substations will be built. F. A. Jaby, Ch. Engr.

Ont., Windsor—The City Commissioners plan to install 2 new electrically driven pumps in its pumping plant.

Que., Valleyfield—The Montreal Cotton Co. plans to rebuild its power plant which was recently destroyed by fire. Loss $100,000.

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[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, JANUARY 29, 1918 No. 5

Fooling One's Self

Contributed by R. B. DALE

THE EASIEST PERSON in the world to fool is one's self. There is a very good, logical reason for this. As a matter of fact, most of us believe just what we want to believe. The engineer, of all men, because of his training and experience, should be more proof against this mistake than others. The engineer learns to base his decision on facts. Business life today presents some very unpleasant awakenings for the man who bases his convictions on impressions rather than on facts and principles. The engineer marshals the facts together, estimates their value and reasons logically therefrom. Such a man is not likely to be in the wrong very often.

The Irishman who took off his coat, rolled up his sleeves and stated that he would like to see the man who could convince him that he was wrong, evidently was not very anxious to be convinced. Fooling one's self is a popular game. The man who really wants to know whether or not he is fooling himself uses every possible means to test his ideas. He who could lick the big Irishman would not necessarily prove that the Irishman was in the wrong, but the premise would be in that direction. Because the expert scorns your favorite idea, it does not necessarily follow that you are entirely wrong, but it does mean that you must put it to the most rigid test.

THE OTHER DAY a man put a little white powder in a pail of water and then threw the water on some coal that he put in the furnace. He wanted the dope to make good. He wanted it so badly that he did everything in his power to create favorable conditions. He had a better fire. He made less smoke. He made more steam with less coal. He thought it was the dope that caused the improvement. As long as the white powder lasted that fireman had wonderful results, but as soon as it was gone he unconsciously went back to his old, slipshod methods of firing. That man was fooling himself. He would have done even better without the dope had he taken the trouble to improve his methods.

Another man had an idea that he could get remarkable efficiency out of a boiler plant by preheating the feed water in a separately fired heater. He wanted his scheme to succeed, an therefore he used every means in his power to make it succeed. He created favorable furnace conditions. He watched the apparatus with great care and directed its entire operation. He got increased efficiency, but he did not stop to consider where it came from. Experts told him that if he had used the same careful methods, he would have gotten similar results, heater or no heater. He was fooling himself.

DO YOU BELIEVE the methods in your plant cannot be improved upon? Do you think that you cannot get more power with less coal than your records now show? That's where you fool yourself. There are no methods so good that they cannot be made better. It has been asserted that about one-quarter of the coal burned is wasted. How much do you contribute to that waste?

Are you doing the best that can possibly be done with the facilities and equipment at hand? Of course you think you are and that is fine, but how about improving the equipment? The "old man" won't be convinced. That's where you fool yourself. Business men were never so eager to install coal-saving and money-saving equipment as they are today. Have you tried to put the matter before him in a clear-cut, logical way, and have you proved to him what savings might be made with the new facilities?

Are you fooling yourself?

Turn the searchlight of investigation on your own methods. It will pay.

Condensers with Seventy-Foot Water Level Variation

By F. R. Brosius

These condenser wells are five in number. The intake well is 86 ft. deep and 60 ft. diameter. Two condenser wells will contain all the condensing equipment; each is 84 ft. deep and 68 ft. diameter. The two discharge wells are 17 ft. diameter. These wells are necessarily deep owing to the fluctuating water in the Ohio River, which is about 70 ft. between extreme low- and extreme high-water levels.

THE most interesting and unusual feature of the West End Power Station of the Union Gas and Electric Co., of Cincinnati, Ohio, which is now nearing completion under the supervision of Sargent & Lundy, is the type of substructure construction adopted to assure a satisfactory supply of condensing water under unfavorable conditions and to support the great weight of the building and equipment on unstable ground.

The site chosen for the station was the location of the company's old artificial gas plant, which was abandoned when natural gas was brought to Cincinnati and which had to be torn down before the new station could be built. This location is on the north bank of the Ohio River, which at this point fluctuates in level about 70 ft., due to spring floods in the valley above Cincinnati. At the extreme high-water mark, the gas-works tract was covered with six to eight feet of water. The ground consists of a fill of cinders, slag, etc., about fifty feet deep, resting on native sand and gravel at an elevation of approximately 440 ft.—making the surface approximately 490 ft. above sea level.

FIG. 1. CONDENSER WELLS BELOW TURBINE ROOM

Obviously, under such conditions the conventional arrangement of the turbine-room equipment would not be feasible, because of the excessive lift of condensing water that would be required under normal operating conditions—that is, at all times except during flood stage of the river—if the equipment were placed high enough to be safe from water at all times. To overcome this obstacle, the construction described in the following paragraphs was used.

The building is constructed with a river wall tangent to a chord of the harbor line drawn to the property line, the harbor line at this point being an arc of a circle of 4077.56 ft. radius. The turbine room is on the river side of the building, with its basement floor at an elevation of 502 ft. 15 in. above sea level and the main turbine-room floor at an elevation of 516 ft. The boiler room is north of the turbine room, with the basement floor 504 ft. and the main floor 522 ft. above sea level.

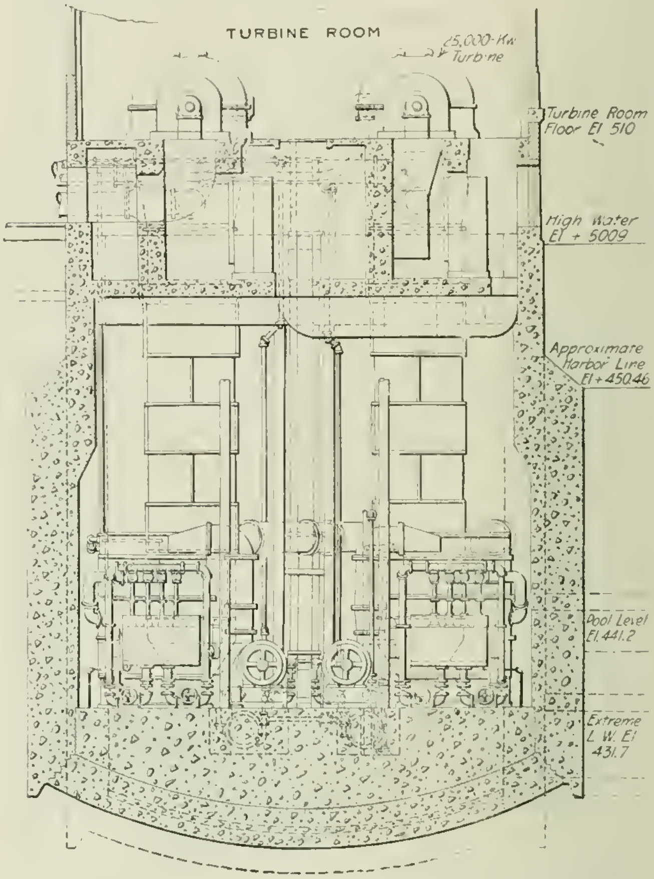

FIG. 2. CROSS-SECTION OF THE WEST CONDENSER WELL

To provide for water, five wells were sunk below the turbine room, arranged as shown in Fig. 1. The center one is the intake well; on either side of it is a condenser well, and between each condenser well and the intake well there is a discharge well, Fig. 3. Tunnels run from the river into the intake well and from the discharge wells into the river bed.

The intake well is 86 ft. deep from the basement floor to the well floor and is 60 ft. inside diameter. This depth brings the bottom of the well to a level approximately 16 ft. lower than the extreme low-water mark, assuring a plentiful supply of water under all river conditions. It has solid reinforced-concrete walls, 6 ft. thick, from the bottom of the well to the basement floor. This well contains a heavy bar-iron grill to remove the coarser débris floating in the river, and behind the grill traveling screens remove any rubbish not caught by the grill. A set of stationary screens is also provided to supplement the traveling screens when necessary. The intake tunnel leads into the bottom of this well. It is 163 ft. long from the river bed to the wall of the well and is 25 ft. high by 10 ft. wide inside, with reinforced-concrete walls 2 ft. 6 in. thick. The mouth of this tunnel opens into the river on the slope of the harbor line, avoiding any projection into the river, and is supported on piling to prevent any damage due to undercutting by the river. The river bed for a radius of 25 ft. from the tunnel mouth is riprapped to prevent erosion.

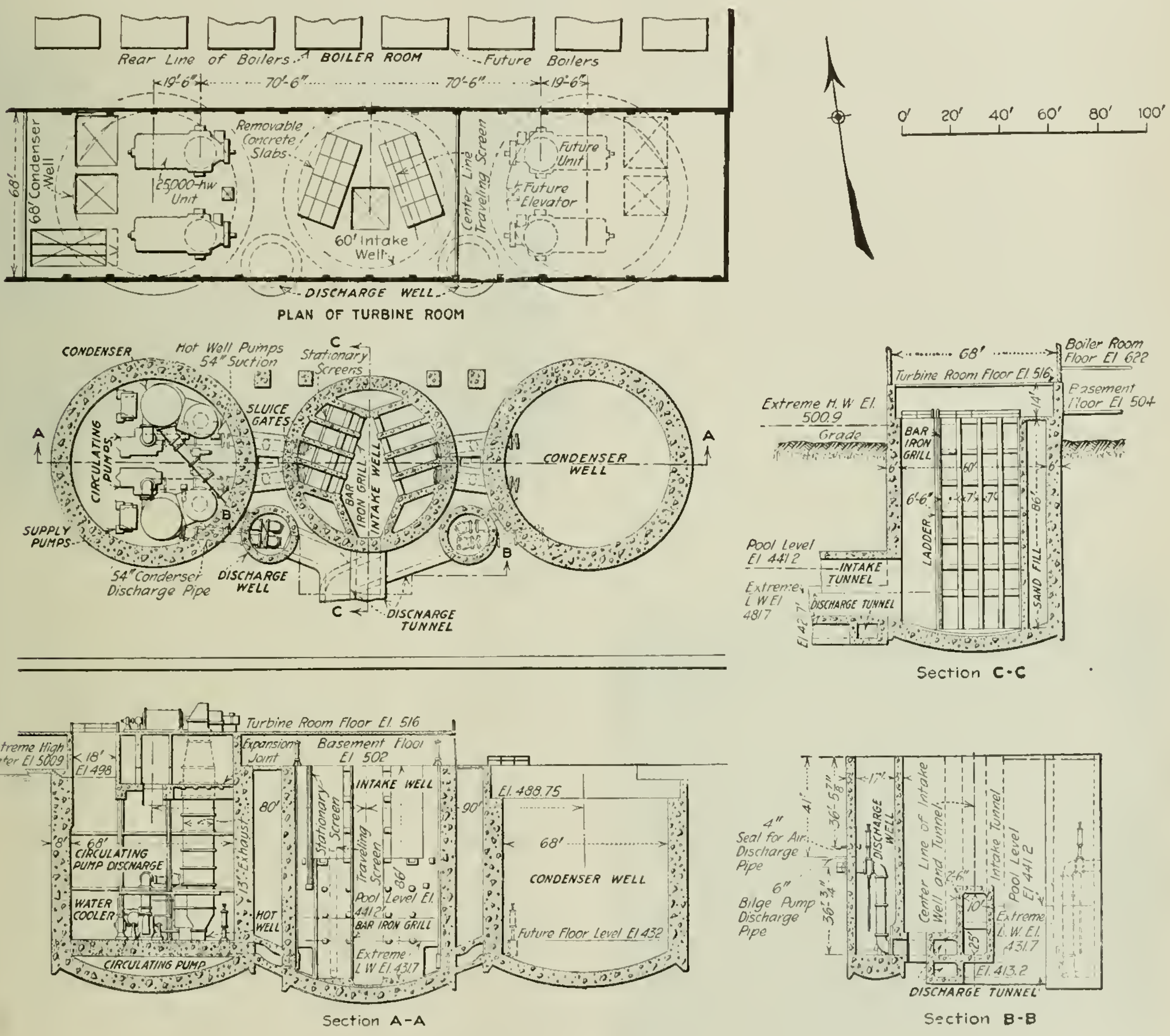

FIG. 3. PLAN AND SECTION OF CONDENSER AND INTAKE WELLS

The condenser wells are each 68 ft. inside diameter and 84 ft. deep from the basement floor, and are watertight to a point above the flood stage of the river. The floors of these wells are of solid concrete 16 ft. thick at the walls and 30 ft. thick in the center, and the walls are of reinforced concrete 8 ft. thick. The west condenser well only is used for the initial installation of two 25,000-kw. turbo-generators, Fig. 2, the east well being reserved for a future increase in the capacity of the plant. This well contains all the condensing equipment for the two turbines, which exhaust through pipes 13 ft. in diameter and 62 ft. long into vertical condensers, each with 52,000 sq.ft. of cooling surface. These condensers and all auxiliaries and sump pumps are placed on the floor of the well, which is 68 ft. below extreme high water.

The discharge wells are 17 ft. inside diameter, with walls 3 ft. thick. As with the condenser wells, only the west discharge well is used for the first installation. Two discharge pipes from the west condenser well enter the discharge well at the level of the top of the condensers and drop to the bottom of the well, where they are sealed into the end of the west branch of the discharge tunnel. Two tunnels, 6 x 10 ft. inside, one from each discharge well, meet at a point south of the intake well and below and west of the intake tunnel, and form a single discharge tunnel 10 x 10 ft. inside, with walls 2 ft. 6 in. thick, which extends 214 ft. in a downstream direction from the intersection, into the river. The construction of the mouth of this tunnel is similar to that of the intake tunnel.

In the operation of the plant condensing water will be drawn through the intake tunnel into the intake well, where all foreign matter will be removed from the water by a grill and screens. It will then pass through 54-in. suction pipes extending from the intake well through the floor of the condenser well to the circulating pumps, then through the condensers and in 54-in. discharge pipes to the discharge well, and back into the river through the discharge tunnel. The entire water system from the point where the water enters the suction pipes in the intake well to where it leaves the discharge tunnel in the river is a closed siphon, thus making any lift of water by the circulating pumps unnecessary and making their only duty that of overcoming friction in the piping and condenser tubes.

The method used for sinking the three larger wells is of interest in itself. An excavation about ten feet deep and with a diameter greater than that of the well was made on the site of the well, and a circular steel shoe, or cutting edge, made of 12-in channels laid flat with plates riveted to the outer flange, with its outside diameter the same as that of the well to be sunk, was set up on the bottom of the excavation. Concrete forms were then set up on the shoe, arranged for concrete the width of the shoe at the bottom and then by 12-in. steps reaching the full thickness of the wall. Concrete was then poured in to make a ring 12 ft. high. When this had set, the forms were removed and the excavation continued inside the ring, allowing the ring to sink of its own weight. By continuing this process of alternately building the ring higher and then excavating and allowing it to settle, the well was sunk to the desired depth. When this had been reached, water was let in the well and the inverted dome-shaped bottom concreted under water by the use of a submarine bucket. Then, when this had set thoroughly, the water was pumped out and the remainder of the concrete bottom put in. The discharge wells were started in the same way as the larger wells, but were finished as closed caissons under air pressure. Figs. 4 and 5 are views of the interior and exterior of the wells respectively.

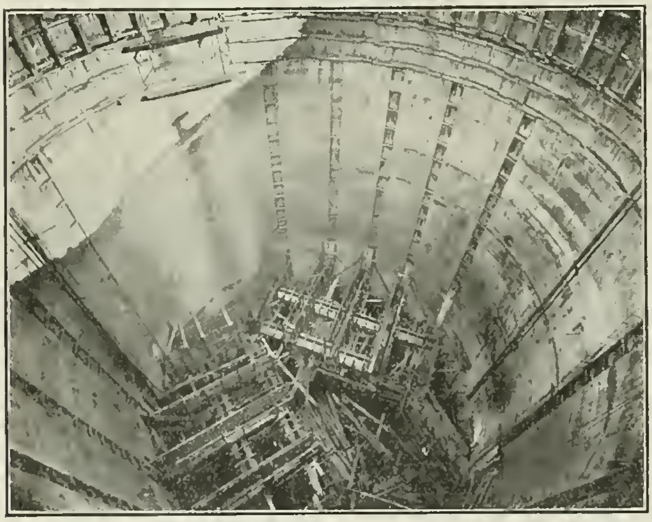

FIG. 4. INTERIOR VIEW OF ONE OF THE WELLS

Part of the weight of the turbine room rests on these wells. The rest of the weight of the building and equipment is supported by nine rows of concrete piers, which were sunk to firm native bed gravel, at depths varying from sixty to eighty feet below the surface of the filled ground.

In this article only a description of the system of wells has been attempted, as a detailed story of the entire plant will be published when it reaches completion. The writer acknowledges his indebtedness to the engineers of Sargent & Lundy, who planned the station, and of the Foundation Co., who built the plant, for their coöperation and assistance in preparing this article, and to C. R. McKay, consulting engineer for the Union Gas and Electric Co., for the photographs reproduced herewith.

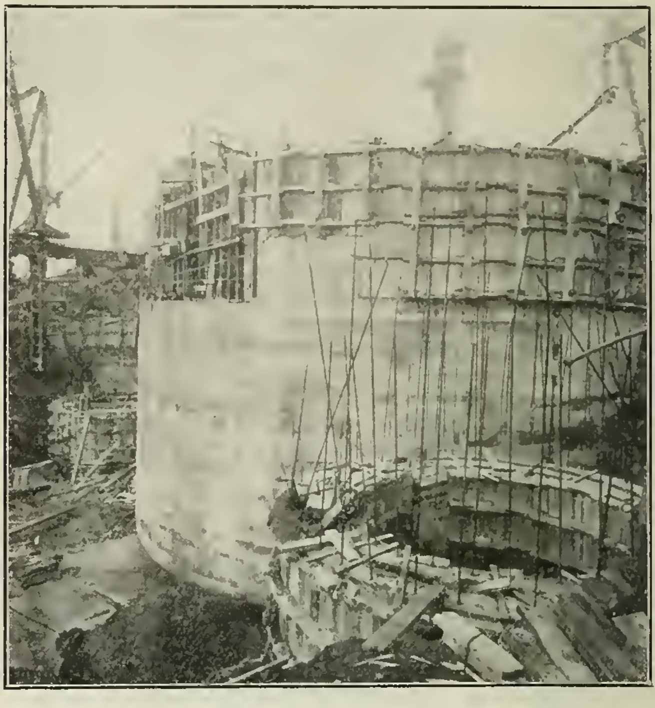

FIG. 5. EXTERIOR OF WELLS, SHOWING FORMS IN POSITION

Abstracts from an Engineer's Letters

Dear Friend—Replying to your inquiry as to whether "the design of a boiler joint can be brought out so a common, everyday engineer and fireman can make it out without the use of so many letters and combinations of letters that the whole matter is befogged," I will say of course it can, but the use of letters is more convenient when you get accustomed to them. In justification of the use of letters and their combination into groups, it may be said that almost every engineer or fireman does exactly the same thing in his daily conversation, where no effort is expended in writing it out and no valuable space is used up on a printed page. It is simply a short mode of expression. He hails his mate as "Bill" instead of Mr. William Muldowney, for example. The only thing necessary is a mutual understanding of just who is meant when "Bill" is called; for if there are others of the same name, there must be some other distinguishing name or letter and in many places the true initials are used, as "Hello, B. M."

One of the first expressions met with in the discussion of the boiler and boiler joint is the "tensile strength" of the plates or the material entering into boiler construction subjected to tension. If, however, the expression is to be frequently used, the initial T (sometimes TS) is used instead of the full name, as in the case of "Bill." Of course it must be known what the term tensile strength (T) means or stands for, but that is easy. If a bar of any material of convenient length is stressed (pulled) in the direction of its length with sufficient force, it will of course pull apart, and with means of measuring the extent of the force applied (pounds pull) the total force is known. An ordinary spring balance may be used to test the force necessary to break a small cotton cord and be satisfactory for that particular cord, but for comparison with cord of another material the size (thickness) of each must be known, so in testing the "T" of iron and steel the standard unit of one square inch has been adopted.

Therefore T is understood to represent the stress in pounds required to pull apart a bar of one inch square section, or its equivalent, which may be a bar one-half inch thick and two inches wide or any such combination of dimensions. Furthermore, the test piece does not necessarily have to be equal to one square inch so long as its actual measurement is known, for if it equals one-half a square inch (not, however, one-half inch square, or measuring one-half inch on each face, which would be only one-fourth of a square inch) and withstands one-half the strain that a bar one inch square does, their T is the same. If the plates from which a boiler is made are not good (low T), evidently its ability to resist the steam pressure which tends to pull the fibers apart will be correspondingly less.

Taking, for an experiment in the design of a riveted joint, a couple of strips of plate 10 in. wide and ½ in. thick and stamped T 60,000, the solid plate would be expected to pull apart at $60{,}000 \times 10 \times \frac{1}{2} = 300{,}000$ lb., since there are 5 sq.in. area times (T) 60,000. But since it is necessary to drill holes in the ends to joint the pieces together, it is obvious that the total strength of the sample will be correspondingly less. The question then arises, How many holes will it be necessary to drill and what size? If five 1-in. holes are drilled in a line, then one-half of the width of the sample is cut away and the "net section of the plate" is only 50 per cent. of the original, and therefore the joint at best can only be one-half, or 50 per cent., as strong as the plate. Besides that, How about the rivets? Suppose rivets made of lead are used, the joint will not stand much of a pull because the lead will shear off easily. A quality, then, that the rivet material should possess is resistance to shearing action. This is designated as S (just another fellow's initial), so S = shearing strength and its value is anywhere from 35,000 to about 42,000 lb. per sq.in. cross-sectional area as before, only the strain is across the bar instead of endwise. Suppose, then, that the rivets used are square and each is one inch square and $S = 37{,}500$, how many will be required to equal the strength of the sample already drilled with five holes? Answer: $300{,}000 \div 37{,}500 = 8$ rivets. If the 8 are put in a row there will be a loss of $\frac{8}{10}$ of the original width of the sample, so they must be placed in two or more rows or other means used to improve conditions, and this leads a step farther.

A joint made by lapping one edge of the plate over the other serves well enough for some purposes, but the strain tends to kink the plates at the weakest point, which is at the rivet holes, therefore it is best to bring the plates edge to edge and to use a narrow "strap" to join them, and it is also advantageous to use such a strap on both sides of the plates so that the rivets will extend through both straps and the plate between. This is termed a "double butt-strap joint," and incorporating the statement of the type and number of rows of rivets gives a full description of the joint, such as "triple-riveted double-strap joint," etc.

When double-butt straps are used, the rivet will tend to shear at two points of its length instead of one, therefore it will withstand a greater strain, and this has been variously stated as 1¾ to 2 times the single shear. The A. S. M. E. Boiler Code Committee has adopted the value as twice S (stated as $2S$ or SS by different writers) for rivets in single shear, and this is being generally adopted.

To get back to the experimental joint, then, four rivets in double shear will do as well as the eight in single shear or will equal the T of the sample, but this still leaves the joint strength only 60 per cent. To increase the efficiency, then, the holes must be smaller and spaced farther apart; that is, less of the plate cut away in a line across the plate in drilling rivet holes. This is accomplished by increasing the pitch in any row (pitch is abbreviated to P), spacing the rivets farther apart, always measured from center to center, and putting in as many rows as may be needed to get the desired shearing strength. There are limitations to pitch on account of calking the joint steam-tight.

Another term met with is "crushing strength" (called C for short) which means that the part of the plate directly in front of the rivet may crush, the same as a bar of flat iron, if set up edgewise and subjected to extreme pressure, would crush. This must not be confused with the tearing out of the rivets through the edge of the plate. The crushing strength (C) of boiler plate, as indicated by numerous tests, is about 95,000 per sq.in. section, so that value is generally accepted as the value to use in all calculations; but since C is such a high value, it does not demand serious attention, for the joint is more likely to fail otherwise before the limit of C is reached. The thickness of the plate is shortened to t and the thickness of the butt straps to t_1 or these may be varied by different writers, but a list of abbreviations is, or should always be, given so there need be no confusion in a given case.

As suggested before, the net section of the sheet between the rivets is the part that is left to resist the strain (this is called the ligament), and the same applies to the slant distance between adjacent rows; so the rows must not be too close together, for the plate may fail in a zigzag line from a rivet in one row to an adjacent one in the next row and back, even though the pitch of a given row be sufficient. This is not likely to happen if consideration is given to the manufacturing process, for space must be allowed for the "dolly" used in riveting.

I think you and your friends will have a lot of fun designing joints (on paper) and testing them out by critical analysis and incidentally become familiar with the "nicknames" used.

A Talk to Firemen on Saving Coal*

BY CHARLES H. BROMLEY†

A simple, straight-from-the-shoulder talk to firemen, giving in one lecture the most important things to do to get the most out of coal with the hope that firemen and their employers will become interested enough to further study fuel economy as the problem confronts them.

FIRING is an art that cannot be learned from books. Experience alone is teacher. But one becomes a much better fireman in a given time by studying and by hearing what those who have studied the subject have to say. That is why your good friends in Baltimore have arranged this meeting for you.

Of course it is impossible in one lecture to tell you all I want to tell you; but I will touch the most important points, hoping you and your employers will become interested enough to take up the subject and each study his individual needs.

EMPLOYERS NEED EDUCATION

So much is at present said about how firemen waste coal and how necessary it is to educate them, that I am impelled to say that the employers of firemen need more education on the use of fuel than do the firemen themselves. The most skilled and technically competent fireman cannot burn coal economically unless the boiler and furnace are, first, suitably designed for the coal used and, second, properly maintained in repair and cleanliness. In the average plant the fireman has nothing to do with design and little to do with repair and upkeep. The engineer or superintendent is properly responsible for these. The fireman is shown the boilers, given the most ragged-edged scoop (the older fellows on the job have grabbed the best ones) and put to work. Firing is hard and dirty work, and the class of men in boiler rooms becomes less congenial every year. These are the conditions.

The employer should learn that he must furnish the most suitably designed furnace and apparatus if he expects good results from his boiler room day in and day out.

The days of hand-firing are numbered. The great variety of mechanical stokers put on the market in the last few years adapts the stoker to almost any coal and any size or number of boilers. There is every physical and labor reason why the commercially unavoidable waste of coal by hand-firing should cease. Firemen, therefore, should visit stoker-fired plants and study the construction and operation of the many types of stokers. Ask your employers to send for the various stoker catalogs and give them to you. But do not use them to set the coffee pot on.

The more the fireman knows about the fuel he burns, and how and why it burns, the better he can burn it. The fireman's job is to put into the water in the boiler all he can of the heat in the coal. To successfully burn most soft coal, the combustion chamber must be of large volume and, for some types of boilers, have arches and wing walls to thoroughly mix the gases rising from the coal. The hand-fired horizontal return-tubular boiler and most hand-fired water-tube boilers should be set so that the heating surface nearest the fire is 60 to 72 in. above or away from the fire. The distance for stoker-fired boilers should never be less than 60 in. If the settings leak, find the cracks by passing a lighted candle over and near the brickwork or by passing the hand over the setting. Fill the cracks with a mixture of old asbestos from discarded pipe covering and fireclay or cement, or with some one of the several preparations on the market.

It is to be assumed that the baffling is tight so that the gases do not go to the stack without passing over the heating surface.

The following refers to soft coal: Coal is composed of carbon, tarry substances in solid form and refuse. The more tarry substances the coal contains the more smoky it is. When heated, the tarry substances vaporize, like ice melts, then vaporizes, if thrown on the stove. The vapors from many coals begin to be driven off at temperatures as low as 400 deg. F. The usual furnace temperature of a hand-fired boiler is 1800 deg. or higher. This explains why soft coal smokes when thrown on a hot fire—the vapors are driven off so rapidly and are so dense and the furnace temperature so reduced by blanketing the fire that smoke or vapor instead of gas forms.

HINTS ON THE CARE OF FIRES

The following instructions apply particularly to soft coal, hand-fired, but are true in general for hard coal.

Starting the Fire: Cover the grate with about three inches of lumpy coal. On top of this throw wood enough to start the fire; ignite the wood with oily waste. The coal will catch fire from the top down and will not smoke disagreeably. For hard coal and coal having less than 20 per cent. volatile, like the New River, Pocahontas, Clearfield and others, the fire will start better by throwing the coal on top of the wood. Do not try to make a thick fire at the start; keep it thin and hot by putting on the forced draft, if provided, except in a Scotch boiler or a newly set boiler. The reason is that the brickwork is cold and good combustion cannot be had until the brickwork, especially the arches, if there are any, is very hot. With most boiler furnaces, letting air in at the fire-doors after firing will prevent the formation of black smoke. If steam jets to blow air in over the fire are provided, use them for a minute or so after coaling the fire.

Holding the Fire: Do not carry the fire more than 12 in. thick. Cover it by coaling the fuel bed first on the front half; when this has burned through, cover the back half. If this method is not desirable, coke the coal by piling it at the dead plate. When coked as much as the condition of the fire gives time for, push the coking coal onto the fire. Cover the fire only where it burns away; that is, in the "holes."

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*From a lecture to the firemen of Baltimore, Md., at the Baltimore City Club, Jan. 9, under the auspices of the Baltimore Engineers' Club, the Baltimore Section of the American Society of Mechanical Engineers and the City Club.

†Associate editor, "Power."

Use the slice bar seldom and be careful not to turn over the fire so that ashes or clinkers get on top of the live coals. If they get there, they will melt, run through the fuel bed and harden at the grate, plugging the air spaces. A very thick fire may have the same effect, except that the grate bars may become overheated and warp enough to ruin them. Run the slice bar between the grate and the fuel bed and raise the clinker enough to break it and let air through to the coal above.

With ordinary coal, if the ash and clinker give frequent trouble by melting, the cause is likely too high furnace temperature. This may be reduced by cooling the furnace arch over the fire, removing it altogether, exposing the bottom row of tubes if covered with tile baffling by putting the tile on the row above, or by bricking off part of the grate if the highest load can be carried with less grate area. The ash-fusing temperatures of Pocahontas, New River, Clearfield and Georges Creek coal are between 2400 deg. F. for the first to 2900 to 3000 deg. F. for the last. Most of the Pittsburgh and Kentucky coals have ash that melts at as high and few at lower temperatures than these.

CLEANING THE FIRES

The following directions are applicable to a stationary grate. Have plenty of live coal before beginning to clean. Push the live coal on the front half of the grate onto the back half; pull out the ashes, cover the bare grate with a thin layer of green coal and pull all live coal at the back of the grate forward onto the front half. "Jump" the ash from the rear over the fire and out the door. Cover the grate as before.

Some prefer cleaning one side half and then the other. The method is the same except that the live coal is pushed or "winged" over to one side, the grate cleaned of ash, covered with green coal and the live coal pushed back. The same is done with the other side of the fuel bed.

With shaking grates the ash is shaken into the ashpit; but if large, heavy and hard clinkers form, they should be pulled out of the fire. Shake frequently enough to keep the fire about eight inches thick and push the slice bar over the grate and under the clinker, lifting it enough to crack it. If the coal crusts over on top, break the crust with the rake frequently.

A FEW HINTS ON THE STOKERS

With most stokers cleaning is done automatically; but if large clinkers form, they must be broken so the air can get through to burn the coal fed to the fire. The coal now being delivered in most localities contains half again to three times as much ash as that supplied before the war, and more serious clinker trouble results. No rigid directions can be given for getting clinker off the side walls without too quickly destroying the wall. Experience with the particular coal and brick in the wall must govern the operator. Be careful to break the clinker so as to burn the carbon out of it before the clinker gets on the dump plate, otherwise it will continue to burn there and in some stokers will burn out the plate. Break the clinker that piles up near the dump-plate so the air can get through it to burn out the carbon.

If the stoker has a clinker grinder and air may be admitted to the clinker on the grinder, be careful not to let in so much air as to overbalance what may be gained by burning the carbon out of the clinker. Experience gained by checking up with analyses of the gases and experience with the particular coal must govern the burning of carbon from the clinker. This is true whether the clinker grinder is run continuously or the clinker accumulated, ground and the carbon burned out periodically.

The more coal you attempt to burn the more carbon there will be in the ash, other conditions unchanged.

It will be found that for nearly every particular coal and type of setting there is a certain combustion rate above which it is uneconomical to go. For peak-load periods this rate is usually exceeded. The engineer must find this rate and instruct you accordingly.

Do not regulate the draft solely by the ashpit doors; use the back damper, which should be operated from the boiler front where the draft gage should be located.

SOME GENERAL HINTS

Keep the coal swept back away from the boiler front.

If you find you cannot help coal dropping off the shovel and going into the ashpit, tell the engineer so and let him put screens of ¼-in. mesh at the ashpit-door openings.

Pull the ash from the ashpit immediately after cleaning the fire, especially if the ashpit is shallow. This avoids warping the grate bars and prevents the formation of clinker. Keep water in the ashpit if it is very shallow.

Do not let the clinker form at the side walls so badly as to interfere with the feeding of the coal or enough to "arch" over the fire.

Never crawl under a fire to replace a grate bar that has jumped its bearing. It is too dangerous for you and too costly for the employer if you are badly injured.

Keep the business end of your scoop trimmed evenly. It won't spread coal rightly if it has a raveled edge.

If steam jets are used to create pressure draft under the grate, keep the jet openings free of the lime or other solids that come over with the steam and plug the tips.

If the fine anthracite is dry, wet it before firing, provided it cannot freeze before you want to shovel it. If it blows away at the dead-plate, clear the place and put lumps of coal or clinker over the slit from which the coal blows away.

Feeding water to the boiler is, perhaps, more important than feeding coal to the furnace. The feed water should be as hot as exhaust steam and live steam can make it, and there should be a thermometer in the feed line. Aim to feed water when the load is light and have a shade more than two gages full when the heavy load comes on, so that you can shut the feed valve almost entirely during the heavy load. When down to a little above the first gage-cock, open the feed valve just enough to keep the water going into the boiler as fast as it goes out in the form of steam. But make sure the injector or spare feed pump is ready for business in case the feed pump breaks down. If the water is such that it foams badly at heavy loads, keep it low and feed it continuously; that is, don't try to fill up the boiler and then shut off the feed when the heavy load comes on. Practice will tell how high a water level you may have before you get foaming trouble. Clean the fires during the lightest load periods only.

If the engineer neglects to keep in working order the dampers, damper regulator, the balanced draft apparatus, the feed valves, the feed-water regulator or anything important to the boilers' operation, pester him until he does act. If he is still negligent, every man jack in the boiler room report the conditions to the chief.

If stoker-fired, keep the stoker-coal hoppers full all the time and see that lumpy coal does not segregate at one side or both and fine coal in the middle of the hopper; otherwise you cannot keep a fire free of holes. The more uniform the size of the coal fed to the stokers the better fire you can maintain.

Never allow the wooden ladder to be taken from the boiler room, even by the chief himself.

It is foolish to try and cheat the CO_2 recorder or the gas-sampling tank. You can do it, of course, but you are the one who suffers. Play square with these watchmen, who, after all, are your best friends.

If the other fellow makes a better firing record than you do, don't get sore—learn from him. But if he cheats by shutting off the blowers on his boilers and makes yours do most of the work—well, use your own judgment.

I cannot say too strongly that opportunities for bright, studious boiler-room men are great now and will be greater as time goes on. There is always a good job, at good pay, for the man who knows the boiler room and how to get the most out of it.

M. I. T. a Military Camp

The remarkable registration of the Massachusetts Institute of Technology, which has today 88 per cent. of the students who were there in June at the close of the last school year, is due to two important factors: First, there was the plain statement by a student committee to its fellows that their patriotic duty was to "sit tight" and finish their studies, when they would be of much greater benefit to the country; and second, there were the summer military camps.

Two camps were established—one for sophomores (200 registered) at East Machias, Me., and one for juniors in Cambridge, Mass. The Institute has, on Gardner Pond, Me., a summer engineering camp ground of about 600 acres. Attendance there is obligatory upon sophomores in the civil-engineering courses. It was decided to utilize the facilities for a larger sophomore camp whose studies would be engineering as well as military.

Twelve weeks in uniform with military regime was the course, and to assure it to students to whom the uniform, transportation and camp costs would be a burden yet who were patriotic in wishing to undertake it, the expenses up to $25,000 were underwritten by Mrs. Edward Cunningham, widow of a former member of the Institute Corporation, through a memorial fund to her husband.

The work at East Machias included all kinds of engineering. Situated on the lower one of three large ponds, with considerable flowing streams at hand, hydraulics was an important topic. Railroad engineering was also taken up under natural conditions surrounding such work, and trenches were laid out and excavated. The summer was passed in this way, and the students were all the while engaged in the study of military science and evolutions and manual with considerable artillery practice. These students almost to a man returned to the M. I. T. for their junior year.

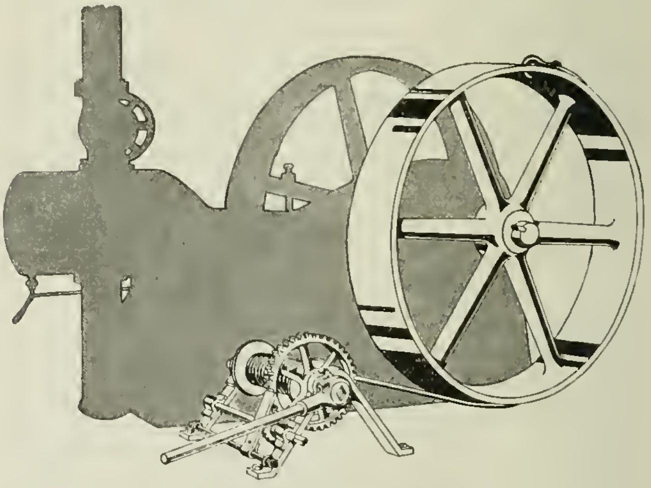
At the same time the junior camp was established at the Institute in Cambridge. This was a camp of nearly 200 students in khaki uniform, officered and taking calisthenics and military work. Students who wished to attend this camp but whose circumstances would ordinarily have caused them to seek positions during vacation had the benefits of the Cunningham memorial fund. There students with a long day, lasting till 5:30 p.m., not only had military training, but were anticipating the studies of the senior year so that they will actually receive their degrees a month hence and be able to go at once into that technical service which the country so much needs.

Institute men to the number of 1200 are already in khaki in positions of responsibility in all branches of military and naval service, while a larger body, more than 2000, are in the equally necessary supporting industries allied to war.

Engine-Turning Winch

Many devices have been used in power plants for turning engines off the dead-center. These are generally bars of one kind or another by which the engine is pried over, the bar gripping, or engaging in holes or notches in, the flywheel rim.

A different method of doing this work was recently seen in operation in a steam plant. The engine was a center-crank with flywheel governor. In the rim of the flywheel were holes for changing the governor for reverse running. On the floor in front of the flywheel was a winch, over the drum of which a wire rope was wound, the loose end having a hook. This hook is placed in one of the holes in the flywheel rim. On the extension of the winch shaft a ratchet is attached to which is fitted a handle.



WINCH FOR TURNING ENGINE

With the hook in the hole of the flywheel the ratchet is operated, thus winding up the wire rope and turning the engine to the desired position. The winding spool is prevented from turning backward by a dog engaging with the gear teeth.

Gas-Engine Troubles and Remedies

By A. L. BRENNAN, JR.

Although during the past few years internal-combustion engines have reached a high degree of perfection, they are still subject to many of their former troubles. How these troubles may be quickly and intelligently diagnosed is told in the following.

THE troubles in gas engines can in the most part be avoided by careful attention, but at the same time they are liable to take place, even if an engine is in charge of an expert. It must not be understood from this that gas engines are not entirely dependable, for the service they are giving in all motive-power applications should be sufficient to convince even the most skeptical of their reliability.

Considering the fact that the functions of gas engines are partly performed by combustion, partly mechanical and partly electrical, it is not surprising that they cause trouble at times. When a gas engine refuses to start, it may be due to any one or more of three general causes—mechanical, fuel or electrical.

Mechanical troubles are:

1. Lack of compression.
    a. Inlet valves stuck (automatic).
    b. Inlet valves out of time (mechanical).
    c. Broken, scored or worn piston rings.
    d. Dry or worn cylinder.
    e. Leaky gaskets or compression valves, etc.
    f. Faulty exhaust valves.
2. Excessive friction.
    a. Poor quality or insufficient lubrication.
    b. Load not disengaged, or clutch sticking.

Fuel troubles are:

a. Insufficient volume of gas allowed to cylinders.
b. Improper gas mixture.
c. Water in cylinders.
d. Water in carburetor.
e. Needle valve of carburetor clogged up.
f. Pipe line clogged up.
g. Gasoline supply exhausted or tank air-locked.
h. Throttle not opened wide enough.

Electrical troubles are:

a. Open circuit due to switch not in contact.
b. Open circuit due to loose or broken wire.
c. Short-circuit due to broken-down insulation on wires.
d. Igniters hung up (mechanical make-and-break).
e. Weak or depleted batteries.
f. Poor contacts at timer.
g. Vibrator contact points dirty or out of adjustment.
h. Dirty or defective spark plugs.

Although there are many minor troubles that might be listed here, they would in general only tend to confuse the operator. The leading troubles, as outlined in the foregoing, should prove of benefit to the average engineer in helping him to quickly decide upon and locate an existing fault.

As a first step toward locating trouble in a gas engine the mechanical features of the motor should be tested by trying the compression. That is, crank the motor over with all relief valves and cocks closed; if considerable resistance is encountered on the compression stroke without any indication of binding, it is evident that the compression is good and that the valves and other actuating parts that control the compression are in good order. It must be remembered that each cylinder should undergo this test and if the compression is not satisfactory, the cause should be ascertained and remedied. No internal-combustion motor can develop its maximum power without good compression, although it may be able to operate in a fairly satisfactory way.

Also, if the compression is good, the features affecting the combustible are in all probability in good order as well. These have to do with the factors that control efficient carburization. Carburetors are an auxiliary feature of a gas engine for converting the liquid fuel into a gas, but at the same time carburization is largely dependent upon the condition of the motor. Therefore, any troubles that interfere with good compression, such as a badly pitted exhaust valve, for instance, also operate against efficient carburization, and, as already stated, this point is brought out by testing the compression. Therefore the first thing for an operator to do when confronted with difficulty to start is to try the compression; if this is good, the trouble is in the carburetor or the ignition.

When Motor Fails To Pick Up

Assume that the ignition is known to be in good order, and an attempt to start the motor is made but it fails to pick up, and each cylinder is primed and the motor again cranked over. If, now, the engine starts and runs in a regular manner, it shows that there was nothing much at fault to begin with and that the motor failed to start owing to lack of fuel in the cylinders when first cranked over. But on the other hand, suppose that after priming and cranking the engine it fired the priming charges and stopped, accompanied by sharp backfiring in the intake manifold or carburetor on four-cycle motors, or in the base or carburetor on two-cycle motors. Backfiring of this nature indicates a weak mixture, but does not necessarily show that the needle or air-valve adjustments are at fault, for the trouble may be due to the needle valve in the carburetor being clogged up or the flow of gasoline in the pipe line may be impaired by sediment or the tank may be airbound, etc. If, after priming and cranking the engine, no explosions took place, this would indicate that the motor is flooded. Therefore the next thing to do is to get rid of the extra gas, by closing the throttle, opening the relief cocks and cranking the engine over several times. It is a good plan to keep the switch on during this cranking, for then when the gas is thinned down sufficiently, firing will take place and the motor will start. Just as soon as the motor picks up its cycle, open the throttle a little and close the relief valves or cock and then advance the spark.

Remember that failure to start is not due to a retarded spark, and under no circumstances should the spark be advanced before the engine is operating under its own power. Failure on the part of the operator to fully retard the spark before cranking has resulted in many serious accidents. When a motor is started either with or without being primed and runs in a powerful manner for two or three cycles, but slows down or stops sluggishly, it is in nearly every case a positive indication of an over-rich mixture, consequently steps should be taken to reduce the amount of gasoline allowed or increase the volume of air.

On the other hand, suppose it appears that the ignition is at fault. The best way to see if the entire system is all right is to test the spark plugs, if the motor is equipped with high-tension coils. To test the plugs they should be removed from the cylinders, the high-tension wires reconnected and the threaded portion of the plugs rested upon the cylinder, care being taken to keep the top of plug and terminal from contact or near the cylinder. Then place the switch in position and crank the engine over to the several firing points—that is, to the firing point of each cylinder—and note if a spark takes place between the points of the plugs. If a good spark appears at each plug, evidently the ignition is good, but this should not be taken as final for the reason that a weak battery or poorly adjusted coil can produce a spark under natural conditions, but the same potential will prove inadequate to induce an electric arc in the high pressure inside the cylinder. Therefore this fact should be kept in mind, and unless an exposed plug shows a good, fat spark, steps should be taken to make up this discrepancy by adjusting the coil or using new batteries.

Another point to remember in connection with spark plugs is that the porcelain part is liable to crack and cause them to fail in their function, owing to the current leaking through the cracked porcelain and grounding.

If, when the motor was turned over to the firing point, no spark appeared at any one or more plugs, but the vibrators worked all right, this would show that the existing trouble is either in the secondary windings of the coil, in the high-tension wires or in the spark plugs. It is very rare that an operator is troubled by a defective coil, therefore the trouble is probably due to a loose high-tension wire or to a defective spark plug, and so the best thing to do is to change the spark plug of the faulty cylinder to one that is known to be in good working order.

On the other hand, if the motor was turned over to the firing point of each cylinder and each vibrator failed to buzz, it would indicate a weak or depleted battery, loose or broken wire in the primary circuit, poor contacts at timer or vibrator contact points dirty, pitted or out of adjustment.

Some Shaft-Governor Pointers

One evening as Willis was passing the plant of the Davis Machine Co., where a young fellow named Arnold was in charge of a couple of shaft-governed cross-compound engines, he noticed that Arnold was putting in some overtime, and as the latter usually made it a point to get away from the plant about as soon as the office boy, Willis stepped in to see if he could be of any help.

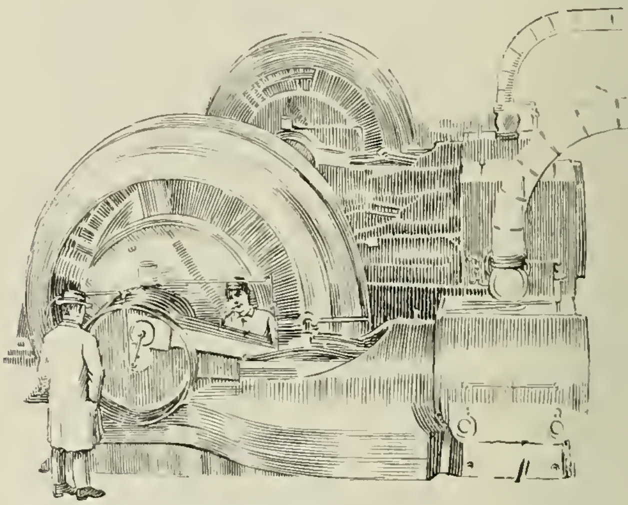
"What's the trouble?" he asked, as Arnold stuck his head up by the governor wheel. "I thought you would be at the movies by this time."

"Movies nothing," growled Arnold. "I have all the movies that I want right here with the blasted governor of this engine."

"What seems to be the trouble? Perhaps I can help a little."

"Racing, that's all. You'd think that the blamed engine was going to its first circus if the speed were anything to go by."

"Well, let's see if we can't get down to brass tacks before you take that governor down. What receiver pressure have you been getting since this trouble began?"



IT'S KIND OF FUNNY YOUR ENGINE SHOULD START TO RACE ALL OF A SUDDEN

"Oh, around 45 to 50 lb. Of course that is high, but what can a fellow do? The plant has to run, racing or no racing."

"Sure, sure. But it's kind of funny that your engine should start to race all of a sudden, when it was running all right only a couple of weeks ago. Do anything to her since then?"

"Nothing to speak of," answered Arnold. "I did a little valve setting about a week and a half ago, but that hasn't had anything to do with the racing. How could it?"

"Now let us reason together, as someone has said. You carry about 115 lb. of steam at the throttle and get between 45 and 50 lb. receiver pressure. It looks to me as if there was something the matter with the valve setting. I'll bet your fireman will swear that you are eating up steam faster than you used to."

"He has kicked a little, but I told him it was his imagination. I don't see how it could be anything else."

"If I were you, Arnold, I would look at the valves just the same. Suppose we take off the bonnets and see what we shall see. I have an idea that you are blowing live steam right into the receiver from the high-pressure cylinder."

"I don't believe it, but just to show you that you are wrong we will look into things and see."

"There you are," exclaimed Willis when the valves were exposed to view. "Just what I thought. You have given the steam valve about $\frac{3}{16}$-in. negative lead, and your piston will be at about $\frac{5}{8}$ of its stroke when the valve opens and keeps open until near the end of the stroke. At the same time the exhaust valve on that end of the cylinder is open and the steam doesn't do a thing but rush right out through the exhaust port to the receiver. Can't you see that you are working the low-pressure cylinder at a pretty high pressure? It's no wonder that the engine races. Let's set these valves as they should be and see what happens when you start up.

"Another thing for you to consider is that with this valve setting an excessive back pressure is set up in the high-pressure cylinder and of course that reduces the power developed by that cylinder. With the low-pressure cylinder doing the most of the work, it is out of the control of the governor and there is no reason why the engine wouldn't race. Now with these valves set properly, according to my notions, I'll bet a plugged ten-cent piece that your engine will govern all right."

When Arnold started up for a tryout, he found that the tendency to race had disappeared.

"Well, I'll be blown!" he exclaimed. "I wouldn't have believed I had set those valves so as to knock out that governor. I'll be more careful the next time."

"That is a good resolution to make, but every engineer should be so familiar with his engine that he knows just what he is doing when changes are made. And that applies to the governor. Many times poor regulation is due to a faulty governor—not so much in the design as to the wear of parts, which will frequently cause them to bind. A governor should be known to be in balance as to weights and friction."

"I don't get you," said Arnold as he seated himself on the edge of his desk. "How are you going to find out whether the weights and friction balance, whatever that is?"

"That's easy enough. All you have to do is to detach the springs from the weight arms and move the weights out to their full travel and back again with a free movement. If the governor binds, it is well in testing out to remove the eccentric rod so as to give the governor free action without having to drag the valve gear. Working the weight arm from one position to another will give a good idea as to whether there is binding in the parts or not. If there is a feeling of sticking, you won't have to guess very much as to where the trouble is."

"Suppose you do feel a sticking when working the weight arms, what are you going to do about it, and where would you look for the cause?"

"The first thing I would do would be to examine the pins and bearings to see if they were getting enough oil, or for caps binding on the end of the pins. If you feel a sticking of the movement, you can be pretty sure that the trouble is in some of the governor bearings or pins. Naturally, if after testing out the governor it is found to be all right, you will turn your attention to the valve gear. It may be that a pressure plate is binding, or the valve stem may bind in the stuffing-box. Flat pins can bring about a lot of trouble."

"I don't see why that should be," said Arnold as he started to remove his overalls and jumper preparatory to getting ready to go home.

"That's easy to explain. When an engine runs day after day with practically the same load, the bushings and pins will wear out of true, because the governor arms assume practically the same position during the run. Naturally, the pins and arm bearings wearing together have a free motion, but if the load changes to any great extent so that the weight arms take a new position, the bearing between the arms and the pins do not fit properly and excessive friction is set up, often so great that the governor sticks, the result being that the engine will race."

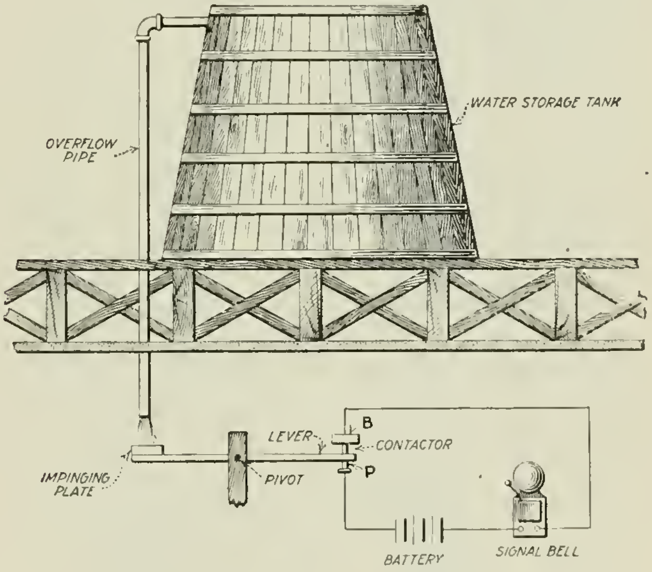
"I guess there is considerable in what you have said," answered Arnold. "One thing is sure and that is that poor valve setting will cause an engine to race, but for the 'love of Mike' don't go away from here and tell the bunch what a mess I made of setting those valves."

"I won't," replied Willis, as he buttoned up his overcoat. "I've been guilty of pulling off just such fool stunts myself"; and with this he left Arnold to wash up, while he hurried home to another belated supper.

Tank-Overflow Alarm

By T. A. Nash

An effective tank-overflow alarm circuit is detailed in the figure. When the tank becomes so full that water flows through the discharge pipe, the water impinges on a block mounted on the end of a lever as shown. This forces the contact point *P* of the lever against the metal contact *B* and completes the signal circuit, causing the bell to ring.



LAYOUT OF TANK AND ALARM CIRCUIT

Experience has shown that undercutting the mica is desirable on most commutators having peripheral speeds exceeding 1500 ft. per min. In the case of very low speeds, slight undercutting, possibly one sixty-fourth inch, may be desirable. Nonabrasive brushes should always be used with undercut mica, because where there is little wear on either brush or commutator, there will be practically no grinding off of either copper or carbon, hence no fine material to fill the grooves. In general, undercutting is entirely satisfactory for any machine operating at engine-type or higher speeds.

The Electrical Study Course—Forms of Field Magnets

Some of the earlier and the modern types of field-frame structures used for direct-current machines are described.

THE function of the field magnets in an electric generator or motor is to furnish the magnetic field, which in a generator is cut by the armature conductors to generate voltage, and in a motor reacts upon the current flowing in the armature conductors to produce rotation. In the development of the dynamo-electric machine the field magnets have taken on a multiplicity of forms. The field magnets of the earlier types of dynamos were permanent horseshoe magnets, similar to that shown in Fig. 1. Even today this type of field pole is used, in some cases, on small magnetos for ignition, signaling and other purposes. However, this form of magnet was never used on machines of any considerable size, chiefly because the magnets would have to be very large; the strength of the magnets decreases when in use, owing to the vibration of the machine and the effects of the magnetic field set up by the current in the armature winding; also because there is no way of controlling the strength of the field, which is the chief means usually employed for controlling the voltage of the generator or the speed of an adjustable-speed motor. These defects soon led to the adoption of electromagnets; that is, coils of wire placed on polepiece of soft iron and excited from some source of electric current.

Early Types of Field Magnets

Since the permanent-magnet field poles were of the horseshoe shape, it is to be expected that most all of the earlier electromagnets used for field poles were of this form. Fig. 2 shows one of the early types of Edison two-pole machine, and Fig. 3 is a somewhat later and improved type of the same machine. In this arrangement of poles, if they were mounted on an iron base it would short-circuit the magnetic field; that is, instead of the lines of force passing from the N pole across the air gap, and through the armature core into the S pole, they would take the easier path around through the iron base. To overcome this defect, a nonmagnetic plate of brass or zinc was placed between the polepieces and the baseplate, as indicated. To prevent the lines of force from leaking out along the armature shaft down through the bearing pedestals into the base of the machine and back into the polepieces, the pedestals were usually made of brass.

To get away from the nonmagnetic bearing pedestal and bedplate, the polepieces were turned upside down with the armature placed in the top, as in Fig. 4. With this arrangement the field magnetism passes from the N pole into the armature through the armature core into the S pole, and down around through the baseplate. Another form of field magnet is that in Fig. 5. This type was usually mounted on a wooden base, for the same reason that the nonmagnetic plate was used in Figs. 2 and 3

In all the foregoing schemes the flux from the polepieces passes directly from one field pole into the armature, and then to the opposite pole and around through the field structure. Such an arrangement is called a salient-pole machine.

Consequent-Pole Type Machine

Another type of field pole used in the development of the electric machine is given in Fig. 6. In this construction if the top of one field coil is made north and the other south, the lines of force will flow from the N pole around to the S pole without ever passing through the armature at all. To overcome this difficulty the top ends of both coils are made the same polarity; therefore the bottom ends must also be the same polarity, as shown in the figure. In this arrangement the two N poles oppose each other, and the lines of force must take the next easiest path, which is down through the armature to the S pole. A machine having a field frame in which like poles oppose each other, so as to cause the flux to pass through the armature, is called a consequent-pole machine. One of the serious objections to this type is that the opposing poles cause a heavy magnetic leak around through the air from the N to the S pole; that is, instead of all of the flux passing from the N pole into the armature and then to the S pole, a large number of the lines fly out in all directions into the air and around to the S pole. This leak constitutes a direct loss. In all types of machines there is always a certain amount of magnetic leakage, but it is much more pronounced in the consequent-pole machine than in the salient-pole type.

Motors or generators with only two poles are called bipole machines; those having more than two poles, that is, four, six, eight, etc., are called multipolar machines. None of the types of field frames so far considered lend themselves readily to multipole construction, consequently very few of these types were developed into multipole designs.

Materials Used in Field Poles

The arrangements of poles in the field frame that have been exploited could be carried out almost indefinitely, but the one design that is now used almost exclusively is the arrangement shown in Fig. 7. This construction is of the salient-pole type; that is, there are no opposing poles. This design can be used as readily for bipole as for multipole construction.

All of the earlier field frames and polepieces were constructed of cast iron or steel. In some of the modern types the whole field structure is laminated; that is, built up of thin sheets of iron or steel. Others again have a cast-iron yoke to which laminated polepieces are bolted. The yoke is the circular portion in Fig. 7. Other types have cast-iron polepieces with laminated poleshoes. The poleshoe is indicated in Fig. 7. This part is built up of thin sheets of iron or steel and bolted to the cast-iron polepiece. This subject will be given a more detailed study in future lessons.

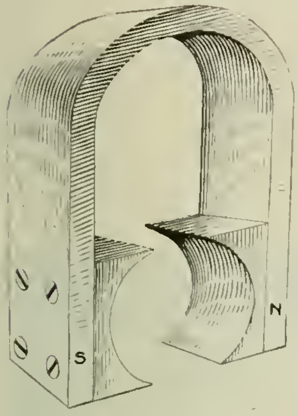


FIG. 1

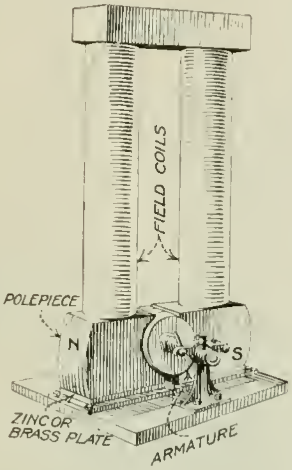


FIG. 2

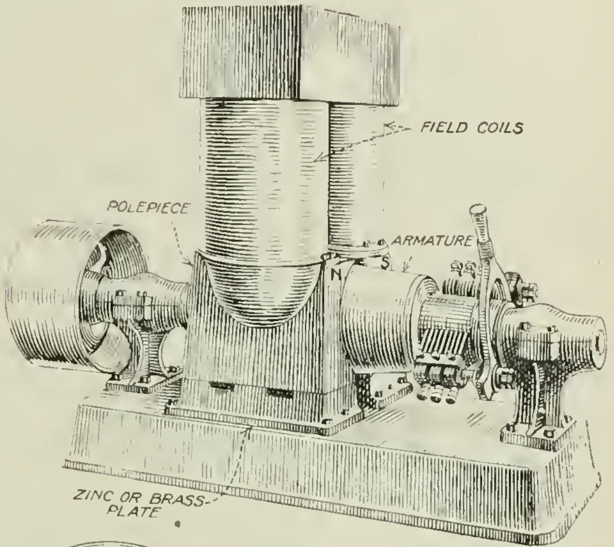


FIG. 3

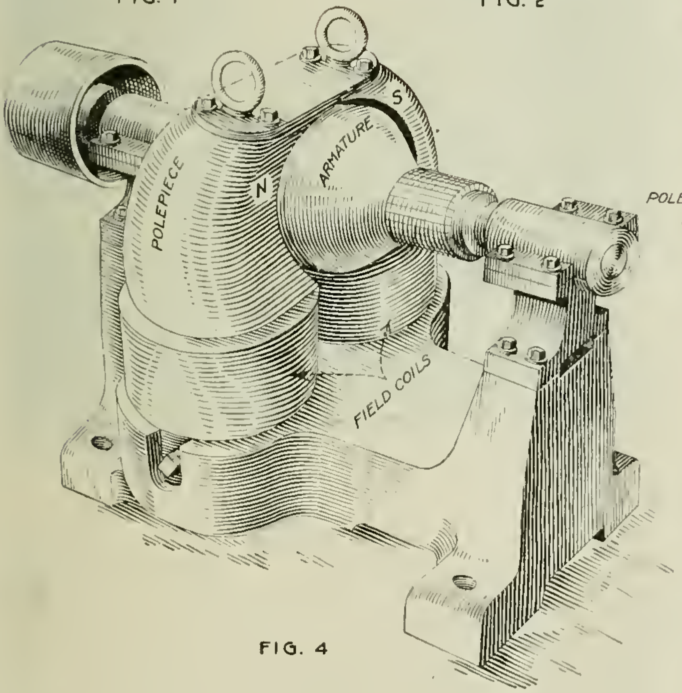


FIG. 4

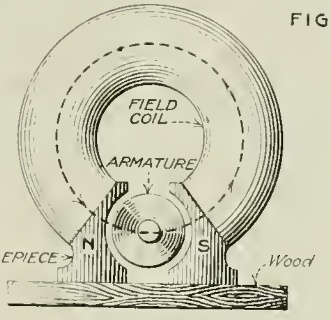


FIG. 5

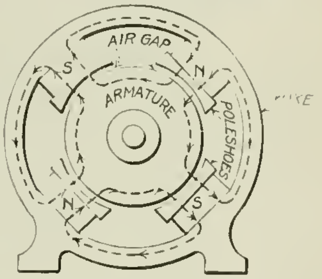


FIG. 7

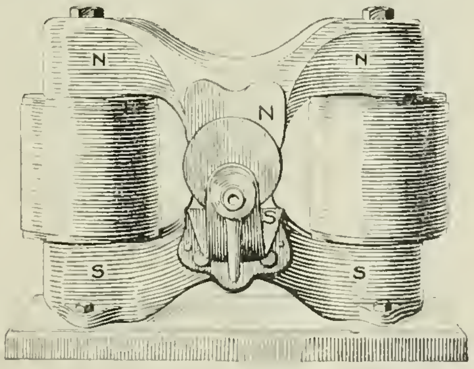


FIG. 6

FIGS. 1 TO 7. DIFFERENT TYPES OF FIELD-POLES FOR DIRECT-CURRENT MACHINES

Fig. 8 shows the layout of the study problem given in the last lesson. The current required by the motors is equal to total horsepower × current per horsepower $= 37.5 \times 3.8 = 142.5$ amperes; the current consumption of the lamps equals the watts required per lamp × the number of lamps ÷ volts $= 75 \times 64 \div 235 = 20.4$ amperes; and the total current is the sum of that required by the motors and lamps, or $142.5 + 20.4 = 162.9$ amperes. The volts drop in the line is $E_d = E - E_a = 240 - 235 = 5$. Then the size of the conductor required is

$$Cir.mils. = \frac{21.4DI}{E_d} = \frac{21.4 \times 475 \times 162.9}{5} = 331{,}176$$

or the nearest larger size standard conductor is 350,000 cir.mils., which is the size that will have to be used. This size rubber-covered conductor can be used, since the National Board of Fire Underwriters allow it to be loaded up to 300 amperes. Total watts = volts × total current, or $W = E_a I = 235 \times 162.9 = 38{,}281.5$; total kilowatts $= \frac{W}{1000} = \frac{38{,}281.5}{1000} = 38.2815$. The total time during which the power was used is hours per day × number of days. In this problem $6.5 \times 26 = 169$ hours. Then kilowatt-hours = kilowatts × hours $= 28.2815 \times 169 = 6470$. The cost of the first 800 kw.-hr. at 7.5c. per kilowatt-hour is $800 \times 7.5 = \$60$. The next 1000 kw.-hr., at 6c. per kilowatt-hour, cost $1000 \times 6 = \$60$. The remaining kilowatt-hours $= 6470 - 1800 = 4670$, and the cost, at 4.5c. per kilowatt-hour, is $4670 \times 4.5 = \$210.15$, and the total cost is $60 + 60 + 210.15 = \$330.15$.

1. What will be the voltage drop per foot of copper wire 18,750 cir.mils. in cross-section, when transmitting a current of 35 amperes?

2. Three lamps having a resistance of 45, 90 and 180 ohms respectively, are connected in parallel at the end of a 75-ft. circuit, the conductors of which have a cross-section of 6530 cir.mils. If 135 volts are applied to the power-plant end of the circuit, what current will flow through the lamps? Also the current taken by each lamp?

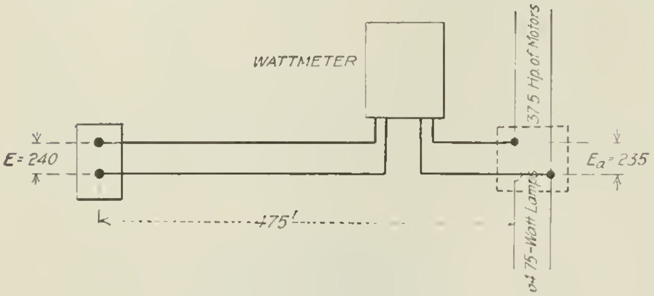


FIG. 8. FEEDER AND BRANCH CIRCUITS

Power Without Cost?

The Paterson (N. J.) *Morning Call* of a recent date contains the description a "near perpetual motion" discovered by a local inventor who, it is said, has been granted a patent on the device, which is expected to develop unlimited power by the upward rush of air through a conical stack or tower containing a vertical shaft on which are several propeller-shaped blades. "The apparatus may permit mills to discard coal." "Model develops 325 r.p.m." (doing no work except—overcoming its own friction presumably). The inventor "is too modest to permit the use of his name." "He does not wish his apparatus to be confused with so-called perpetual-motion machines." The reporter, however, suggests that "if the machine is as successful as he claims it will be, there is no reason why it should not be perpetual, as the air currents are continually mounting skyward." "It is not expected that one of these towers will furnish enough power for ordinary manufacturing purposes, but a whole battery of towers can be put in use at the same time," and "it will not be necessary to use any kind of manufactured drafts or currents."

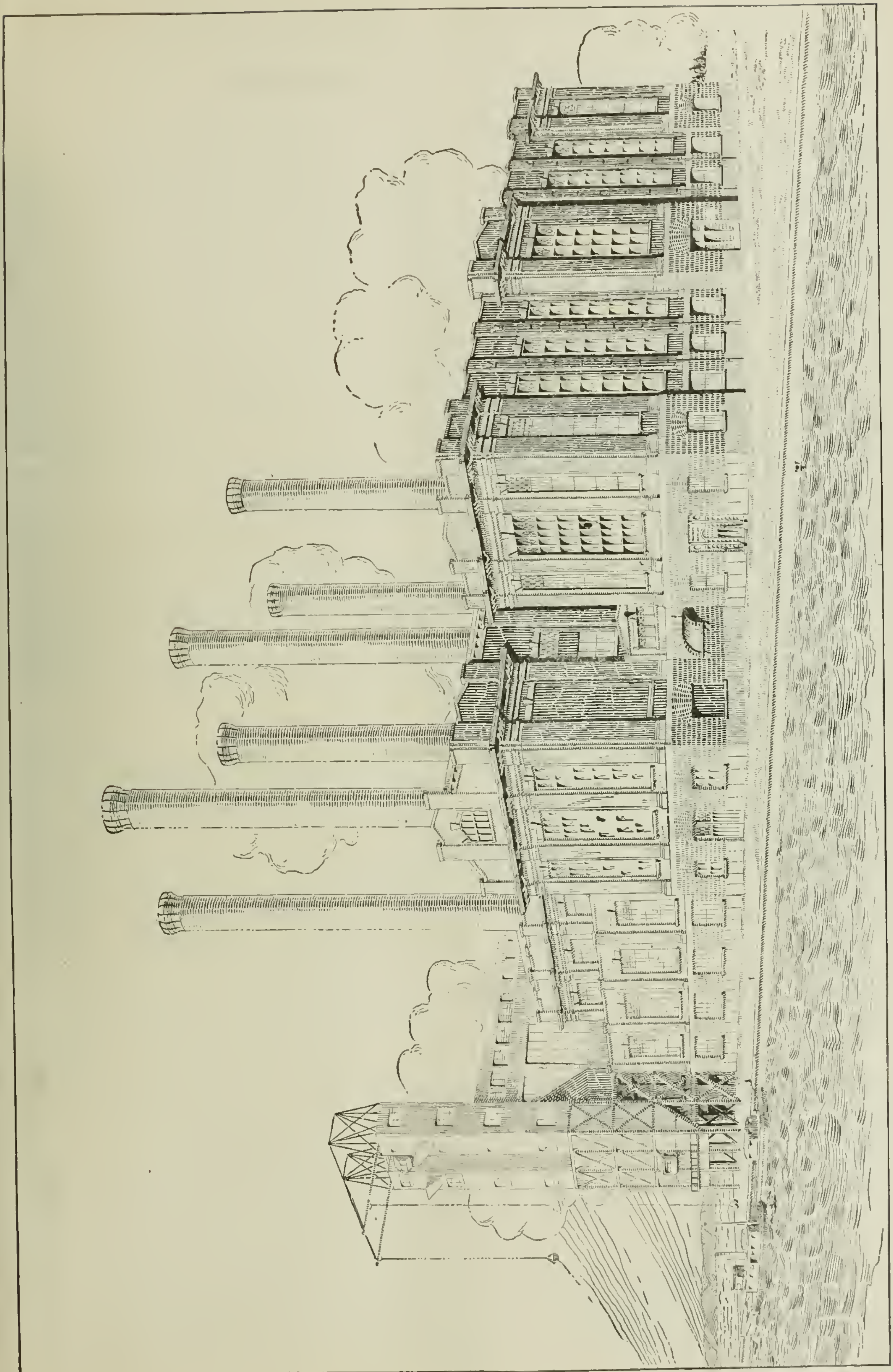
APPARATUS FOR DEVELOPING POWER

Engineers will recognize the fallacy of the reasoning in the foregoing, in that there can be no upward flow of air except when the air inside a chimney is at a higher temperature, therefore lighter. A chimney is the simplest form of heat engine and at the same time probably the most inefficient. It costs something to "stir up a breeze" in any case, and even if it costs nothing to produce, it might easily cost more than it is worth to get any useful work out of it.

"Ideal" Commutator Resurfacer

A commutator resurfacer made of abrasive nonmetallic material has been perfected recently by the Ideal Commutator Dresser Co., 8 South Dearborn St., Chicago. The resurfacers are made in various sizes to fit any condition of service. They are secured to permanent handles, giving the operator easy control of the device while on the commutator. The resurfacer is designed to do what would be accomplished by putting the commutator in a lathe and turning it down. There are two grades, known as coarse and fine. The former is recommended for bad commutators; the latter for a commutator in fair condition. Both cut down high mica, high bars and smooth out low spots, ridges and grooves. It is claimed that the abrasive material of the resurfacer does not collect copper dust nor wear smooth. Consequently there should be no short-circuiting, so that the device may be applied to a commutator or to collector rings while the machine is in operation. The illustration shows one of several designs of resurfacer with handle, made by the company.

APPLICATION OF RESURFACER TO A COMMUTATOR



Essex Station, Public Service Electric Co., Newark, N. J., as It Will Look When Completed

Ultimate capacity, 250,000 hp. Four stacks are now up

Work of the New Orleans Fuel Administration Committee

By LEO S. WEIL

This article describes the work being done by the New Orleans Committee of the United States Fuel Administration to conserve the supply of coal in that city under the direction of the writer, who is acting as Advisory Engineer to the committee. Considerable saving of coal has already been effected.

THE Fuel Administrator has appointed state administrators with advisory committees, whose duties are (1) to stimulate production, (2) to regulate prices, (3) to control the distribution, and (4) to conserve the supply of coal. While these duties are all important, those which deserve the greatest attention at the present time are stimulating the production and conserving the supply. If these two aims can be carried out successfully, there will be sufficient coal to satisfy the needs of all. The New Orleans Committee of the United States Fuel Administration has inaugurated an energetic campaign for fuel conservation, and an outline of the work being done will probably be of interest to other communities.

After a careful study of the situation, the committee decided that coal could be saved in three ways: (1) By the substitution of other fuel where available, (2) by shutting down unnecessary plants and lightening the loads on plants that must run and (3) by improving operating conditions. Steps were first taken to find a substitute for coal, and to this end a letter was sent to all woodworking plants in New Orleans and vicinity asking for a report on the amount of wood waste they had in excess of their own requirements, with the idea of using this excess instead of coal wherever it was commercially practical. To obtain this information "General Letter No. 4" was sent out.

UNNECESSARY PLANTS SHUT DOWN

Investigation showed that the ice plants of the city operate in the winter months at about one-third of their normal capacity, and an arrangement was therefore made whereby a large number of these plants were shut down and the remainder run at nearly normal capacity supplying ice to those which were shut down. Coöperation to the same end has been received from other industries such as the laundries and the New Orleans Railway and Light Co., which have dispensed with all unnecessary loads. The greatest possibility of saving exists, however, in improving plant-operating conditions, and to this the committee is devoting much of its effort. The Government has appealed to mine workers to speed up the production of coal in order to take care of the increased demand, and it was thought that a similar plea could well be made to power-plant owners, their engineers and firemen not to waste coal, because any amount of coal saved would be of even more benefit than a corresponding increase in production, as it would release freight cars for other service. A meeting of the industrial-plant managers was therefore called, at which the necessity of fuel conservation and the individual duties of owners, engineers and firemen were impressed on those present. It was pointed out to the managers of the plants that one of the principal reasons that they did not receive the most efficient coöperation from their operating forces was because suggestions from the latter were not given proper consideration when these suggestions called for improvements entailing a small expenditure. They were advised to encourage suggestions from their engineers even if they did not always adopt them, because nothing stimulates the interest of a man in his job so much as the realization that his opinion is valued and that any improvement in results that he obtains will not pass unnoticed. The plant owners were given to understand that they would not be expected to make large investments to improve operating conditions, but that they would be expected to keep their present equipment in good condition and to utilize this equipment to the best advantage. "General Letter No. 6" was distributed, pointing out where most of the easily preventable wastes occur in steam plants, and it was requested that the various suggestions on this sheet be checked up to see that these wastes were cut to a minimum.

COMMITTEE OF OWNERS FORMED

The necessity of coöperation on the part of both owners and engineers was strongly urged, and it was decided to form a committee of owners and also an organization of engineers to assist in this work. In pursuance of this policy "Circular Letter No. 8" was sent to all industrial plants in the city, and it is gratifying to state that pledges of coöperation and support were received from all these plants. A committee of five industrial-plant owners has been appointed to confer with the advisory engineer and to help direct this work. "Questionnaire No. 9-A" has been mailed to the engineer of every plant in the city. The information called for on this questionnaire will indicate whether the results being obtained are as good as they should be and will help to show why they are not good if the efficiency is low. A committee of operating engineers will also be appointed to assist the advisory engineer in analyzing these reports, and suggestions will be made to each plant on the best method of improving its operating conditions. This same staff of engineers will also visit the various plants to study conditions and; after consulting with the engineer of that plant, will report to the owner on possible savings that can be effected. A similar questionnaire will be sent out each month, and the replies received will show what saving is being made. Posters that have been prepared by the United States Fuel Administration (General Letter No. 6) will be placed in every boiler room and an appeal made to the firemen to show their patriotism by following directions on these posters.

Both engineers and plant managers have shown every inclination to help the work along, and a considerable saving has already been effected, which will be increased as time goes on, and it is hoped that the results obtained will fully justify the effort made.

GENERAL LETTER NO. 4

To the Woodworking Plants of New Orleans.

Gentlemen: As an aid in the work of fuel conservation, the New Orleans Committee of the United States Fuel Administration request that you give them the following information:

1. What kind of power do you use to operate your plant?
2. Do you make any use of the wood waste obtained in manufacturing your product?
3. Does this waste exceed your own requirements, and what disposition do you make of the excess?
4. State the amount of this excess and advise whether you are willing to dispose of it to other steam plants in your vicinity.
5. Give the names of the plants in your neighborhood that might be able to use this wood waste as a substitute for other fuel.

If further information is needed by you in order to answer these questions, you will please communicate with the advisory engineer of the board, Leo S. Weil, 303 Whitney-Central Building.

Your prompt coöperation will be of great assistance to the committee, and is earnestly requested.

Yours very truly,
HAROLD W. NEWMAN, Chairman.

GENERAL LETTER NO. 6

To the Users of Industrial Coal in New Orleans.

Subject: How To Reduce Coal Waste.

1. Keep the heating surfaces of the boilers free from soot, scale and oil.
2. See that the baffling is in good condition and that the gases follow the proper path.
3. Be sure that the boiler settings are tight and free from air leaks.
4. Work your boilers up to their rated capacity. Do not have more boilers in operation than are necessary to carry the load.
5. Do not have too much grate surface for the size of the boiler.
6. Do not have openings in grates so large as to lose a large amount of combustible with the ash.
7. Fire light and often, spreading the coal over the thin spots in the fire.
8. Keep the fires level and free from holes.
9. Use the dampers to regulate the draft; not the ashpit doors.
10. Do not carry the fires so thin or have so much draft as to draw a lot of excess air through.
11. Do not carry the fires so thick or cut down the draft so much as to have incomplete combustion of the coal.
12. Admit some air over the fire to complete combustion.
13. Do not soak the coal with water before firing.
14. Be sure the blowoff valves do not leak.
15. Do not have the safety valve popping off continually.
16. Use your exhaust steam to heat the feed water; do not waste it.
17. Have the valves on your engines properly set.
18. Minimize radiation losses by covering steam pipes.
19. Do not allow the waste of steam through leaky traps, valves, etc.
20. Never use live steam where exhaust is available and can be used as well.
21. Do not have belts too tight or so loose that they slip; keep all shafting in line.

CIRCULAR LETTER NO. 8

To the Managers of the Industrial Plants of New Orleans.

In accordance with the suggestions presented at the meeting last Thursday night, it has been decided to form an organization of owners of industrial plants in this city to coöperate in the efforts for the conservation of fuel. All coal users in New Orleans will be expected to join this organization, and a committee will be appointed from the members to coöperate with the New Orleans committee of the United States Fuel Administration.

The members of the organization will pledge themselves to use every effort to save coal; to follow suggestions approved by the local committee to this end; to provide the necessary instruments for ascertaining their operating conditions; and to keep records of these conditions, which will be submitted periodically to the Fuel Administration.

The local committee is confident that the patriotism of all steam users here will prompt them to join in this work. You are requested to signify your intention of coöperating by filing your membership pledge with the committee not later than Dec. 21.

The engineers of the local industrial plants will also be organized for the same purpose, and you are requested to bring this matter to the attention of your engineer and ask him to pledge himself to the work, at the same time.

A meeting of the operating engineers will be called to discuss ways and means of conserving coal, as soon as the replies are received.

We urge upon you the necessity of this fuel conservation work, and feel that we may count upon your coöperation.

Yours very truly,
HAROLD W. NEWMAN, Chairman,
New Orleans Committee Federal Fuel Administration
for Louisiana.

December ...., 1917.

Kindly enroll the undersigned in the conservation campaign of the United States Fuel Administration as above indicated.

....
....

Name of engineer employed:
....

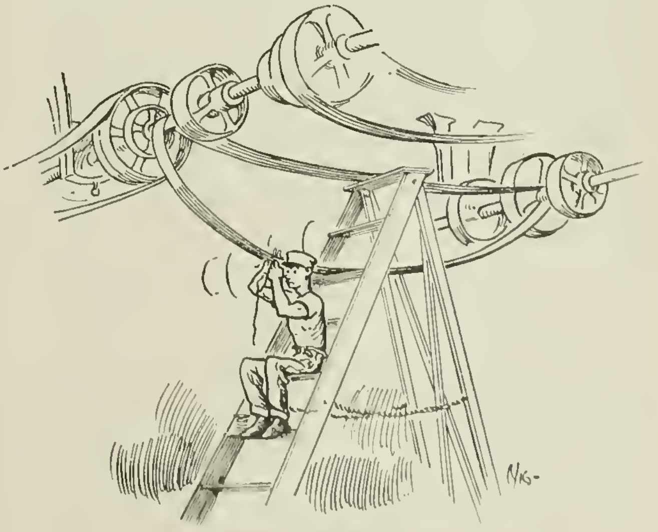
After signing the above, and furnishing the information requested, kindly return to the New Orleans Committee, Federal Fuel Administration, 402 Canal Bank Annex.

QUESTIONNAIRE OF THE POWER PLANT, NO. 9-A

(Date)..................

Name of plant........ Manager........ Engineer........
No. of boilers in plant........ make........ size........ grate surface.......................
Plant runs....hr. per day....days per mo.....mos. per year
Daily output of plant in per cent. of maximum............
No. of boilers operated.........method of firing.........
Kind of fuel used........ Amount per day........ Heating value........B.t.u.
*Water evaporated per day.........per lb. of fuel.........
*Temperature of feed water..........
*Average stack temperature...........
*Average per cent. CO_2...........
*Draft in furnace..........in uptake........(usual).
Usual thickness of fires.............
Do the firemen keep fires level and free from holes?.......
Are the boiler walls cracked or leaky?...........
Is the baffling in good condition?............
Is the heating surface clean from soot and scale?..........
How often are the tubes blown?............. System of blowing................
Do the blowoff valves on the boiler leak?.............
Are the valves on your engine properly set?.............
When indicated last.................
Is steam pipe covered?............
Live steam used for...........................
Exhaust steam used for..............
Can you suggest any way of reducing the fuel consumption of your plant, and how much do you estimate can be saved?......................

*If you lack instruments to measure these, say so.



THERE ARE OTHERS

Faulty Lubricating Methods

By Charles W. Oakley

The brasses of the eccentric rods on a large engine are of the marine type. An oil hole drilled through the end of the brass and an oil cup mounted on a pipe connection, as shown in Fig. 1, were to provide the means of lubrication. As a matter of fact, however, lubrication should be by way of the oil hole *A* in the top of the brasses, the cup being of little value because the oil fed from it flows to the bottom of the brasses and away from the pin, which has its principal bearing at the top. If the pin made an entire revolution instead of a slight rotating movement, the oil from the cup would do some good, but in any event the cup should have been mounted on top of the brasses with an oil hole leading down through the rod end and brasses to the pin.

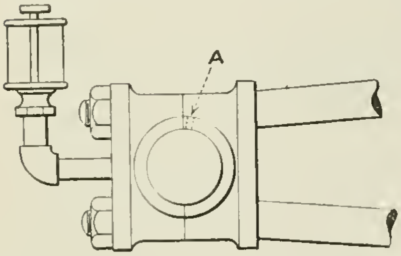


FIG. 1. OIL CUP SHOULD BE AT A

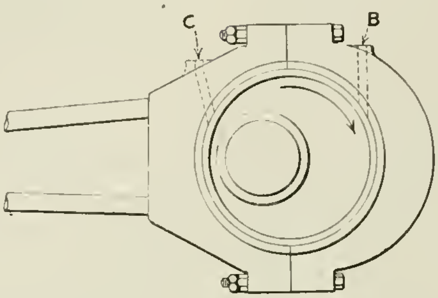


FIG. 2. STRAP SHOULD BE OILED AT C

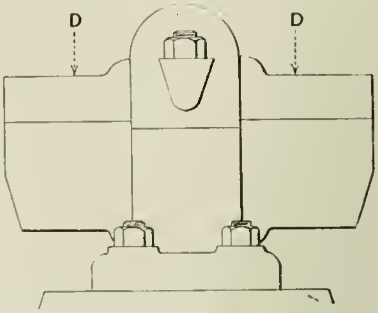


FIG. 3. SUGGESTED RINGS SHOULD BE AT D

Another case of poor design in applying lubrication is found on the eccentric strap of the same engine, where the oil is introduced through the strap at *B*, Fig. 2. As the direction of rotation is toward *B*, as shown by the arrow, most of the oil is carried down and lost at the slack side or bottom of the eccentric strap. If the oil cup were mounted at *C*, the oil would be carried immediately to the top of the eccentric where the weight of the strap and rod are supported, and the lubrication would be accomplished with less oil.

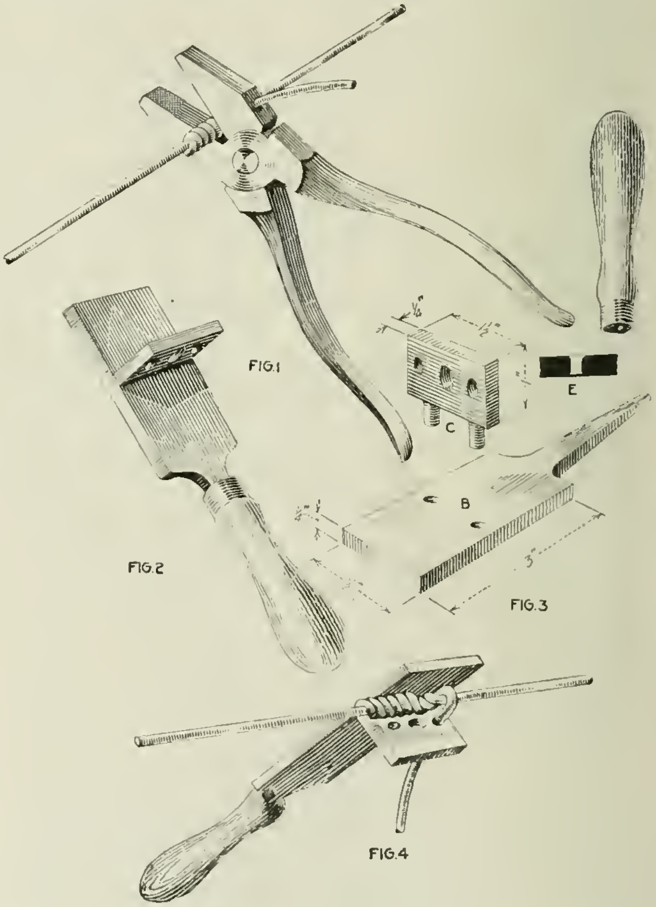
In the same plant a pair of jackshaft bearings carry a $6\frac{1}{4}$-in. shaft, the journal being about 26 in. long and constructed about as shown in Fig. 3. They are of the ring-oiling type with a single ring in the middle of the bearing, covered and hidden from view by the cap and yoke. This single split ring is not only insufficient to carry oil enough to properly lubricate the bearing, but in case of the ring stopping or coming apart, which has happened, there is no way of detecting it until the bearing is overheated. A pair of oil rings placed at *D*, *D*, with an opening over each for observation, would give better results and insure against a possible shutdown from a hot bearing.

Tools for Splicing Wire

By M. P. Bertrande

Everyone knows what a difficult job it is to splice solid hard-drawn copper or iron wire without suitable tools. In order to obtain a perfect joint, tension must be exerted on the wire ends while winding the splice, and this cannot very easily be done with the common type of cutting pliers. The self-explanatory illustration, Fig. 1, gives a clear idea of what may be done to overcome the difficulty. A $\frac{3}{16}$-in. hole is drilled in the soft part of one jaw of the pliers. Then by inserting the end of the wire to be wound and rotating the plier, a perfect tight joint is obtained.

Fig. 2 shows a wire-splicing tool that makes an excellent joint. It winds the joint tight up to the very end of the wire, something impossible with any kind of pliers. While the joint is being made, the other end of the wire is held by a pair of pliers. The tool consists of a piece of machine steel *B*, Fig. 3, to which a right-angle extension *C* is riveted. Three holes for the different sizes of wire are drilled, for holding the ends of the wire to be wound on the splice, as shown in Fig. 4. The holes for the wire should be well rounded, as shown at *E*, Fig. 3, so as to give the wire a good sliding surface.



FIGS. 1 TO 4. SPLICING TOOLS, PARTS AND ASSEMBLY

Editorials

The Pooling of Power

AT THE meeting of the American Institute of Electrical Engineers held in New York on January eleventh, there was read and discussed a very timely paper, "The Effect of War Conditions on the Cost and Quality of Electric Service," by L. S. Goodman and W. B. Jackson. Toward the close of the discussion, W. N. Smith called attention to the fact that in the large manufacturing districts in and about New York and other large cities there are, among the larger factories, many steam-power electric-generating plants which could be made available as auxiliaries to the central stations in times of emergency by commandeering them into a pooling system under the jurisdiction of Federal or state authority, which could be exercised through public-utility commissions or boards of engineers appointed for the purpose. While such auxiliary stations could not generate with as little fuel per kilowatt as the large central station, their load factors would probably be benefited. These distributed facilities and fuel supplies already existing would, in times of shortage, become immediately available for the needs of the community without having to wait longer than it would take to switch the auxiliary equipment to the existing systems of distribution.

The application to public use, on an extended scale, of such stand-by auxiliaries, would, of course, have to be carefully worked out by competent engineers, but it is perfectly feasible of accomplishment, both as to apparatus and circuit connections.

With a system of private plants pooled under control of public authority, it would become possible to enforce greater fuel economy than now exists in many of the factory plants available for commandeering, since they would be supervised by engineers who would be in a position to enforce the most economical methods of operation under the circumstances. It is an unfortunate fact that the average factory plant, in which the expense for fuel and power is small in comparison with the total manufacturing cost, is not run as economically as a similar plant owned by a public-service corporation or a manufacturer whose principal expense is for steam power. The manager of a plant of the former type pays little attention to the manner in which his steam is generated or used, provided he gets it when and where he wants it. In such cases boiler efficiency is as likely to be forty per cent. as seventy per cent. But with the system proposed, there could be brought to bear upon commandeered private plants some authoritative pressure from without, which is about the only method left to persuade an inefficient factory superintendent that it is better for him to improve his boiler and engine efficiency than to have his fuel supply for factory purposes reduced or cut off as a penalty for wasting it. Another advantage to the commandeered factory plant would be the increased certainty of its fuel supply upon becoming an auxiliary public utility.

In localities where war activities have put extra pressure upon all sorts of industry requiring fuel, it is time to apply to the central-station interests the same principles of coöperative pooling as are now being applied to the steam railroads by the highest public authority, to the great advantage of the public interest. It does not require much imagination to perceive both the ready-to-hand possibilities of helping out the central stations and of aiding in fuel conservation at factory plants used as auxiliaries, which would result from the institution of a system such as that outlined, of pooling central stations and private plants in the public interest.

The nonarrival of a single bargeload of coal, prevented by an ice blockade from reaching a central station, would not then be a matter of such moment to the community as it is now, when without warning, any part of the load on a large central station or important substation may be "pulled" by the load dispatcher and some sections of the community deprived of transportation or of the means of factory operation, or plunged into darkness.

We take occasion to remind the engineering profession and the general public of some of the methods of electric-power generation and distribution that were commonly practiced in the largest cities twenty-five or thirty years ago, in the early days of the electric-lighting industry, before the advent of the modern central station. At that period responsible central-station companies operated not only central stations of a few thousand horsepower capacity, but also had tied in with them or operating on separate circuits little isolated stations with a few small belted units in each, stuck around town in basements or in rented space adjacent to convenient boiler rooms; or else bought the output of small units operated by owners of factory plants at wholesale rates and resold the distributed output for both public and private lighting and power. To be sure, rates were higher then than now and fuel and wages were cheaper; but the point is that the public actually received pretty fair electric service from these heterogeneous, disjointed outfits operated in private isolated plants that were auxiliaries to the small central stations of that day. An emergency service from an auxiliary system of commandeered factory plants would certainly be better than no service at all from a large central station.

If this whole matter were taken up under public authority in any industrial district by the utilities commission having jurisdiction or by a board of engineers appointed for the purpose, it would be a simple matter to prepare an inventory of available isolated plants, with all necessary data as to their present duty, hours of service, usual fuel supply and storage capacity, cost of operation and the equipment and connections necessary to harness them to the existing distribution systems. With this information at hand and with the organization for utilizing it in the public interest, the central stations could be effectively supplemented and reinforced in their important functions. The public would then have additional protection against the sudden crippling of a big steam-turbine unit or against a blockade on the fuel supply of some important central station, both of which causes have recently operated to curtail electric service in the New York district.

If the attitude of the central stations is one of helplessness in a difficult situation, for which they are not responsible, they should be willing to be helped by public authority in the interest of the public whose creatures they are and whom it is their main business to serve. No one, least of all a private manufacturing concern, wants to subtract anything from the legitimate business of a central station or any other public utility; but if the public interest in the present vital emergency requires more perfect continuity of service than the central stations can give it unaided, it would seem that a concrete, practical remedy is not nearly so remote as the pessimistic statement of the problem would lead us to believe.

By utilizing the auxiliary steam-plant resources now available, the public will be better served, the strain on man-power and on financial credit will be to a large extent relieved, the available fuel will be more intelligently used than it is at present, the private power-plant owner will be stimulated into realizing his public obligations and will be incidentally rewarded by greater certainty of his fuel supply; and while the central-station interests will not be permitted to assume that their electric-supply facilities are the only ones available in a grave public emergency, they will, on the other hand, not be expected to perform the impossible.

While it is perfectly reasonable under ordinary circumstances to consider that a central-station electric-supply system is best administered as a monopoly, the status of the central station, being primarily just as dependent on the fuel supply as the isolated plant, takes away its apparent independence, after all, and makes it really a competitor of the isolated plants, so that in its economic relation to the community it becomes subject to the principle that, as in the case of the railroads, the public interest is better served by coöperation than by competition.

The War and the Individual

IT IS highly probable that the Third Liberty Loan will be launched about March first; but this much is certain—it will not only exceed in amount the two that have preceded it, but it will be the largest single war loan ever offered by any nation.

The prompt and complete absorption of so vast a sum —and no right-thinking person has any misgivings as to the successful accomplishment of that end—will require the whole-hearted support of every loyal citizen. It will mean sacrifices greater than those that have been made; it will involve self-denial to an extent which neither necessity nor inclination have yet been able to enforce; and it will demand of the individual the giving up of purely personal pleasures and conveniences to contribute to the benefit and well-being of all. But the true American stands ready to undergo all these discomforts when he realizes that by so doing he is strengthening our fighting arm and thus bringing the end of the war nearer.

There has been an unfortunate tendency on the part of some individuals to view the war as a thing remote and detached. They agree that conservation policies are needed to prevent waste, but they have done little themselves to carry out such policies. They continue to indulge in luxuries and extravagances to which they were accustomed in peaceful times, and by that very act they divert to the production of nonessentials a part of the labor and materials which should be devoted to the one great, overwhelming purpose of the present—the winning of the war.

It is charitable to explain away such action on the ground of thoughtlessness; but to admit that excuse is to emphasize the necessity of wider publicity concerning the relation of the individual to the present conflict. We must get away from the bald statement that the nation is at war and realize that we ourselves are in the war; for, after all, the nation is but the aggregate of individuals. The responsibilities and the hardships must rest upon us in equal measure, just as we expect to share in equal measure the fruits of victory.

The scarcity of foodstuffs and the shortage of fuel have done much to impress upon the individual how close the war comes to his own doorstep. He is at last awaking to the fact that his habits of living must be readjusted to meet the greatly altered conditions, and to prevent the rapid recurrence of such stringencies as have already been experienced. The lesson has been taught severely, but the truth is wholesome.

From this time forward there will be a closer watch kept on individual expenditures, greater economy in the consumption of necessities, and a growing willingness to do for oneself the things that were formerly left to others, all of which will result in making available additional wealth and energy for carrying on the war. The Third Liberty Loan will be oversubscribed, exactly as the two that have preceded; but it will be done by the dollars of those who put necessities before nonessentials, service in place of self-gratification, and patriotic devotion above all else.

Yet it is not enough that the loan be fully subscribed; it should be absorbed quickly. The rapidity and spontaneity with which our people answer the appeal of the Government for funds will be an unmistakable indication of their interest in the war and their willingness to assume its burdens. The effect produced on the minds of German militarists by the swift raising of the whole amount of the loan is an advantage not to be regarded lightly.

The cost of running the thousands of lights which are burned unnecessarily may be insignificant, but the cost to the average householder of running a few extra bulbs overtime makes a very significant difference in the monthly account rendered. We are glad to see that Fuel Administrator Garfield has made a positive move toward restricting this waste, and hope his order will be complied with without disparaging criticism.

We have often wondered why some philanthropists and conservationists have not endowed a fund to put a few convincing talkers on the road to show power-plant owners how much their engineers may save with the aid of a water meter, coal scale, Orsat and a few thermometers. Gifford Pinchot, Andrew Carnegie and the Rockefeller Foundation please take notice.

Correspondence

Change in Water Supply for Air Pump of Leblanc Condenser

In *Power* of Nov. 20 Mr. Forseille brings up some interesting points on the subject of the change in water supply for air pump of Leblanc condenser. The two problems as stated in his query are: First, that of furnishing a Leblanc condenser with enough water to get a good vacuum; second, that of getting rid of slush ice on strainers in the water-supply line to the air pump.

The first is by far the most serious as it causes a loss during the whole year. In Table I is given a comparison of the conditions as stated by Mr. Forseille with those that would obtain with larger amounts of condensing water. Water rates of 32 (Mr. Forseille's stated rate), 45 and 60 lb. per pound of condensed steam are shown as representative of the range of possible improvement. For intermediate points curves can be drawn or reference can be had to tables of vapor tension, and this tabulation can be augmented to cover any comparisons required. In this table it is assumed that the exhaust steam discharged to the condenser contains 950 B.t.u. per pound. Under each of the three water rates are tabulated the conditions for cooling-water temperatures of 32, 60 and 100 deg. F., which nearly cover the range Mr. Forseille says he has to operate on.

TABLE I. A COMPARISON OF REPRESENTATIVE CONDENSER CONDITIONS

Lb. Water per Lb. Steam	32			45			60		
Cooling-water temperature, deg. F.	32	60	100	32	60	100	32	60	00
Rise in temperature, deg. F....	30	30	30	21	21	21	16	16	16
Discharge temperature, deg. F.	62	90	130	53	81	121	48	76	116
Vapor tension at above discharge temperature, lb.	0 56	1 41	4 52	0 40	1 06	3 52	0 33	0 90	3 05
Corresponding vacuum with 30 in. barometer...	29 44	28 59	25 48	29 60	28 94	26 48	29 67	29 10	26 95

Actual vacuum is likely to be from 0 3 to 0 4 in. mercury lower than these values.

A rearrangement of the above vapor tensions and vacuums to make the comparisons more clear is shown in Table II.

TABLE II SUMMARY OF VAPOR TENSIONS AND VACUUMS ARRIVED AT IN TABLE I

	Cooling Water Temperatures, Deg. F		
Water per Lb.; Steam, Lb	32	60	100
32	0 56	1 41	4 52
	29 44	28 59	25 48
45	0 40	1 06	3 52
	29 60	28 94	26 48
60	0 33	0 90	3 05
	29 67	29 10	26 95

Referring to the tables, it is seen that increasing the condensing water from 32 lb. to 60 lb. will improve the vacuum about ¼ in. when cooling water is at 32 deg., about ½ in. at 60 deg., and 1½ in. when water is at 100 deg. The result of improvement in vacuum in terms of cash value is brought out forcibly in Mr. Baker's article in the Dec. 4 issue of *Power*.

If the pump turbine in this case is now working to the absolute limit of its capacity, little can be done but to replace it with a turbine or motor big enough for the job; but if it is capable of being speeded up by overhauling or readjustments, there can be no doubt that it would pay.

I notice that Mr. Forseille says that the air-pump supply valve is kept at a constant setting under all conditions. This suggests to me that it may be taking more water than necessary and, if so, is giving the turbine extra work to do from which there is no return.

The vapor tension values used above are from a table given by the Westinghouse Machine Co. in its instruction book WM 102.

The second problem is that of preventing ice formation on the strainers in the supply lines to the air pump. One point involved here is that of vapor tension of the hurling water. As this water is depended on to condense any condensable vapors that may reach the pump, and as it passes through a region of vacuum after it passes through the blades of the impeller, the vacuum produced is controlled by the temperature of this water and its corresponding vapor tension. See the tables.

Another factor of importance is the air discharged, entrained with the water, through the main discharge pipe. There is always some air passing out of the condenser in this way, the amount probably varying with the depth of submergence of the pumps; but if the pumps are run fast enough to lower the water level to the suction opening of the pumps, additional air will be trapped and carried out with the water. To use this water in the air pump would add to the free air in the condenser. It would also be likely to interfere with proper working of the air pump by breaking up the "water pistons" as they leave the impeller blades.

If Mr. Forseille had given more details as to elevations and the vacuum gage readings on suction or injection lines, more might be said about how operating conditions could be improved.

For preventing ice forming on the screens I suggest tapping in a jet of steam or hot water just below where the air-pump line leaves the main line or a jet just ahead of each screen.

The above discussion was written before reading Mr. Johnson's contribution in the Dec. 18 issue, and from the start it was assumed that it was impossible to follow the scheme Mr. Forseille suggests. C. W. BELL.

Hauto, Penn.

Worn Latch Blocks Cause Racing

When I took charge of this plant, which is equipped with Laidlaw-Dunn-Gordon-Hamilton gear pumping engines, I had a great deal of trouble with the latch blocks wearing and the engines racing, caused by the head end letting go too early and the crank end going in full gear or not unhooking at all. I did not know what the matter was; neither did the builders nor those who did the erecting. The crank end would go in full gear about every third or fourth revolution, so you can imagine what a time I was having. I had been a marine engineer and had had no experience with Corliss engines, but it occurred to me that possibly the blocks were unlatching too soon; so I put my thumbs on the springs to help the tension of the springs, and to my surprise the engine stopped racing. I then got wise and turned the blocks around so that new edges or sides came together. That was all right so far, but all the service I could get out of the new edges was about 15 days, after which they would begin to cause racing again.

One day when *Power* came, I sat down to read it, and under the head of "Correspondence" I came across a letter by an engineer who had been having the same kind of trouble that I was having. He said that he had had blocks made out of No. 00 steel and it cured the trouble. I made up my mind that if it was a good thing in his case, it would be good in mine; so I had similar blocks made and put a set on one engine Aug. 3, 1911, and on another Sept. 30, 1911. I have not had a bolt out of one of them since.

If there is anything in this that you think worth publishing, do so, but do not send me anything for it, for I do not want it and will surely send it back if you do, as it is written in gratitude for the "pointer" received from *Power* several years ago. I hope this may do someone some good. R. A. DAVIDSON.

Colton, Calif.

Operating Two-Phase Motors Single-Phase

A number of years ago, when the plant in which I am employed was built, two-phase alternating-current equipment was selected, consisting of one 50-kw. and one 75-kw. generator, with exciters, supplying twenty 5-hp. induction motors of the squirrel-cage type, some fifty inclosed arc lamps for general illumination and about two hundred and fifty 16-cp. carbon lamps for local lighting. The motors were 220 volts as well as the carbon lamps. The arc lamps were of the multiple type, and groups of four were served by compensators or balance coils, furnishing 110 volts. Shortly after the plant was put in service, business became dull, and as a result many of the machines were shut down; consequently a number of the motors were running considerably under full load, causing the power factor of the plant to be low.

A test was made, and the load conditions of the plant at that time were about as follows: Apparent kilowatts as shown by the ammeters and voltmeters, 47.4; true kilowatts as shown by direct-reading wattmeters, 19.6; power factor at switchboard, equal true kilowatts ÷ apparent kilowatts = 19.6 ÷ 47.4 = 0.41.

As the 50-kw. generator, which was supplying the load at that time, was heating considerably, it was decided if possible to improve the power factor. After considering several plans, I fell upon the idea of operating the two-phase motors single-phase, starting on two-phase and then cutting one phase out when the machines were up to running speed. This would give the single-phase in use nearly full load and perhaps correct the power factor. I also discovered that by removing two contact blocks I and II, shown in the figure, from the drum of the auto-starter, one phase could be cut out when in the running position. Since with this type of compensator the drum always turns in one direction, the section with the two contacts removed would be in phase *A* at one time when starting and the next time in phase *B*. The motors were started and stopped twice per day, consequently if phase *A* was in service in the morning, phase *B* would be in use in the afternoon, so that both sets of windings of the stator would be in use during alternate halves of the day. However, if for any reason any of the motors were stopped during the day, the handle of the starter would have to be thrown over twice to maintain the load balance in the phases. Two ammeters on the main distribution-panel box circuit indicated the load in each phase, therefore making it possible to see that the system was kept as nearly balanced as possible.

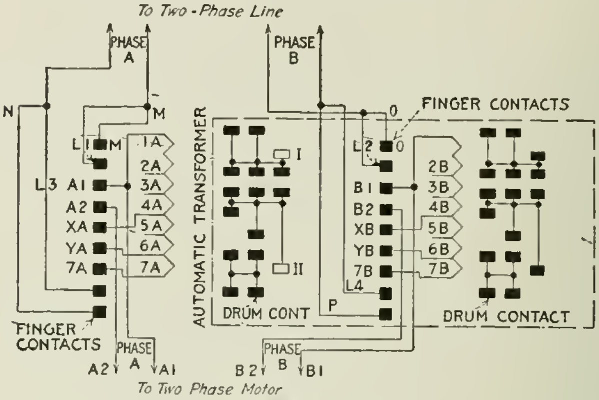


DIAGRAM OF COMPENSATOR CONNECTIONS

One motor was at first arranged to run single-phase as planned, and operated for a week with no trouble. The manufacturers of electrical equipment were then consulted as to what would result from the change. They replied that under the circumstances there would be a slight improvement and that no harm could come to the apparatus operating under such conditions. Eight motors were run on that plan during slack seasons, which occurred during every summer and recently both summer and winter; but I had never known, owing to the lack of proper instruments, how much improvement the change had produced until in October, 1916, when, owing to the high price of coal and the difficulty in obtaining it, the manager was persuaded by a central-station company to permit a test to be made by their expert. The result of the test was as follows: Apparent load, 37.125 kw.; true load, 19.4 kw.; power factor = true load ÷ apparent load = 19.4 ÷ 37.125 = 0.52. It will be seen that although the true load in both tests was nearly the same, the apparent load was much less with part of the motors running single-phase.

During recent years the tungsten incandescent lamps have been substituted for the arc lamps, and in order to permit the use of the 110-volt current necessary, the old balance coils of the arc lamp were employed with satisfactory results, 3000 watts or less being carried by each without difficulty and with very little heating. These coils are arranged on the roof trusses, one in the center of each group of lamps. When the incandescent lamps are burning, they have practically 100 per cent. power factor, and the power factor on the whole circuit is 76.8 per cent., the power factor of the motor load being as stated. With every machine in the factory running and all motors operating two-phase, the motor-load power factor was 66 per cent. With this motor load and the lights all on, the power factor was 77.4 per cent. These are the central-station company's own figures.

Weehawken, N. J. F. W. **Plumb.**

[Operating polyphase motors single-phase is a practice that in general is advised against, but under the conditions it would seem to have some advantages. *Power* invites the opinion and experience of interested readers on the foregoing subject for publication.—Editor.]

Modification of the Pitot Tube

It would appear that the modified Pitot tube depicted on page 876 in the issue of Dec. 25, 1917, is not fully described or else is entirely erroneous. The static pressure within the pipe would cause a full-caliber flow through the valve even if there was little or no flow in the main, therefore the slight velocity head added in any case would make little difference.

It is possible that the intention is to calibrate or measure the flow through a restricted orifice under a given pressure at no flow, then measure the flow under the combined influence of the static and velocity head and calculate the velocity from the increased delivery. At any rate the contrivance does not seem to be logical as presented. J. **Lewis.**

New York City.

Electric Lights for Small Plants

When on an automobile trip recently, I stopped at the pumping station of a Massachusetts town. I was cordially greeted by the engineer who, among other things, took pride in his lighting set inasmuch as it was original and, as he thought, cheap to operate. Fig. 1 shows the set, which consists of a small Pelton waterwheel direct-connected to two small direct-current generators. The wheel's water supply, at 180-lb. pressure, is through a 2-in. pipe connected with the pressure pipe of pumping engine, and the discharge from the wheel is connected to the pump suction. The engineer claimed that the cost of current was considerably less than two cents per kilowatt-hour.

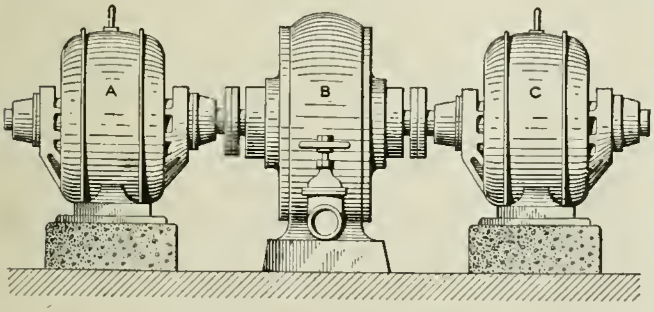


FIG. 1. TWO GENERATORS DRIVEN BY A WATERWHEEL

In another plant visited, the generator was driven as shown in Fig. 2. Two heavy iron columns *D* were erected near the flywheel of the pumping engine, and two long screws *E* were secured to them on which two bearings *C* could be raised or lowered at will to bring the leather-covered pulley *B* in contact with the flywheel.

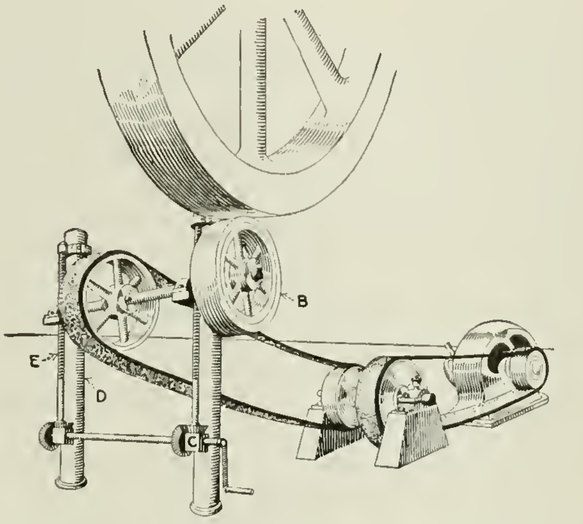


FIG. 2. DYNAMO DRIVEN FROM A FRICTION PULLEY

By this means the station was electrically lighted, otherwise oil lamps would have to be used.

Methuen, Mass. P. E. **Merriam.**

Care of Hydraulic Elevators

Hydraulic elevators require more attention than electric, and where there are a great many cars in service they should be placed under the management of a competent elevator man.

On high-pressure systems the pilot valves will most frequently require attention, as they become clogged with dirt and particles of packing carried through the pipes, and must be blown out. Next comes the packing of operating valves with leather cups, which either blow out if end cups or blow through if inside, either of which will cause the car to creep or settle. Motor valves, operating the pilots, should also be inspected and the flax packing rings renewed if necessary.

Each morning the water that has accumulated in the lunger pans should be removed and the plungers oiled (while running) with lard oil, as this is best where there is water. When the glands are within a half-inch of all the way in, the stuffing-box should be refilled with flax packing.

Hoisting cables will need to be shortened occasionally as they lengthen with wear. This will be determined by running the car to the upper floor and observing whether it comes flush with the floor or falls short. Cutout, operating (or tiller) and governor ropes should be inspected weekly, because much damage can be caused by the failure of any one of them. The practice of relying on the insurance inspections, occurring as they do about once in three months, is very bad.

Phosphor-bronze is the best material for the main operating valve, as a soft brass one will soon wear to a shoulder from the constant rubbing back and forth, and these valves should be purchased as unfinished castings so that the small holes can be drilled in as desired. The brass bushings in the pilot valves will require to be renewed occasionally and of course must be made a driving fit.

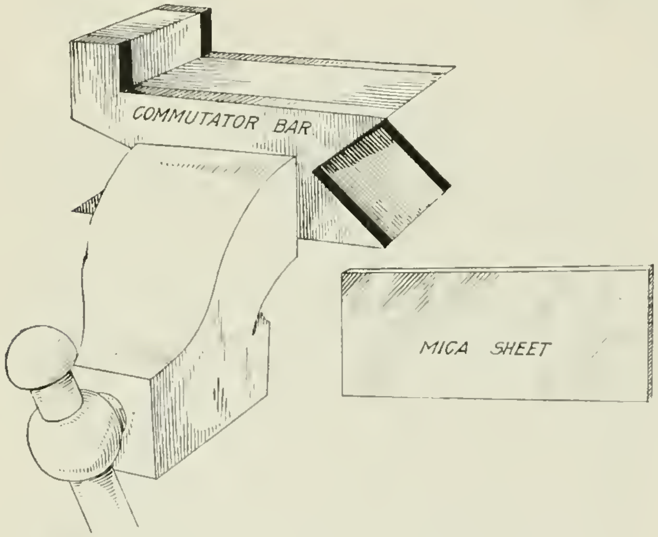
Of the safety devices on elevators, there is one that I believe should be especially mentioned, and that is the valve lock that prevents the car from being moved if any gate in the shaft is open even a fraction of an inch. Many accidents occur at the gates, as the operator is prone to start the car first and shut the gate afterward, but with this device in operation the car remains stationary until the gate is closed. It will not, however, prevent a car from settling or creeping, as that is caused by defects before mentioned, but it does prevent the operator from starting the car before closing the gate.

The surge tank will need a thorough cleaning out about once a year to keep the system clear of dirt, etc., that may lodge in the pilot valves and cause serious trouble. W. T. Osborn.

Newark, N. J.

Cutting Mica for Commutators

The following may help someone in a small shop, who has the job of cutting mica for refilling an old commutator. In a good many shops the practice is to take one of the bars, lay it on a single piece of mica, mark it off with a scriber and then cut it out with a pair of shears. A much quicker and more accurate way is to cut the mica in pieces slightly larger than the bars, then clamp about a dozen of these sheets between two of the bars in a vise and saw out to approximately the shape with a hacksaw and finish the dressing with a file.



MICA SHEETS CLAMPED FOR FINAL SHAPING

Stone, Ky. J. E. May.

A Wooden Tank Repaired

A wooden water tank on the roof began to leak, and it was found that some of the planking was decayed at the tongue-and-groove joints.

It seemed that the old tank had seen its day and would have to be replaced, but one of the maintenance men suggested that it be emptied, cleaned, dried out and lined with portland cement. Lathing nails were driven all over the inside walls at about six-inch intervals, leaving each nail head projecting about one-quarter inch, after which the whole interior was plastered over, about three-eighths inch thick, and when set, the surface was washed over with a thin coating of clear cement a couple of times.

The result was gratifying, for the tank is tight, and there are no signs of further deterioration.

Concord N. H. Charles H. Willey.

Gas Engines of Former Times

In going over our data file recently, I found a letter from a man in Pennsylvania who was using a gas engine, and I am sending you an exact copy, thinking it may be of interest, as indicating the status of gas engines at that time, the kind of service to which some were put, etc. Seventeen years have shown remarkable development in equipment of this kind.

Newark, N. J. N. A. Carle.

.... Opera House
.........., Pa., July 30, 1900.

To united Electric Company of New Jersey

Gentle Men Yours of July 27 received In regard to Gas Engines I have used automatic Gas Engine for running Dimo to Light my Opera house last winter 25 horse Power I got 300 lights I got 15 Kilowatt Dimo I had good steady light Engine run from full load to no load you now Opera house Lighting To hard on Engine we go so many dark cein we would have on 300 lights and then we would have nothin. I use natral Gas Cost me 20 cents Per thousand avrige cost Per night of run of 10 hours 27 cents Repairs on Engine for 7 months $5.67 all the Engine want is care no experimenting with It and It will work all right I consider the Engine as a hole a good one

Now for Its disinantiges It Is hard Engine to Start I have been starting mine with Powder and It Is dangerous and leavs a bad smell In house your Electric Spark must be Perfect and your Storige battry must be all right the battries I got with Engine Is now Plaid out there was 4 cells I wish you would send Me the adress of some good firm I will have to have Storige battries before I star up again I am goaning to Put In a air Pump & Tank and Start It with air this season the Engine cannot be started By hand there Is a saving to Me of about 60 Dollar Per month I consider the Engine will Pay for It self In 3 years we run the Engine 280 revelutions Per minut we get Explosing Every time If you want to now any other Point about It let me now and I will Try and Explane It as well as I can

Yours Truly, ...

Sucking from a Condenser

In reply to Mr. Baer's request, on page 807 in the issue of Dec. 11, for a sketch and description of how an engine could suck up a cylinderful of water from the condenser, I will say that I cannot furnish a sketch of the piping as I have been away from the plant for some time and cannot get a correct sketch of it. Maybe I was in error in saying the engine sucked up a cylinderful of water, for the least little bit over clearance volume is enough to wreck the engine as water is practically incompressible.

The condenser was an old-time Conover with vertical pumps working on the same shaft. The circulating water also sealed the condenser, and when the latter was shut down and the circulating water not shut off, the steam could not exhaust and was condensed, and when the engine made a return stroke the water was sucked back, or a portion of it, owing to the vacuum not being entirely gone. W. H. Nostan.

Philadelphia, Penn.

Inquiries of General Interest

Dry Materials for Extinguishing Fire—What material could be used in dry powdered form for extinguishing fire? L. S. E.

Pulverized bicarbonate of soda (baking soda) or pulverized salt is a good material for extinguishing fire. Dry sand is a good material for smothering small oil fires.

Lengths of Splices for Leather Belts—What is the rule for the length of splices for leather belting? W. R. K.

For belts up to 10 in. wide, make the splices 10 in. long. Belts that are 10 to 18 in. wide should have the splices as long as the belts are wide. Eighteen inches is the greatest length required for the splice of a double belt.

Steam Cylinders for Compound Duplex Pump—A compound duplex steam pump of 12-in. stroke and having 8½-in. water cylinders is to work against a discharge pressure of 180 lb. per sq.in. What should be the sizes of the high- and low-pressure steam cylinders if exhaust takes place against 2 lb. pressure above the atmosphere? G. R. W.

With ordinary clearance and other proportions of design, each side of the pump should have a 9-in. diameter high-pressure and 15½-in. low-pressure steam cylinder.

Rating Boiler Size on Heating Surface—In rating boiler horsepower according to the number of square feet of heating surface, is not superheating surface to be included? L. G.

The horsepower rating according to heating surface is purely commercial. Water-heating surface, or surface in contact with fire or hot gases on one side and water on the other, is very effective in transmitting heat, and this is the principal kind of heating surface in nearly all types of boilers and in most boilers it is the only kind. The heat transmission through superheating surface which has fire or hot gases on one side and steam on the other side is very slow, and it is not customary to count in this kind of heating surface in rating the nominal or manufacturer's horsepower of a boiler. The superheating surface should be separately stated as such.

Air Gathered in Feed-Water Oil Filter—The returns of a vacuum steam-heating apparatus are delivered to an air-separating tank and thence discharged to a receiver and boiler-feed pump. After being discharged by the pump, the return water, on its way to the boiler, is passed through a cloth-bag filter for removal of the oil. Air collects in the upper part of the filter. What is the cause and remedy for removal of the air gathered in the filter? G. G. W.

It is probable that the "air" complained of consists of oil vapor and air liberated out of the water when the pressure of the water is suddenly reduced, after being subjected to the greater pressure necessary for forcing the water through the filter. If it is permissible to have a small air space in the top of the filter, the air or vapor can be relieved automatically by connecting a float type of radiator air valve with the upper part of the filter chamber, or with an appropriate enlargement of that space by employing a small air chamber made of pipe and fittings.

Advantages and Disadvantages of Steam Dome—What are the advantages and disadvantages of providing a horizontal return-tubular boiler with a steam dome? L. D.

The advantage of a steam dome on a boiler is that it increases the volume of the steam space and allows the steam to be taken from the boiler at a point somewhat removed from the surface of the water, thereby insuring a supply of drier steam than if the supply were taken directly from the shell. The leading disadvantages are the added expense, difficulty of making and maintaining safe and tight connections of the dome with the shell and the uncertain weakening effect of the dome opening on the shell. The advantage of obtaining drier steam can be met, however, by a good form of dry pipe or separator placed within the shell or by employment of an exterior steam drum. A steam drum with nozzle connection to the shell is usually less expensive than a dome, and besides affording the opportunity for much safer construction has all the advantages without any of the disadvantages of a dome, excepting the requirement of practically the same if not less headroom.

Independent Stacks for Horizontal Return-Tubular Boilers—For a suburban factory power plant, begun with the installation of two horizontal return-tubular boilers that probably will be duplicated within a year, would it be better to supply each boiler with a separate steel stack set over the uptake, or provide a steel stack that will be adequate for all boilers? J. B. N.

The best draft control would be obtained by furnishing each boiler with a separate stack, but placing the stacks directly over the boiler uptakes is objectionable on account of the expense of providing supports suitably independent of the boiler settings and trouble will be experienced from soot and scale dropping from the inside of the stacks into the uptakes of the boiler. The arrangement also would be likely to give trouble from rain water running down the sides of the stacks and finding its way to the boiler settings. These disadvantages can be obviated and nearly the same draft advantages of independent stacks can be secured by setting the stacks at the sides of the settings or to the rear of the firing spaces, and providing the connections from the uptakes to the separate stacks with easy bends. For most situations the independent stack supports and connections should cost no more than proper provision for independently supporting the stacks directly over the uptakes of the boilers.

Sufficiency of Chimney Draft—Trouble is experienced in burning sufficient coal and keeping up steam in two return-tubular boilers each 72 in. in diameter and containing 92 tubes 3½ in. diameter by 18 ft. and with breechings connected to a brick stack 48 in. in diameter at the smallest part and 80 ft. high. Is the chimney size at fault, or if not, what may be the cause of the trouble? W. K. C.

The rated size of each boiler is about 150 boiler horsepower. Allowing for combustion of 5 lb. of coal per boiler horsepower, ordinary form of breeching and other smoke connections, a fair quality of fuel and proper firing, the chimney should be adequate for about 310 boiler horsepower or ample for the boilers. It may be that the draft is impaired by proximity of high hills, or that air enters cracks or opening in the chimney flue or connections. The size and form of the connections from the boilers may be at fault for realizing the draft effect of the chimney. The uptake from each boiler should have an unobstructed cross-sectional area of not less than 775 sq.in. The cross-sectional area of the breeching and connections to the chimney should be not less than 1600 sq.in.; the breeching should be provided with a baffle for carrying the smoke of the boiler farther away from the chimney over or around the uptake of the boiler nearer the chimney,and the breeching connections, especially the junction with the chimney flue, should be beveled or curved to admit of easy passage of the gases.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

The Failure of Boiler Plates In Service[*]

BY E. B. WOLFF[†]

The author's investigations show that peculiar cracks in boiler plate occur at the riveted joints in all boilers examined. These cracks are found on the inner surfaces of the rivet holes or on the surfaces of the plates where they are held together. The cracks are due to fatigue.

THIS research was undertaken with the view of finding the causes of the cracking of boiler plates over the riveted seams.

The boilers were of the single-ended ordinary marine type, with three flues. The shell plates and the rivets were generally approximately 32 mm. (1 in.) thick, made some from basic and some from acid openhearth soft steel with an ultimate tensile strength of 42-48 kg. per square millimeter (59,700 to 68,000 lb. per sq.in) and an elongation of 23 per cent. to 20 per cent. on 10 diameters. The phosphorus and sulphur contents had to be under 0.05 per cent. Most of the boilers with the cracked plates belonged to steamship companies, the boats of which made voyages with a great many stops, so that the fires were frequently extinguished and relighted. Most of the boilers being oil-fired, this could be done very easily. The plates of coal-fired boilers, however, cracked in the same manner. Boilers made of the same material for other companies, the boats of which had only long nonstop runs, did not fail.

CRACKS AT FIRST OF MICROSCOPICAL DIMENSIONS

All the cracks found are, in the beginning, defects of microscopical dimensions. After having increased in length and breadth, they could be detected. It would occur that a boiler, the side seam of which had failed, would be sent back to the boiler shop to be fitted with a new shell plate. After detaching the front plates, nothing abnormal would be seen, and it would be decided to make use of the old front plates and fit new shell plates to them. The shell plates were bent with great care to the radius of the front plates and bored in position. When the first rivet joining the front and shell plates was put in, cracks appeared in some of the old rivet holes of the front plate. By a renewed examination of the other rivet holes, after cleaning the metal by scraping it carefully and later etching it, minute cracks were detected. The etching of the front plate, in the manner presently to be described, disclosed a great many miniature cracks, so that it was impossible to use it any more.

As already stated, the cracks were found in the butt joints as well as in the lap joints, but in all cases they started either from the inside of the holes, in two places, where the highest tensile stress occurred, or at the surfaces of the plates, where they were pressed on the surfaces of other plates. The fact that cracks start frequently on the inner surfaces of boiler plates has been mentioned by several investigators,[1] but a good indication of the causes has not been given.

The cracks cover a certain part of the surface, depending on the direction of the stresses that acted on that part. Where they are found in the rivet holes of the plates, they occur generally on two sides of the holes; in the case of the pipe holes of the tubular boiler, they spread from the top of the hole inward. When they occur on the surface of the plate, it is in general mostly around the rivet holes, but also in other places.

As mentioned, the cracks start as miniature surface cracks of microscopical dimensions; it appears that every little crack has been formed by itself, without the slightest reference to its neighbors. A polished and etched section through these cracks shows that the crystallites in the immediate neighborhood have not been deformed. The structure of the material has in most of the cases been found quite normal, no free cementite being present. Afterward the cracks grow in length and depth, and unite in longer ones, forming a peculiar stepped line.

PECULIAR DESTRUCTION OF SURFACE LAYERS

All evidence points to a peculiar form of destruction of the surface layers of otherwise very plastic metal. As the cracks always started at the surface of the metals and in the holes over the entire thickness of the plate, phosphorus or sulphur segregations, if these had occurred, could have had no influence. No segregations of importance were, however, found in most of the cracked plates. At first it was thought that the deformation of the material in the rivet holes made by the boring of these holes might have had a great influence. As it was not possible to produce similar cracks in holes that were bored with a blunt drill, and as pieces cut out of such a hole and bent open till the deformed surface broke showed sufficient deformation before breaking, it was concluded that if the deformation had been one of the causes, it could only have been a secondary one. As hand-riveted joints cracked in exactly the same manner as joints where the rivets had been pressed in by the hydraulic riveting machine, the pressure of this machine on the plate also cannot be the cause of the cracking.

Parts of the cracked plates, where no cracks occurred, were tested by joining them by rivets, driven in with the maximum pressure the press could give. Afterward the rivets were taken out and the plates examined and bent. Here a great deformation of the surface also preceded the rupture.

To reveal the miniature cracks it was found necessary to etch the metal with dilute sulphuric acid (1 : 10) during twenty-four hours or more. Before this etching the cracks were covered by the surface oxides, and they could not even be detected after scraping the plates thoroughly. It was necessary to ascertain that this etching did not cause similar cracks. It was found that in no case of deformation could cracks be seen after etching, not even if the metal were left in the etching solution for an abnormally long time. The deformed places were corroded in most of the tests before the rest of the metal, but this corrosion never caused sharply defined cracks. By an abnormally long immersion the deformed places could not be differentiated from the neighboring metal; the cracks, however, showed very clearly. Microscopical sections through nonetched parts showed that the cracks were clearly to be seen without the aid of an etching solution.

Some parts of plates from other seams of the cracked boilers did not even show cracks after prolonged etching.

ETCHING AN AID IN DETECTING BAD PLATES

The etching with sulphuric acid has been of great aid in detecting the bad plates from those that could be used again. It dissolves the metal quite regularly and discloses even the finest cracks. The only phenomenon known where cracks of the kind described have been observed in plastic material is that known as "fatigue." The beautiful researches of Ewing and Humfrey have disclosed the mechanism of the formation of these very local hair-cracks in plastic metal. A case of the formation of similar cracks in a large shaft, where overloading in service could be proved, showed quite the same kind of cracks after etching with diluted sulphuric acid.

Photomicrographs show that the crystallites in the immediate neighborhood of the crack were not deformed. This

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[*] From report in "Engineering," London, Sept. 28, 1917, of a paper read before the Iron and Steel Institute, September, 1917.

[†] Bussum, Holland.

[1] C. Sulzer, "Wärmespannungen und Ritzbildungen," "Zeitschrift des Vereins deutscher Ingenieure, 1907. Report by the National Physical Laboratory of an investigation of some unusual defects in the plates of two combustion chambers on board a foreign-going passenger steamship, and note by the engineer-surveyor-in-chief; "The cracks themselves were unusual, as they appear to have started at the inner surfaces, where the plates were laid together for riveting, and were invisible until extended through the plates." —"Engineer," 1910

was also the case with the boiler-plate cracks. These parts in the boilers being subjected to stresses of such magnitude, it may be asked how it is that the few alternations during the lifetime of a boiler can cause these cracks. It may be observed, in the first place, that the ships with boilers that have cracked made relatively short voyages along the coast, and that in the beginning no care was taken to avoid changes in the steam pressure. When, later, care was taken to maintain the steam at a regular pressure, the cracking diminished, but did not stop altogether. The first boilers were oil-fired and were made of basic openhearth material; afterward boilers, both oil- and coal-fired, made of first-quality Scottish acid steel, cracked in the same manner. Notwithstanding the severe conditions of the service, the number of the alternations is, however, only few when compared with that required to produce ordinary fatigue breaks. Only when it can be proved that at the places where the cracks are found abnormally high stresses can occur, may we accept "fatigue" as the cause of these cracks. It was necessary, therefore, to start an investigation of the stresses occurring in these parts of a boiler.

It is known from the theory of Kirsch and Leon and the tests by Preuss that the tensile tension at the edges of a hole in a bar loaded in the direction of its axis may amount to three times the average tension calculated for that bar. When it can be proved that the holes of a riveted joint can behave as in ordinary bars, we have an explanation for the fact that the tension at the edges of the holes can reach a very high value. The average tensional stress in the cracked plates was approximately 11 kg. per mm. When this value is trebled we reach such a high stress in these places that very few alternations will suffice to cause a crack. It is thus necessary to prove that the friction between the plates will not be sufficient to counteract the deformation of the sides of the holes.

USING SPECIAL TYPE OF EXTENSOMETER

With a view of testing this, and to learn the values of the local stretch in different places of the surfaces of the plates that are pressed against each other, the author has made use of a special type of extensometer, designed by Mr. Okhuizen.

It consists of two knife-edges that are pressed to the surface where it is sought to ascertain the elongation as a measure of the stress. The change in the distance between these edges, one of which belongs to the fixed part, the other to a movable one, can be read from a scale by means of a simple arrangement of levers.

The Lap Joint—It can be clearly seen that although the plates are pressed together by the rivets, the material of both plates shows a similar elongation only in the immediate neighborhood of the rivets. In all other places the elongation is different, so that the surfaces move along each other.

It can be seen that the load is more or less gradually taken over from the shell plate by the cover plates; the gradual change will be different for every vertical section through the joint, depending on the position of the neighboring rivets in relation to the section and on the pressure of these rivets on the plates.

Photomicrographs of the separation line of the two plates disclose that in those cases where the plates have been cleaned before riveting by scraping them with a stiff brush, as in normal practice, the metallic parts do not come together, but are separated by a very compact layer of some sort of oxide. This layer has irregular breadth, the surface of the plate being very irregular under this magnification. When elastic displacements of the plates occur of the magnitude demonstrated, we can easily accept the supposition that stresses will hereby be caused high enough to explain the cracking of the plates.

P. D. Merica[2] has published the results of an investigation on the embrittling action of sodium hydroxide on mild steel and its possible relation to seam failures of boiler plate. The conclusion drawn is that the influence of alkali on steel can be detected principally by means of the alternate bending test, the number of alternations being some 20 per cent. lower for the metal treated by the alkali than the values for the untreated metal. A recovery of the material occurs after a week's time of treatment at the temperature of 180 deg. C. (356 deg. F.).

I should like to observe, in the first place, that the same kind of cracks mentioned in the present paper was found by Mr. Merica in different kinds of boilers; that the cracks described by me have occurred not only in the water space, but also in the steam space of boilers; that the cracks being extremely local, in most cases no leakage was observed and no boiler scale was found between the plates; that as the boilers crack after having been in service for one or more years, recovery of the material from the effect of the alkali, mentioned by the author, should have taken place long before the cracks started.

Baltimore Encourages Fuel Economy

Baltimore, despite its proximity to the coal fields, and that it is a great coal-distribution center, suffers in common with other Atlantic coast cities from shortage of coal. The water power available, chiefly from the large station at McCalls Ferry on the Susquehanna River, has prevented such extended interruptions of service as more northern localities have experienced.

Recognizing the need not only of interesting the industries in fuel economy, but of discussing specific measures to achieve it, the Baltimore Section of the American Society of Mechanical Engineers, the Engineers' Club and the City Club held the first of a number of large meetings at the City Club, Thursday evening, Jan. 10. The meeting was made possible chiefly through the efforts of Prof. A. G. Christie, of the engineering department of Johns Hopkins University. Harry D. Bush, president of the Engineers' Club, presided. Besides many plant owners and managers and professional engineers, there was the largest gathering of operating engineers and firemen that ever came together in a local meeting, it was said.

The main address was made by Charles H. Bromley, associate editor of *Power*, and that part of it directed particularly to firemen and the operating men appears on page 146 of this issue.

Mr. Bromley said that while the many efforts made to educate the fireman would doubtless do good, it was his opinion that because of the urgency of coal saving, the best way to meet the situation was the payment of bonuses to the boiler- and engine-room crews for coal saved. The most suitable method of bonus is not to be expected at first, but some form may be used in the beginning and perfection developed as the result of experience gained. The speaker regretted that it was not possible to give more than the fundamentals on which to base a bonus system, declaring that an equitable bonus for a particular plant required particular study. The fundamentals, he said, were, first, the ease with which saving could be effected; second, the magnitude of the saving; and third, the number of persons to participate in the bonus. In conversation subsequent to the meeting Mr. Bromley said he believed the rate of payment in bonus should be based either upon the weight of coal saved per unit of output or upon the price per unit weight of coal saved per unit of output.

The speaker urged manufacturers and plant owners to inquire into the equity and adequacy of the wages paid their power-plant employees, declaring that there is no small measure of unrest among engineers and firemen. It would be well, he said, to inquire if it would not be well to anticipate organized effort on their part to secure fairer remuneration. Engineers, on the whole, have not organized in a labor way, having faith in the "learn more, earn more" slogan. The employer would do well to strengthen this faith rather than weaken it.

The fuel crisis has lent great impetus, Mr. Bromley said, to the use of the lower grades of coal, and although the engineers and firemen of Baltimore scorned hard coal, it is likely that they, in common with men of other sections of the country, must learn to burn mixtures of the Somerset semibituminous, widely used in Baltimore, and culm.

It is the speaker's opinion that the advantages of operating engines and turbines on a compromise back pressure are not widely enough known or thought of by those in-

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[2] "Metallurgical and Chemical Engineering," May, 1917.

stalling power plants for mills, buildings, etc. With compromise back pressure the engine or turbine is operated condensing, the condenser being "hooked up" to the return of the heating system, while the steam supply to the heating system is taken off the main exhaust steam line between the unit and the condenser, with a valve to control the steam flow. The back pressure on the engine is varied from the most economical vacuum, say 26½ in. in summer to, say, 1 lb. gage during extremely cold weather. Mr. Bromley referred to the Mar. 27, 1917, issue of *Power*, in which he described, with drawings, an installation of this kind at the Lynn (Mass.) Realty Co.'s buildings. The extraction turbine offered similar possibilities, said the speaker.

Following Mr. Bromley, George Goodwin, engineer at the Sheppard-Pratt Institute, representing the American Association of Steam Engineers, spoke on coal saving by care in ventilating buildings. John Powell, of the International Association of Steam Engineers, encouraged the use of combustion and other appliances for saving coal. Charles L. Mintien, of the National Association of Stationary Engineers, advised the consolidation of the various engineers' organizations that better educational and conservation measures might be made possible to the engineers of Baltimore. John Milne, inspector, United States Steamboat Inspection Service, encouraged saving in the small boats that ply the shore and harbor. Robert Mugford, chief engineer, Monumental Brewing Co., pointed out how licensing and examining of engineers would promote economy in power-plant operation. Philip Kirkwood, of Sharpe & Dohne, spoke on firing methods.

Prof. A. G. Christie, of Johns Hopkins University and secretary of the Baltimore section of the American Society of Mechanical Engineers, through whose efforts, chiefly, the meeting was brought about, spoke briefly, saying that if Baltimore could save 15 per cent. of its usual consumption of coal, it would amount to over $2,000,000 per year.

Captain Webster, of the Ordnance Department, gave a few rousing remarks, in which he said that it required about four pounds of coal to get one pound of steel in the form of shells to where it would do the most damage to the Germans.

The Engineer's Public Duty

In the course of an address before the New York Chapter recently, President Edmund T. Perkins, of the American Asosciation of Engineers, said:

There are 56,000 engineers enrolled on the membership lists of the various engineering societies of the United States. This easily indicates a total of 100,000 engineers in active practice throughout the United States. The profession has existed and been recognized for centuries and shows a remarkable growth in numbers engaged therein, but unfortunately does not show an equal growth in position and standing in the community, for the engineer has been too much engaged with the complex problems that arise in his daily labors, to reflect on the part he has actually played or should play in society.

It has been said that the engineer is all head and no heart. This may be true of the composite head and heart of the engineering profession, but there is no more companionable, congenial, lovable man among his familiar associates than the engineer.

Now, while the engineer himself is to blame for his present position, a greater amount of blame can be attached to our engineering organizations and societies. For with the exception of the American Association of Engineers, there has not been one engineering organization or association which deals with the human side of the engineer. This one exception has awakened to the fact that engineers are not occupying their rightful position of usefulness. Engineers have considered politics as undignified and corrupting. It is true that there are corrupt politics, but this is so because men who should have kept them righteous have stood aside. There is no class of educated people more bound to traditions than the engineer. No one has made slower progress toward collective efficiency. We must join together, we must coöperate in working out reforms. A technical education never made a real engineer; 40 per cent. of his work has to do directly with humanity rather than with technicalities.

In the past the trouble has been too much modesty—too little public interest; too much independence—too little coöperation; too much technicality—too little humanity; too much aloofness—too little goodfellowship.

The engineer of tomorrow, if he is to assume and maintain the position in society that his past achievements entitle him to, must become a man of larger sympathies and wider visions. He must play more and work less by himself. He must aspire to hold the honorable offices of the state, that he may administer them for the public welfare. He must be an arbiter, not an advocate, and he must have for his watchwords, Service and Coöperation.

Electric Motors for Ammonia Compressor Drive

The largest meeting yet held by the New York Section of the American Society of Refrigerating Engineers occurred Tuesday evening, Jan. 15, at the Machinery Club, 50 Church St., New York City. About sixty were present. The section has forty members, all of whom are members of the American Society of Refrigerating Engineers, the parent body. At the yearly meeting of the parent society in December, changes to the constitution were proposed to allow local sections to have affiliated members who are not members of the parent society. This amendment will likely pass at the next yearly meeting, and in the meantime the New York Section will take in affiliated members, refunding their dues of $6 per year if adverse action is taken on the amendment at the parent society's meeting next December.

The question of a suitable emblem for affiliated members came up for considerable discussion, but was left open.

A committee of three will be appointed by the president to assist the A. S. R. E. Subcommittee on Refrigeration in the Council of National Defense. F. E. Matthews and Henry Torrance are the members of the parent society serving on this subcommittee.

The nominating committee, consisting of F. E. Matthews, William Ross and Karl Zesterdahl, nominated L. Howard Jenks, New York manager of the Frick Co., president of the section to succeed John E. Starr, whose term expires. Mr. Jenks has been acting president during nearly the whole year, Mr. Starr having been and still being ill. Mr. Jenks was elected. The secretaryship was left open on the expiration of the term of Van R. H. Green. Charles Herter, who has been acting secretary during most of the year, was requested to continue as such. Mr. Herter is responsible for much of the success of the section's meetings.

Without attempting to criticize, President Jenks emphasized the need of greater thoroughness in drawing up specifications for refrigerating apparatus specified by the Government for various purposes. The sixteen specifications now circulated show the need of the application of engineering attention, suggested Mr. Jenks.

W. J. Moore, of the New York office of the General Electric Co., requested that some disinterested member check over test results of and examine some small refrigerating machines about to be shipped to France for the Red Cross hospitals and food bases. The Red Cross has asked some of its members connected with the New York office of the General Electric Co. to ship these machines. The examination would, of course, have to be gratis. President Jenks appointed Fred Ophuls to give his services, which Mr. Ophuls expressed himself as most willing to do.

Suggesting papers desirable for presentation before the section, Mr. Herter reminded President Jenks that Adolph Koenig promised a paper on brine-circulating systems; that Harry B. Joyce, of the United Electric Light and Power Co., New York, promised one on electric drive for ice plants; F. L. Fairbanks, one on high-speed compressor valves. Mr. Herter said that Mr. Dickerman, of the De La Vergne Machine Co., would be pleased to present a paper on ice storage.

F. J. Bartlett, of the Electric Machinery Co., 161 Devonshire St., Boston, Mass., read a paper on the synchronous motor for ammonia compressor drive. Following are the chief points brought out by Mr. Bartlett.

Compressor design has followed closely the development of the compressor prime mover. The very slow machines of years ago were driven by long-stroke engines; the Corliss engine increased speeds somewhat, while a marked increase in speed has been brought about by direct motor drive, aided by the introduction of the high-speed plate valve of low lift for the compressor. The plate valve is good for speeds up to 240 r.p.m. About 40 per cent. is saved in floor space and headroom by use of the high-speed, motor-driven compressor. While direct drive is usually desired, Mr. Bartlett recognized that belted motors are sometimes necessary.

The speaker aimed to show that for motors of similar horsepower and speed, the full load efficiency of the synchronous motor was appreciably higher than that of the induction motor by 5 to 10 per cent., although he gave a general statement of 15 per cent. difference credited, he said, to a handbook distributed by the Condit Electrical Manufacturing Co., of South Boston. Mr. Moore said such a difference was very much too high and was not true of average standard motors of both types. Mr. Bartlett agreed with Mr. Moore.

In the past objection has been raised to the synchronous motor because of the separate excitation required. Advance in design has eliminated this objection, said Mr. Bartlett, and experience has shown that exciter troubles are not even serious enough to be a factor.

Air compressors are now without flywheel effect other than that given by the rotor of the motors driving them. This does not mean that ammonia-compressor builders should strive to eliminate the flywheel; but it is likely that they will find it advantageous to cut down the weight of flywheel used. The reason for lightness of flywheel is to reduce the starting torque.

The air gap in the induction motor is smaller than for the synchronous motor; therefore wear of the bearings may be greater without fear of mechanical and magnetic troubles.

The central station more and more demands that its distribution lines be working at high power factor. Because the synchronous motor gives unity power factor, its use is highly desirable from the central-station standpoint. Considerable emphasis was laid on this point by those discussing the paper, the substance of their remarks being given farther on in this report.

Mr. Bartlett hoped that there would be the closest coöperation between the manufacturers of motors and the builders of ammonia compressors.

DISCUSSION

J. W. Moore, General Electric Co., New York City: Relative to the efficiencies of the two types of motors a synchronous motor of 600 r.p.m. and 200 hp. had an efficiency of 94 to 94½ per cent., and a slip-ring induction motor of the same speed and capacity would have an efficiency of 89 per cent. This represented the difference in efficiency to be expected usually.

J. C. Carpenter: It should be pointed out that the power factor would have to be considerably sacrificed to design an induction motor which would have characteristics similar to a synchronous for the same purpose.

Air-compressor builders have gone through the experience of induction and synchronous motor drive, and they have widely adopted the latter type of motor. For air-compressor drive the synchronous motor requires, to give a broad figure, about 30 per cent. with about 15 per cent. pull in. It is not certain that the ammonia compressor will take as much. Mr. Carpenter also urged the motor manufacturers and builders of ammonia compressors to come together.

Charles D. Neeson suggested that the section seek a paper dealing with results found in experimental work to be done by the motor and compressor builders some time during the year. He urged that the central station present its suggestions and claims in the same paper. The matter was left open other than that President Jenks appointed Mr. Neeson to get such a paper before the section.

J. W. Moore: Four years ago the first electrically driven ice plant in this section was installed on the plant of the Syracuse Ice Co. Much had been learned from this installation, and the chief thing it taught, Mr. Moore believed, was that the best plant is one that can use standard apparatus "taken from the shelf." The belted induction motor was the only logical motor at the time the Syracuse plant was built.

As showing the growth of the synchronous motor for air and ammonia compressor drive, he said that during 1917 motors to the number of 177, aggregating more than 65,000 hp., had been sold by his company.

It is Mr. Moore's belief that a compressor of speeds up to 500 r.p.m. is yet to come, and will come, and that when it does, the induction motor will be more suitable as the prime mover than the synchronous motor. Between 350 and 500 r.p.m. the controversy as to which motor is most suitable is chiefly one around the questions of simplicity and efficiency.

Harry Joyce (United Electric Light and Power Co., New York City): It is customary in this locality for the consumer to pay for the transformer losses. These are so very much greater with the induction motor than with the synchronous that it is of vital concern to the consumer. The time is not far distant when the central station must compel the consumer to stand the costs occasioned by low power factor.

Mr. Hill, of Ophuls, McCreery & Hill, consulting engineers, New York, pointed out that for the same service an induction would cost more than the synchronous motor. He also laid emphasis upon high power factor as desirable to central station and consumer, stating that a line loaded to 80 per cent. power factor gave 20 per cent. less return on the investment than was true for unity power factor, meaning return to the company selling power.

The section requested Charles H. Bromley, associate editor, *Power*, to give a paper on "Specific Fuel Wastes and Their Reduction," at the next meeting, Mar. 19. Mr. Bromley will give such a paper.

Ordnance Department Needs Civilian Workers

The Ordnance Department urgently needs several thousand civilian workers to serve in the United States. The Civil Service Commission is conducting an extensive campaign to obtain this needed help. Among the positions to be filled are the following:

Clerical Positions: 2000 stenographers and typewriters, men and women, $1100 to $1200 a year; 2000 typewriter operators, men and women, $1100 to $1200 a year; 2000 general clerks, men and women, $1100 a year; 500 index and catalog clerks, men and women, $1100 to $1200 a year; 200 clerks qualified in business administration, $1200 to $1500 a year; 300 schedule clerks, men and women, $1400 to $1600 a year; 300 production clerks, not more than $1500 a year; 200 clerks qualified in statistics or accounting, $1100 to $1800 a year; 100 statisticians, $1800 a year; 100 multigraph operators, men and women, $1000 to $1200 a year.

Testing Positions: 200 engineers of tests of ordnance material, $1500 to $2400 a year; 200 assistant engineers of tests of ordnance material, $1000 to $1500 a year.

Mechanical Trades Positions: 2500 machinists, $4 a day; 500 machine operators, $2.75 a day; 200 drop forgers, $5.75 a day (piecework); 300 tool makers, $4.50 a day; large numbers in practically all other trades.

Drafting Positions: 500 mechanical draftsmen, $800 to $1800 a year; 50 gage designers, $2000 to $3000 a year; 100 apprentice draftsmen, $480 a year.

Inspection Positions: 300 inspectors of small-arms ammunition, $1500 to $2400 a year; 100 inspectors of artillery ammunition (high-explosive shell loading), $1500 to $2400 a year; 100 inspectors of artillery ammunition (forgings), $1500 to $2400 a year; 100 inspectors of artillery ammunition (ballistics), $1500 to $2400 a year; 300 inspectors of field artillery ammunition steel, $1500 to $2400 a year; 300 assistant inspectors of field artillery ammunition steel, $3.50 to $5 a day; 500 inspectors of small arms, $1500 to $2400 a year; 100 inspectors of material for small arms, $1000 to $1800 a year; 100 assistant inspectors of cannon forgings, $1500 to $2400 a year; 100 assistant inspectors of finished machine parts, $1500 to $2400 a year; 100 assistant inspectors of gunfire-control instruments, $1200 to $1500 a year; 50 assistant inspectors of steel helmets, $1000 to $1800 a year; 50 assistant inspectors of cleaning and preserving materials, $1000 to $1800 a year; 400 inspectors and assistant inspectors of powder and explosives, $1400 to $2400 a year.

Salaries named are the usual salaries at entrance. Higher or lower initial salaries may be paid in exceptional cases. Positions paying salaries higher than those named are usually filled through promotion.

Men only, unless otherwise specified.

For further information apply to the representative of the United States Civil Service Commission at the post office or custom house in any city, or to the Civil Service Commission in Washington, D. C. Except for the positions of stenographer and typewriter, typewriter operator, multigraph operator, and general clerk, applicants are not assembled for a written examination, but are rated principally upon their education, training, and experience, as shown by their applications and corroborative evidence.

Fuel Economy in Private Generating Plants

Engineering Offices
PERCIVAL ROBERT MOSES, E. E.
366 Fifth Avenue
New York, Jan. 15, 1918.

Mr. Albert H. Wiggin,
State Fuel Administrator,
61 Broadway, New York City.

Dear Sir—My attention has been called to your circular letter, addressed to owners and operators of private electric generating plants.

I do not think it is possible that my letters on this subject have misled you, because I have tried to be very clear in bringing out the fact that fuel economy can be obtained by operating the private plants to their limit during such part of the year as their exhaust steam can be used for heating.

If you will call up any one of fifty private-plant owners in your immediate vicinity, you will find that practical experience has shown them that they will use no more coal during the months of January, February and March, and in many cases also in April, for supplying their total requirements of heating and electricity than they would for supplying their requirements of heat alone. This is such a well-known fact that it is hardly disputed by unbiased engineers.

Mr. Bion J. Arnold, the great exponent of central plants, who is now a major in the United States Army, stated the other night at the American Institute of Electrical Engineers that there could be no question that the private generating plant using its exhaust steam was the most efficient method of producing electricity.

I would suggest that you call up Mr. Harris A. Dunn, of the Columbia Trust Co., whom you probably know, and ask him for his experience. In that building, the actual coal used in two successive years—one buying Edison current, and the other making the current—was less when the current was made than it was when the current was bought.

The same thing was true in a test we made in the Mutual Insurance Co.'s building in Richmond, and you will find that this is the universal experience.

I would like very much to come down and have a talk with you about this matter, and explain exactly what I did mean in my previous letters.

Yours very truly,
P. R. Moses.

Research Fellowships

At the end of the academic year there will be 12 vacancies in the 14 research fellowships maintained by the University of Illinois. Two other such fellowships have been established under the patronage of the Illinois Gas Association. These fellowships, for each of which there is an annual stipend of $500, are open to graduates of approved American and foreign universities and technical schools. Appointments are made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Not more than half of the time of the research fellows is required in connection with the work of the department to which they are assigned, the remainder being available for graduate study. Nominations to these fellowships, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the director of the station each year not later than the first day of February. Appointments are made in the spring and take effect the first of the following September.

As to the attitude of the War Department toward graduate students in engineering, the office of the Chief of Engineers has ruled that resident graduate students in engineering who are candidates for an advanced engineering degree may avail themselves of the privileges provided by the new regulations, under which engineering students may be enrolled in the Enlisted Reserve Corps of the Engineer Department and placed on the inactive list until they have completed their educational training.

Shipping Board Schools

Official announcement was made Jan. 19 by Henry Howard, Director of Recruiting for the United States Shipping Board, that under a recently issued regulation of the Provost Marshal General's department all students entering Shipping Board schools for deck officers or engineers will be exempted from military duty and will remain exempted so long as they pursue the calling for which the school fits them. This affects six hundred or more students now in Shipping Board schools and will apply to students enrolled in the future.

There are now thirty of these schools training deck officers for the merchant marine and eight training engineers. Only men who have had two years' seafaring experience are admitted to the schools. On graduation a student is either sent to sea for further training as a reserve officer in the merchant marine or is licensed at once for the grade in which he is eligible.

About four thousand new officers for the merchant marine have been licensed since the United States entered the war. The Shipping Board schools will continue to receive a limited number of students monthly, the course being one month in the engineering schools and six weeks in navigation schools.

Soldiers' and Sailors' Insurance

The Treasury Department is making every effort to have each member of America's fighting forces take advantage of the Government-insurance plan, which Secretary McAdoo asserts to be "the most just and humane provision ever made by any nation for its soldiers and sailors."

The purpose is rapidly being achieved, the insurance having passed the third billion mark in the total of policies written, and there are many military units in which every member has taken insurance.

The automatic insurance provided by the law is only partial and limited protection, payable only to wife, child, or widowed mother and ceases after Feb. 12, 1918. It is important, therefore, not only to the soldiers and sailors of the country, but to their families and dependents, that before that date they avail themselves of the full Government protection, which can go as high as $10,000 and is payable to a wife, husband, child, grandchild, parent, brother or sister.

Materials Division, Quartermasters' Corps

The following is the report of the Quartermaster's Corps, U. S. Army, Materials Division, 15th and M Sts., Washington, D. C.:

Major J. N. Willcutt in charge. Purchasing: Capt. O. F. Noss, assistants N. A. Lufburrow, J. C. McCubbin, C. G. Graves and R. T. Vaughn, buying plumbing, tank heaters and hot-water tanks; J. H. Prentiss, buying refrigerating machinery; M. O. Pinkham, buying hydrants, storage tanks, valves, wood pipe, steel pipe, cast-iron pipe and pipe fittings; E. W. Case, assistants A. F. Knibiehly and L. W. McCrea, buying ash hoists and conveying machinery; Lieut. A. C. Nell, assistant H. H. Easterly, buying pumping equipment, air compressors, rail and track materials, locomotive cranes, sprinkler systems, water meters, recording apparatus, coal and engines; Capt. W. H. Riblet, assistants S. W. Newcomb and H. Goodkind, buying heating equipment, heating boilers, heating pipe, heating tanks, feed-water heaters, boiler-feed pumps, insulating material, valves, fittings, traps, regulators and radiation; J. E. Erickson, assistants M. S. Donally and M. A. Closs, buying motors, power transformers, oil switches, switchboards, lightning arresters, series regulators, wire, electric supplies, battery-charging equipment and storage-battery trucks.

Considerable speculation has been occasioned by an advertisement which appeared on the front page of the New York *Tribune* daily for a couple of weeks, which read, "Employ Your Local Consulting Engineer," but was signed by John A. Stevens, of Lowell, Mass. It seems that the wide-awake chairman of the Boiler Code Committee got to thinking of all the coal that could be saved if everybody would follow the advice of a competent mechanical engineer, and so he ran the advertisement, hoping that it might lead to an improvement in the fuel condition by the employment, by those who might see it, of the nearest or most available consulting engineer.

New Publications

"VULCAN"

The December, 1917, issue of "Vulcan," which is the house organ of the Vulcan Steel Products Co., 120 Broadway, New York, appears in an attractive and seasonable cover. The history of steel making, another installment of which is given in this issue, is doubly interesting because of the reproduction of woodcuts illustrating early steel-working machinery. Articles on export business and a profusion of halftones round out an excellent number of this well-edited journal. Copies may be obtained free on application to the publishers.

THE OXIDATION OF COAL

Bureau of Mines Technical Paper 98, by S. H. Katz and H. C. Porter, under the title of "Effect of Low-Temperature Oxidation on the Hydrogen in Coal and the Change in Weight of Coal on Drying," gives the following as the results of the investigation:

The temperature basis of nearly all the recorded work of previous investigators of the oxidation of coal as related to the hydrogen of the coal substance was at the temperature of boiling water and above, and water was invariably produced in readily determined quantities, but three different investigators have studied the subject with regard to changes at ordinary temperatures. The results obtained by these investigators vary widely—from the statement that "quite a large amount of water is produced in oxidation" to those of the authors who can find no water produced by their method of experiment. The third investigator found that in some cases very small amounts of water were produced and in others none whatever. The authors of this paper conclude that at ordinary temperatures coal undergoing oxidation produces no water. They have also determined that the change in weight of the coal is less than that of the water removed from the coal when drying takes place in an inert atmosphere. Others have noted this discrepancy. A possible explanation is that the discrepancy results from the absorption of gas by the coal on drying.

The conclusions are: (1) There is a lack of agreement between the weight of water evolved by coal and the loss of weight when dried in an inert atmosphere; the excess weight of the coal may be due to absorption of gas. (2) A study of the vapor tension of water in coal, as indicated by the water removed by a regulated current of dry nitrogen and air used alternately, shows no production of water by the oxidation of coal at ordinary temperatures.

Obituary

C. H. Newhall, chief engineer and building superintendent of the Chamber of Commerce of Minneapolis, died Jan. 7, 1918, of pneumonia. Mr. Newhall was well known among the engineers of Minneapolis. He came from Chicago in 1909 to take the position he held until his death.

Personal

Prof. A. N. Talbot, of the University of Illinois, has been elected president of the American Society of Civil Engineers.

Guy E. Tripp, who was chairman of the board of directors of the Westinghouse Electric and Manufacturing Co., has been placed in charge of the Production Division of the Ordnance Department.

John D. Stout has been appointed Chicago representative for The Terry Steam Turbine Co. Mr. Stout was at one time assistant engineer of the company and was recently transferred from the New York office, where he was assistant manager.

Milton Rupert was recently elected vice president and assistant treasurer of the R. D. Nuttall Co., of Pittsburgh, Penn. He has been with the Nuttall Co. since March, 1893, holding various positions. In 1903 he was appointed head of the general offices. During the latter part of this period he was assistant to the president and general manager. In his new position Mr. Rupert will have charge of sales and manufacturing activities.

Engineering Affairs

American Institute of Steam Boiler Inspectors will hold its regular meeting Thursday evening, Jan. 31, in Engineering Societies Building, 29 West 39th St., New York City. The annual election of officers will take place and business in connection with the annual dinner will be taken up.

New Chapter of the A. A. E. Started in Philadelphia—The first meeting of the American Association of Engineers was held at the Bellevue-Stratford Hotel on Friday, Jan. 18. Frank P. Roth was elected chairman and a temporary club was formed with fifteen new members. A. H. Krom, general secretary of the organization, was principal speaker and he outlined the "National Association Plans." Discussion followed by T. J. Stone Edelen, Kern Dodge, Joseph B. Smith and Howard K. Hayes. The spirit of the meeting indiciated that Philadelphia will soon have a local office of the national business organization for engineers. The meeting was a close "second" to the one in New York City on the evening of Jan. 16.

Miscellaneous News

Boiler Explosion Wrecks Train — The night express train of the Rutland R.R., bound from Montreal to Boston, was wrecked near Middlebury, Vt., early Jan. 22, by an explosion in the locomotive. The fireman was killed and the engineer probably fatally hurt. Some of the cars of the train were derailed and several passengers received minor injuries.

A Boiler Explosion occurred at the sawmill of D. K. Walters at St. George, S. C., on the afternoon of Jan. 7, severely injuring three persons, including the owner and his son, the latter's condition being serious, and completely destroying the mill and machinery. Several negro workers were shaken up and mules and horses which were nearby were injured. The cause of the explosion is unknown.

A Boiler Explosion wrecked the plant of the municipal water-works at Swansea, Ill., on the night of Jan. 12, killing two men and seriously injuring two more. The plant, a story and a half brick building, was completely destroyed by fire, the village having no fire department. The cause of the explosion is unknown, but it is supposd it was because of low water in the boiler. The loss is estimated at $15,000.

A Boiler Head Blew Off in the heating system in the basement of the Chittenden Hotel, Columbus, Ohio, on Jan. 8, flooding the engine room with boiling water and steam, and injuring six men, one severely, who died later at the hospital. At the time of the explosion the men were busy removing coal from a pit near the end of the boiler to the fuel room, and when clouds of steam made it impossible for them to find their way out, they were forced to stand in the scalding water until firemen and police arrived to remove them in ambulances. The hotel manager stated that the system had been inspected and approved more than a month ago. A weak tube in the boiler was probably the cause of the accident, it was said.

Business Items

Orleans Cotton Mills, Inc., is the new name of the corporation formerly known as the Kohlman Cotton Mill and Manufacturing Co., New Orleans, La.

The Hydraulic Press Manufacturing Co now occupies its new buildings at Mount Gilead, Ohio, and the plant is again in operation to its full capacity. The new equipment is specially adapted for the building of hydraulic presses, pumps and valves.

Ford, Bacon & Davis, Engineers, announce the formation of the Ford, Bacon & Davis Corporation, organized for the purpose of conducting a general contracting business, with particular reference to industrial, public-utility and power plants, steam and street railroads, docks, steamship and railway-terminal facilities, subways, tunnels, hydro-electric and irrigation projects. In effect this means the continuance in corporate form of construction work which heretofore has been handled by the firm direct. The corporation's organization comprises men skilled and experienced in engineering and contracting work by the most modern and economical methods. It is provided with ample capital to insure the successful completion of any work which it may undertake, and starts business with important work already entrusted to it. Its headquarters are at 115 Broadway, New York, with offices at New Orleans and San Francisco. The facilities available to the new corporation from the firm of Ford, Bacon & Davis, now in its 24th year, which continues as heretofore, assure a continuance of this firm's standard of both engineering and construction efficiency and enable both design and construction to be carried on with a degree of coördination which should make for economy and rapidity of work.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 24, 1918	One Year Ago	Jan. 24, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Jan. 24, 1918	One Year Ago	Jan. 24, 1918	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 24, 1918	One Year Ago	Jan. 24, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.00—7.25
Buckwheat ..	4.30—5.00	2.75	5.50—6.00	6.50—7.00
Rice	3.75—3.95	2.20	4.50—5.00	4.50—5.00
Barley	3.25—3.50	1.95	4.00—4.25	3.25—3.50
Boiler	3.50—3.75	2.20	....	....

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)...........................	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Jan. 24, 1918	One Year Ago		Jan. 24, 1918	One Year Ago
Buckwheat ...	$3.15–3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65–3.65	1.25	3.65	2.15	3.35
Boiler	2.45–2.85	1.10	3.55	2.00	....
Barley	2.15–2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	...	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 24, 1918	One Year Ago	Jan. 24, 1918	One Year Ago	Jan. 24, 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.35-2.75
2-in. lump..	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Steam egg ...	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Mine-run ...	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.00-2.25
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cababa ...	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Geneva—The Geneva Power Manufacturing Co. has plans under consideration for the erection of a hydro-electric plant on Double Bridge Creek.

Ind., Ft. Wayne—The Board of Public Works plans to build extensions to the electric-lighting plant. Estimated cost, $25,000. F. M. Randall, City Engr.

Iowa, Independence—The State of Iowa plans to build a power house in connection with the State Hospital for Insane, including the installation of 1 generator and 2 boilers. H. T. Liebbe, State House, Des Moines, Arch.

Kan., Oakley—City plans to install new generating equipment in its electric lighting plant, including a 150 to 175-hp. engine and a new well and motor. G. Maurer & Son, Engr.

Ky., Jackson—The Jackson Light and Ice Co. plans to rebuild its power plant, which was destroyed by fire.

Minn., St. Cloud—The Pan Motor Co., care of G. Booth, is having plans prepared for a power house and a drop forge plant.

N. J., Kearny—The Federal Shipbuilding Co. plans to build a large power house to cost $60,000 and a boiler shop to cost $70,000 in connection with its new plant.

N. J., Toms River—The Toms River Electric Co. has been granted permission by the Board of Public Utility Commissioners to issue $15,000 bonds; the proceeds will be used for addition and improvements to its plant.

N. Y., Brooklyn—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, Brooklyn, under Schedule No. 1664, 15,000 ft. single, stranded, rubber covered wire and interior communication plain cable.

N. C., Esmeralda—J. T. Patrick and associates plan to build a new hydro-electric plant here.

Ohio, Akron—The Goodyear Tire and Rubber Co., East Market St., plans to build a brick addition to its boiler house. Estimated cost, $100,000.

Okla., Aline—City is considering the installation of an electric-lighting plant. Burns & McDonnel, Inter-State Bldg., Kansas City, Mo., Engr.

Okla., Wewoka—City plans to install an electric-lighting plant.

Okla., Woodward—City voted to issue $20,000 bonds for the erection of an electric-lighting plant. Noted Dec. 25.

Penn., Clifton Heights—The Kent Manufacturing Co. is having plans prepared by F. E. Hahn, Engr., 1112 Chestnut St., Philadelphia, for the erection of 1-story, 40 x 67-ft. power plant. Estimated cost, $50,000

Penn., Norristown—The Counties Gas and Electric Co. plans to issue $300,000 bonds; the proceeds will be used for extensions and improvements to its system. H. H. Ganser, Gen. Mgr.

Penn., Williamsport—The Lycoming Edison Co. plans extensive improvements and additions to its plant during the coming year. About $250,000 will be appropriated for this work.

Tex., Burnet—The Southwestern Graphite Mining Co. plans to rebuild its power house which was destroyed by fire. Loss, $6000.

S. C., Lockhart—The Lockhart Power Co., a subsidiary of the Monarch Mills, Union, plans to build a hydro-electric power plant here. E. Nicholson, Union, Treas. of the mills.

S. D., Faith—City has plans under consideration for the installation of an electric-lighting plant.

Va., Dungannon—C. F. Hagan, Bristol, trustee of P. Hagan Estate, has plans under consideration for the erection of a hydro-electric power plant on the Clinch River near here.

Va., Glenlyn—The Appalachian Power Co., Bluefield, W. Va., is having plans prepared by Viele, Blackwell and Buck, Engrs., 49 Wall St., New York City, for the erection of a steam driven electric generating plant on New River, including the installation of new equipment. Estimated cost, $2,000,000. H. Markle, Bluefield, W. Va., Gen. Mgr.

Va., Petersburg—The Virginia Railway and Power Co. plans to build an electric transmission line from here to Suffolk. C. B. Buchanan, Gen. Mgr.

Wash., Puget Sound—(Bremerton P. O.)—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, Puget Sound, under Schedule No. 1658, air pressure reducing valves, 56 gate valves, brass, high pressure, steam and water valves, and brass low pressure, steam and water valves; under Schedule No. 1663, 16,000 ft. single-conductor, lighting and power wire and 13,000 ft. 2 conductor, lighting and power wire.

W. Va., Hartland—The French Coal Co. is in the market for an electric hauling locomotive.

POWER

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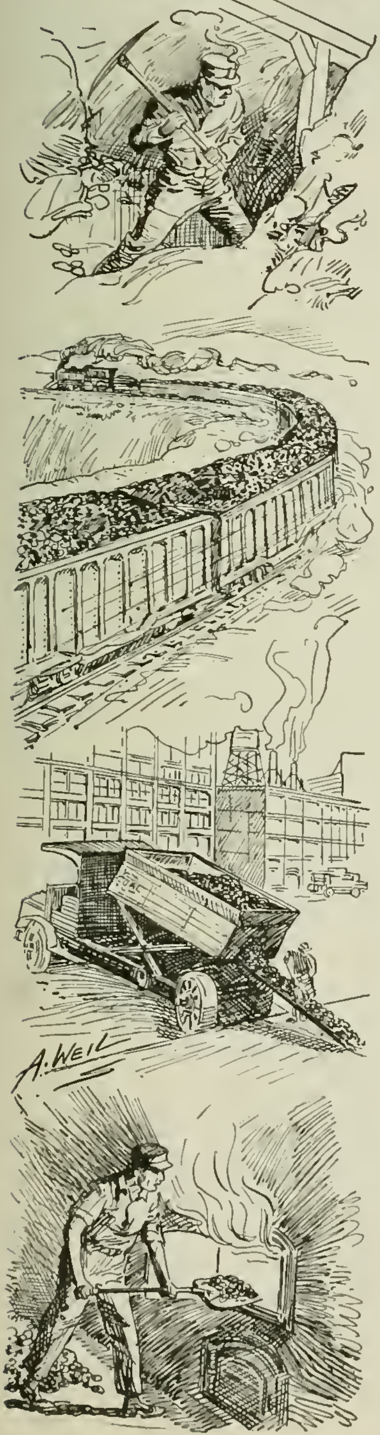
The Greatest Ally

By

RUFUS T. STROHM



FROM crowded cities and scattered farms,
With sobered spirits and simple trust,
The thousands answer the call to arms
To humble tyranny in the dust;
But all their courage and all their strength
May yet come short of the final goal,
Since every effort depends at length
On Coal.

FOR every loyal and sturdy son
Must be accoutered from head to heel
In regimentals of drab and dun
With belt and rifle and blade of steel;
But looms and spindles are still and dead
And forge nor furnace can give its dole
Till boiler fires are gleaming red
With Coal.

WITHOUT its power by rail and sea,
The richest harvest of fruit and grain
Would waste and molder on bush and tree
And rot ungarnered on hill and plain;
While shot and shrapnel that burst afield
Would cease their thunder and crash and roll
If mine and stripping should curb their yield
Of Coal.

FOR coal unleashes the force of steam
That drives the engine and turns the shaft
And pricks the night with the blinding beam
That stabs and searches for hostile craft;
But cold and famine bestride the earth,
And want and suffering claim their toll,
When through disaster there comes a dearth
Of Coal.

LARGEST HIGH-HEAD FRANCIS TURBINE

By Arnold Pfau

The hydro-electric equipment installed in the White River plant of the Puget Sound Traction, Light and Power Co., near Sumner, Wash., is described. This plant contains two 18,000-hp. Francis turbines operating under a net head of 440 ft., which have developed over 44,000 hp. without any detriment to their efficiency. On account of the hydraulic conditions special engineering problems were involved, which have been solved by special features in design. A new 25,000-hp. unit is now being installed, which is the largest hydraulic turbine of this type in the world.

THE commercial results obtained from the electrified operation of the Rocky Mountain Division of the Chicago, Milwaukee and St. Paul Ry. have been so eminently satisfactory that it was decided to immediately proceed with the electrification of the Cascade Mountain division, which extends from Othello, east of the Columbia River, over the Cascades, to the end of the transcontinental line at Seattle and Tacoma. The western slope of the Cascade Mountain division will receive about 25,000 kw. of electrical energy from the Puget Sound Traction, Light and Power Co., at Seattle, Wash. This concern has a number of hydro-electric developments, the largest of which is the so-called White River plant near Sumner, Wash. The plant (see headpiece) with an initially rated output of 36,000 hp., developed by two hydro-electric units, designed and built by the Allis-Chalmers Manufacturing Co., was placed in commercial operation in November, 1911 (Stone & Webster, Engineers), and has since delivered power uninterruptedly and without requiring any repairs. It has been found that the turbines and generators can carry, without difficulty or detriment to their efficiency, a total load of 30,000 kw., or over 44,000 hp. on the shaft. Figs. 1 to 4 show a 25,000-hp. unit recently built, to be installed in this plant, which is the most powerful high-head Francis turbine in the world and is practically a duplicate of the two 18,000-hp. machines already in service.

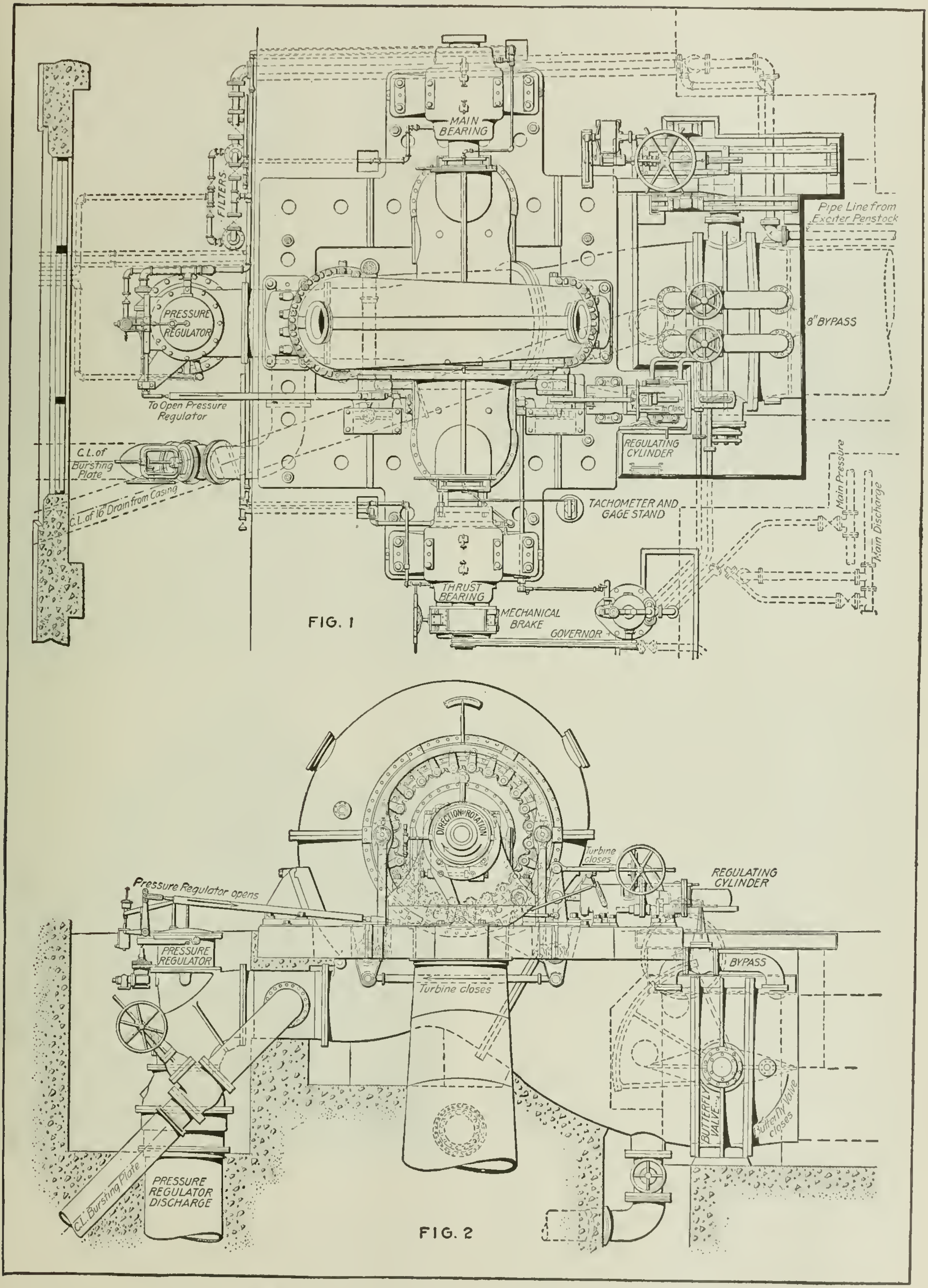
The plant has been laid out with a view of maintaining the highest economy of water, since it is combined with a large storage capacity, which serves to furnish the necessary operating water during dry seasons. The course of the White River, a typical mountain stream fed from one of the glaciers of Mount Rainier, is blocked by a timber-crib dam near Buckley, Wash., on one of the branches of the Northern Pacific's transcontinental line. The water is controlled by sturdy steel gates and led through a heavy timber flume into a forebay, which serves as a settling basin for the glacial silt, carried by the river at times in large quantities. Provision is made for draining and flushing this forebay to prevent its being filled up with deposits.

An open canal leads to the storage reservoir, called Lake Tapps, which was a small natural lake, now greatly enlarged by raising its water level about 35 ft., bringing its storage capacity up to 2,250,000,000 cu.ft., equivalent to 18,000,000 kw.-hr. obtained under the net head of 440 feet.

From Lake Tapps the water is carried through a deep open cut and a tunnel about 3000 ft. long and of sufficient area to carry 3000 cu.ft. of water per second. The tunnel ends in a forebay from which individual 8-ft. steel-pipe lines lead down to the power house.

In order to adhere to the principle of conservation of stored hydraulic energy of this plant, it was necessary to provide hydraulic equipment which is capable of controlling the bulk of the momentary variation of the commercial load of the Puget Sound Traction System. This variation is sometimes very severe, owing to rapid and large changes of the power required by the freight trains of the Puget Sound lines.

The long tunnel combined with the steel pipe lines, about 2500 ft. in length each, together with the requirement of a water-saving method of speed regulation under heavy fluctuations of load over a high-tension transmission line, offered a problem to the hydromechanical engineer, which required careful study and practical experience.



FIGS. 1 AND 2. PLAN AND ELEVATION OF 25,000-HP. FRANCIS TURBINE

In order to prevent excessive variations in speed and voltage of the power system, it was necessary to use a very sensitive governor and to quickly control the gates of the turbine. A sudden change in the flow of the water through the pipe lines and tunnel would cause pressure variations which would not only impair the regulation, but might accumulate to such an extent as to wreck the whole plant. A careful analysis of all the precautionary methods was made, and as a result it was decided to use:

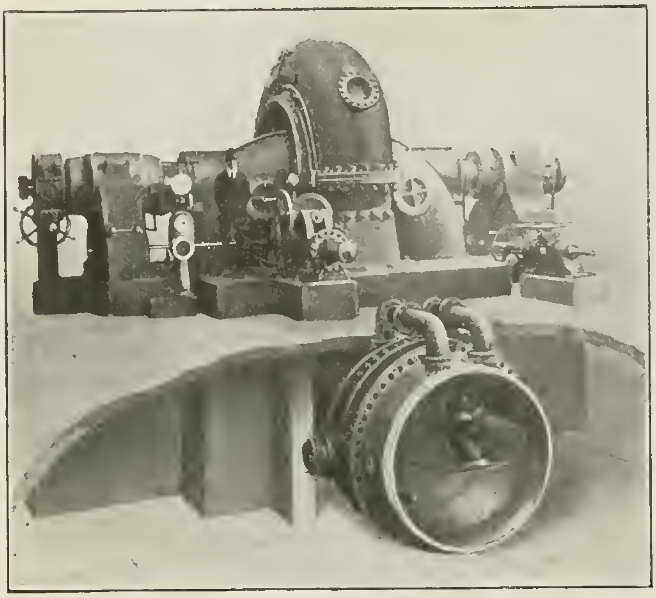


FIG. 3. COMPLETE TURBINE AND BUTTERFLY VALVE

1. A surge reservoir at the end of the tunnel for the purpose of preventing surges set up by the tunnel from materially affecting the pressure in the pipe lines and vice versa.
2. Pressure regulators so combined with the turbines that they permit of a sudden release of the water, otherwise brought to a stop when the governor closes the gates of the turbines quickly. In order to prevent excessive waste of water, these releases or bypasses slowly and automatically close at a rate so adjusted that the flow of water is gradually stopped without causing any appreciable secondary-pressure rises.
3. Air-cushion tanks, which supply hydraulic energy to the turbines when the demand of load is so sudden that the water cannot accelerate in the pipe line sufficiently fast to prevent a serious drop in pressure.

The proper combination of these devices, together with a fairly liberal flywheel effect of the revolving parts of the generators, made it possible to attain an accuracy in speed regulation which has been the subject of considerable comment in engineering circles.

The turbines of the initial installation are of the double-discharge, horizontal-shaft spiral-case type operating under a net head of 440 ft. at 360 r.p.m., similar to the unit shown in the figures.

The water from the penstock passes through a steel butterfly valve, shown in Figs. 1 and 2 and below the turbine in Fig. 3, of seven feet inside diameter, which, when closed by hand or electrically, is sufficiently tight to permit inspection of the interior of the turbine. The total normal pressure on the gate of this valve is about 1,000,000 lb. and it is far in excess of this when the valve is closed against the full penstock pressure in emergency cases. The water is brought to the runner through a steel casing of the scroll type, this being the most efficient method because the flow of water is steady and direct. Before reaching the runner, the water passes between a series of steel guide vanes or wicket gates, by means of which the quantity is quickly changed by the governor in accordance with the load to be carried by the generator.

The steel runner of the turbine is bolted to a flange forged solid with the turbine shaft and is of the double-discharge type, dividing the incoming water into two equal portions which discharge separately through a quarter turn and a tapered steel draft tube. The shaft revolves in two ring-oiling bearings with self-aligning ball-and-socket seats, one end having a solid flange for direct connection to the generator. The opposite end carries the mechanical hand brake (see headpiece and Figs. 1 and 3) for bringing the unit to a dead stop. The bearing near the brake serves also as a mechanical thrust bearing; the main thrust, however, is taken care of automatically by means of a simple and very efficient hydraulic balancing arrangement combined with the two runner rims and the adjacent portions of the stationary cover plates.

The spiral casing, quarter turns, bearings and brake are bolted to a heavy cast-iron bedplate, grouted into the foundation. The guide vanes are held in three bearings and are operated from a concentric steel shifting ring located outside of the casing. Two steel rods connect the shifting ring to bell-crank levers which in turn are actuated by a regulating piston guided by a crosshead. The oil pressure acting on both sides of the regulating piston is controlled by a double-acting, hydraulically balanced regulating valve bolted to the separate governor stand, Fig. 5, containing the flyballs and the relay of the governing device. The oil pressure is obtained from a central oil-pressure system located in the basement of the plant. It is produced

FIG. 4. COMPLETE TURBINE AND PRESSURE REGULATOR

in pumps of the rotary-gear type driven by electric motors or by a small waterwheel operated from the penstock pressure. The governor has a capacity of about 50,000 ft.-lb. and is capable of moving the turbine gates over their full stroke in one second.

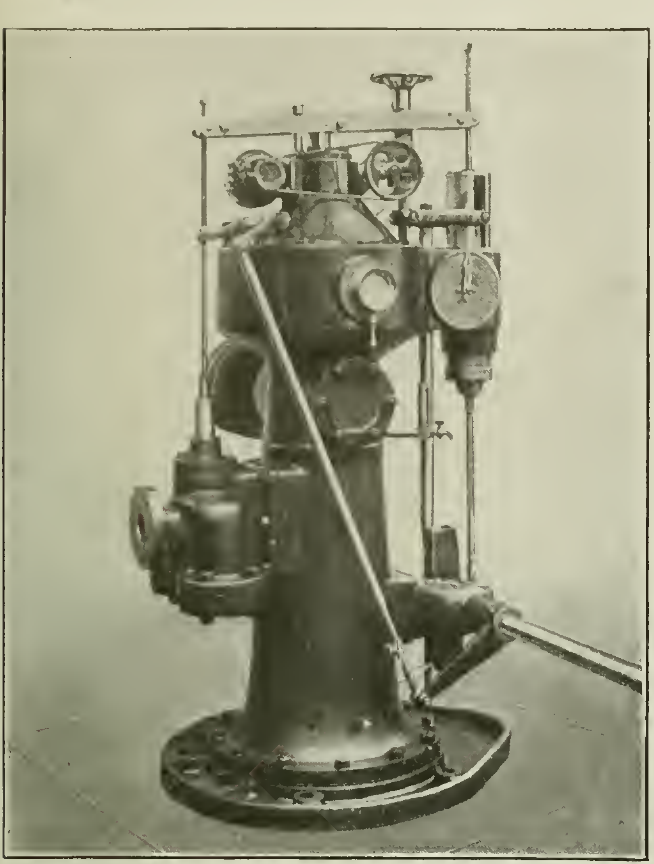


FIG. 5. GOVERNOR ACTUATOR FOR 25,000-HP. TURBINE

A pressure regulator (see Figs. 1, 2 and 4) is directly connected to a branch pipe provided on the lower portion of the spiral casing. It consists of an elbow with a circular disk valve, opening and discharging water downwardly through a plate-steel pipe into the tailrace. This disk valve is connected to a piston subjected to water pressure controlled by a regulating valve, which in turn is relay-operated from a direct connection to the turbine gates. An oil dashpot is so inserted into this connection that the motion of the turbine gates is transmitted to the regulating valve only when the governor closes the former quickly, a slow motion only being completely absorbed in the dashpot. Thus the discharge of the turbine can be quickly switched over from the turbine to the pressure regulator, and is there reduced slowly in accordance with the setting of the bypass in the oil dashpot, determining the rate of the closing motion.

The turbine discharges about 450 cu.ft. of water per second, and when the flow is stopped through the turbine gates in 1.5 sec., it will discharge through the pressure regulator to its full amount by the time the governor has closed the turbine gates. Thus the velocity of the water in the pipe line is not changed abruptly and no serious pressure rises occur.

After the units were placed in commercial operation, elaborate efficiency and regulation tests were carried out by the owner. It was found that the efficiency exceeded 90 per cent. and was still above 80 per cent. at about one-fifth load.

The full load of 20,000 hp. was thrown off suddenly, causing the governor to close the gates quickly. The speed did not rise more than 12 per cent. above normal, and the maximum pressure rise in the pipe line above normal did not exceed 5.5 per cent. as against a guaranteed pressure rise of 15 per cent. and a speed rise of 18 per cent.

After five years of continuous service one of these turbines was opened up for careful examination. The parts subject to hydraulic and mechanical wear were measured up and photographs taken in order to establish their durability. The unit was taken out of service Saturday evening and was delivering its regular power again after midnight, Sunday. No repairs whatever were considered necessary, and it was estimated that it would be good for another five years of continuous service under similar conditions.

The results of this examination were so gratifying that it was decided to build the new third unit, practically a duplicate of the first two. The results obtained as regards efficiency and speed regulation encouraged the purchaser to increase the rated horsepower from 18,000 of the original contract to 24,000 without increasing any parts except those directly affected, such as the runner, shafts, guide vanes, etc. It is expected that 25,000 hp. will be delivered to the generator shaft and that both the efficiency and the speed regulation will be at least as good as they are with the first units.

Conserving Waste Heat

Economists are continually calling attention to the necessity for intensified conservation of resources and greater efficiency in our methods of development. As respects the conservation of heat, it is doubtful if the manufacturers of reciprocating steam engines are giving that study to the saving of the heat of exhaust steam which their interest demands. The practicable savings through higher pressures, increased expansion, superheat, improved vacuum, reduced cylinder condensation and radiation are fairly well realized, but all these are nothing as compared with the potential conservation of the heat of exhaust. Here is presented to the engineer an extended field for endeavor. Where this heat is available for heating or mechanical purposes, the thermal efficiency of the reciprocating engine is vastly beyond that of the Diesel or any internal-combustion engine. Power then becomes a byproduct and the use of any other heat engine is prohibited. By persistent exploitation of this field a new lease of life for the languishing engine trade is possible. It devolves upon the steam engineer to extend the application of waste heat. He should consolidate the diversified industries in such a way that the manufacturer requiring power will take his modicum of heat from the steam and pass the remainder on to his neighbor, for use in mechanical or other processes. At the present time, we utilize, on an average, only 5 per cent. of the heat value of coal. The combustion engineer is rapidly whipping the boiler end of the steam plant into shape; an exhaust engineer is now in demand to coin into money the waste at the exhaust end—*Steam.*

While the Idle Millions Shiver

An exposition of the deplorable conditions at the great coal terminal at Perth Amboy, N. J., from which coal for New York and lower New England is shipped by water after arrival at the terminal by rail.

WALK slowly along the east side of Ninth Avenue between 34th and 35th Streets any day from daylight until after darkness falls and you will see a line of shivering wretchedness.

It is a coal line. It is a full block long and three persons wide. You find there aged women, rheumatic old men, sturdy workmen, young women, young men and belligerent yet laughing children. Each has a bag or a box, a wash boiler, baby carriage, trunk—anything to hold the treasure coal that is portioned out to each while three policemen preserve order. Be there snow, or rain or wind and biting cold, the shivering line is there.

Imagine standing in that line for hours, waiting, waiting, eagerly, hopefully watching for the coming of a two-ton wagon only to see it come in—empty! That happens.

This line is but one of hundreds in that city of six million souls, and it is truly indicative of the cruel suffering throughout the whole of the greater city and the country.

That line has nothing to do with power. But the industries, the buildings, the schools and hospitals are waiting in line just as are these stamping, crying people. And this not only in New York, but from the Atlantic to the Pacific.

This is written on the day following the collapse of industry and commerce at the order of the Fuel Administrator. We are not arguing the expediency of that order, for we believe that as a measure to relieve rail and terminal congestion it is warranted. It cannot have been issued to conserve fuel because for this purpose it is too obviously doomed to failure even for contemplation.

Having seen the woeful coal lines and experienced the shock of the Garfield order, let us see the conditions at the great coal-distribution center that supplies Greater New York and lower New England, as seen by two *Power* representatives on the day the Garfield order went into effect. These are anthracite-consuming sections for the most part. The distribution centers are Perth Amboy and South Amboy, on the New Jersey coast, the former handling hard coal, the latter soft coal almost exclusively. The coal comes from Pennsylvania to the water front by rail and is there transferred to barges which take it to the New York and New England waterfronts. It is not more than twenty miles from Manhattan Island to Perth Amboy—a short tow.

The waterways from the coal-unloading piers have been seriously obstructed with ice; but at the time of our visit they were free. At the docks near the unloading piers was one group of 55 empty barges, averaging 850 tons each. Farther to the left were other groups of a few barges each. Some had just come in, but the greater number had been there many days. To make the irony of the situation most stinging, the "Hurry Up," of New York, had been there 27 days up to Jan. 18, the day of our visit. Demurrage of 5 cents per day per ton capacity is what the coal consumer must pay—is what those wretches in the coal line must pay. The capacity of the "Hurry Up" is about five hundred tons. Twenty-seven days' demurrage means that the consumer of the coal she gets must pay $1.35 per ton, not for coal, but for demurrage. Fig. 2 shows some empty barges.

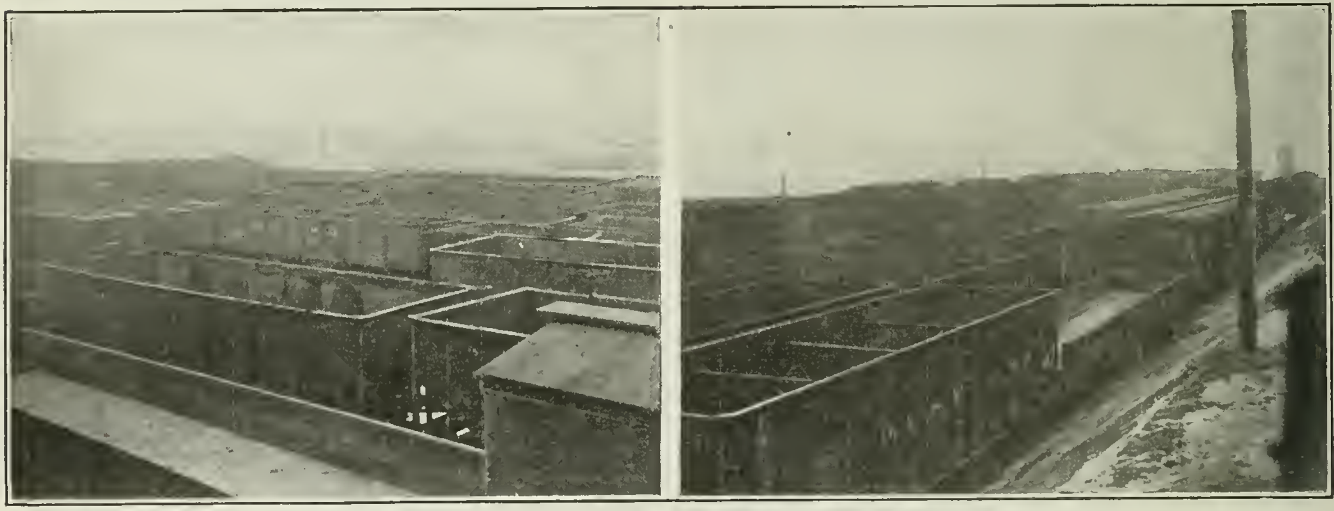


FIG. 1. VIEW OF EMPTY CARS, LOOKING EAST AND WEST, PERTH AMBOY, N. J.

And this while thousands and thousands of tons of coal stand in cars at the unloading piers not a thousand feet away, and while well above 300,000 tons lie farther back along the rails waiting to come in. (See Fig. 1.)

It is to weep!

At Perth Amboy there are two unloading piers where coal is dumped from the cars to the barges. One pier has a machine unloader which lifts and dumps one carload at a time. At the other or large pier the cars are unloaded by hand. There are thirty chuteways down which the coal may run to the barges below. On the day of our visit three were being used—the pier working at one-tenth full capacity. True, a few chutes are missing from the chuteways; but their absence only adds to the neglect so strikingly, so astoundingly, manifest.

Six men per car is the crew used in unloading the frozen coal. Twenty-six men were all that were working on that pier unloading on Jan. 18. There should have been six times as many.

The coal is frozen solid in the cars, and the finer the coal the more solid the frozen mass. Back at the entrance end of the pier are 114 steam thawing heads, all piped, valved and ready for use. Four were in use during the time of our visit. Two cars had one steam lance each stuck into the middle of the coal, and one car was using two lances. It is easily possible to so place cars that four lances per car may be used.

Frozen coal is the most serious cause of the delay in unloading and of the congestion which, remember, affects not only those local yards, but the whole line back to the very mines, where lack of cars to reecive their coal is causing miners to walk the streets even while this is written. And this while the shivering coal lines wait and weep; while industry dumps its fires and the victims of enforced idleness shiver and, in many instances, lose the wages with which they hoped to buy coal.

FIG. 2. A FEW OF THE MANY EMPTY BARGES

But this is not the worst. The writer got into a car of culm on the pier, which the crew, gone to lunch, were unloading. He picked at it with pickax and bar. It was as hard as concrete. Six men have been allowed to spend two full days unloading a car of culm! They were unloading it while we were there. Think of it. Six men two days unloading one car of culm while that shivering line pleads for the nut and stove and pea and egg that lies by the thousands of tons right at this very pier. Fig. 3 shows the little ice in the bay.

No attempt seems to be made to sidetrack the frozen culm until the other grades which, though equally frozen, may, because of the larger particles, be unloaded ten, aye, fifty times as fast. And then there is the relative heating value. Fig. 4 shows frozen culm.

As things are managed now, a dealer must have his barges on the spot or he can get no coal. If one or a hundred cars of his coal come into the yards and his barges are not there, the coal remains in the cars until *his* barges arrive.

They work nine or ten hours a day on this pier, and if it is worked at over one-tenth its capacity there were no evidences of it when we were there. Why has not someone provided for 24-hour day operation?

FIG. 3. THE ICE IN THE BAY IS NEGLIGIBLE

The machine-unloading pier works very slowly owing to the coal being frozen.

At South Amboy, the soft-coal terminal, there is every evidence of adequate and proper equipment, of organization, directive intelligence and adequate labor. There are three thawing sheds, while at Perth Amboy there is no thawing shed.

One who knows something of the bitter suffering, of the idleness, of the loss of production and the general serious disturbance of the whole social, economic and industrial fabric, wonders if the conditions described in the foregoing are general. He cannot but seek a motive for it all. It is preposterous to say that the conditions at Perth Amboy simply happen.

The Fuel Administration may know the answer. The public rightly assumes that it does, and it rightly expects it to lose no time in correcting such conditions.

Through it all one thought frequently creeps into the fore of the writer's mind: Some of the public utilities tried hard to get coal, to keep going. They pleaded, demanded and finally precipitated a crisis by turning off the lights and stopping the industries. Then came action. If that shivering line, that line of humans and of buildings, hospitals and industries discover too many Perth Amboys, how long before it will precipitate a crisis as only the constituents of such a line can precipitate it?

It is worth pondering over, Dr. Garfield.

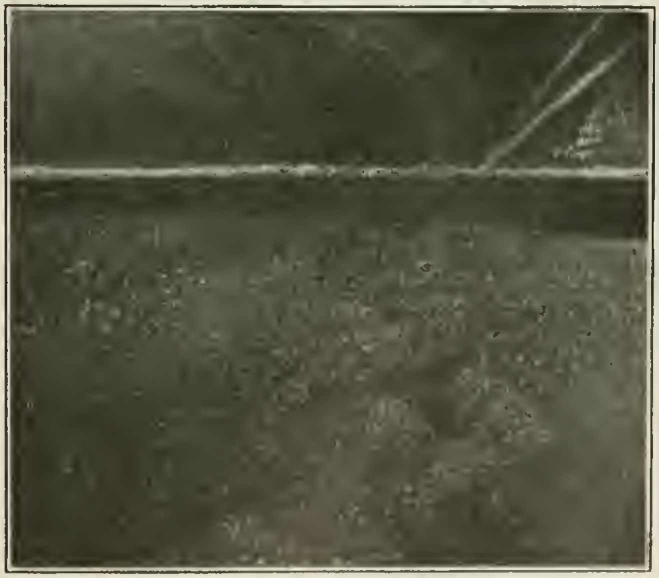


FIG. 4 CULM FROZEN AS HARD AS CONCRETE

Alternating-Current Automatic Starters for Squirrel-Cage Induction Motors

By W. H. PATTERSON
Manager Resale Section, Industrial Department, Westinghouse Electric and Manufacturing Company

An explanation of the operation of an automatic alternating-current starter for squirrel-cage type induction motors. Some of its applications and limitations are pointed out.

ALTERNATING-CURRENT automatic starters are now quite commonly used for squirrel-cage induction motors, especially where it is desired to start the motor from a remote point, such as a motor driving a centrifugal pump, an air compressor, a fan or a blower.

One type of these starters, built by the Westinghouse Electric and Manufacturing Co., consists of a slate panel, Fig. 1, upon which are mounted two alternating-current contact switches—one two-pole switch *R* and one four-pole switch *S*. Both these switches are equipped with magnetic blowouts for quickly destroying the arc when opening the switch. An accelerating relay *H*, a transfer relay *T* and a no-voltage protection relay *P* are also mounted on the panel. Either fuses or overload relays are mounted on the panel to protect the motors from overload. In Fig. 1 fuses *F* are shown on the front of the panel, and in the wiring diagram, Fig. 2, two overload relays *O* and O_1 are used. An auto-transformer is mounted on the rear of the panel. Fig. 2 shows a complete wiring diagram of the controller for starting a two-phase motor. With the line switch closed and all contactors on the controller in their normal position, all circuits through the controller and to the motor are open. The different steps in the operation of the controller are explained as follows:

Closing the start push-button, as in Fig. 3, establishes a circuit through the operating coil of the no-voltage protection relay *P*. This circuit is established from L_1 of the supply circuit through the contact on overload relay *O*, down to 9 on the no-voltage protection relay *P*, through this coil up to the contact on the overload relay O_1, then down to the start push-button to the stop push-button, which is normally closed, back to L_3 terminal on the control board, and to the other side of the supply circuit L_3 on the line switch, as indicated by the arrowhead. This energizes the coil on the no-voltage protection relay *P* and causes it to close its contact *L* and the auxiliary contact 11-12 at the bottom of the relay, as in Fig. 4. Closing contact 11-12 establishes a holding circuit for the relay coil *P*. This circuit is the same as in Fig. 3 excepting, instead of the current passing from terminal 11 on the controller down to the starting button, it goes through the auxiliary contact 11-12 on relay *P* and to terminal 12 on the stop button, through this button back to L_3 terminal on the line switch, as indicated. This shunts out the starting button; therefore it can be released and allowed to take its normally open position, without in any way interfering with the operation of the controller.

The closing of the no-voltage protection-relay contact *L* also establishes a circuit through the operating coil *X* of the four-contactor switch *S*. This circuit is made from L_1 of the supply circuit, through the contact of the no-voltage protection relay, to terminal 6 on coil *X*, through this coil and up to point 1 on the transfer relay *T*, then to point L_3 on the transfer relay, which is directly connected to L_3 on the supply circuit, as shown by the arrowheads. Energizing coil *X* causes it to close the four-contactor switch *S*, as in Fig. 5. With the contactors in this position the motor is connected to the low-voltage taps of the auto-transformer.

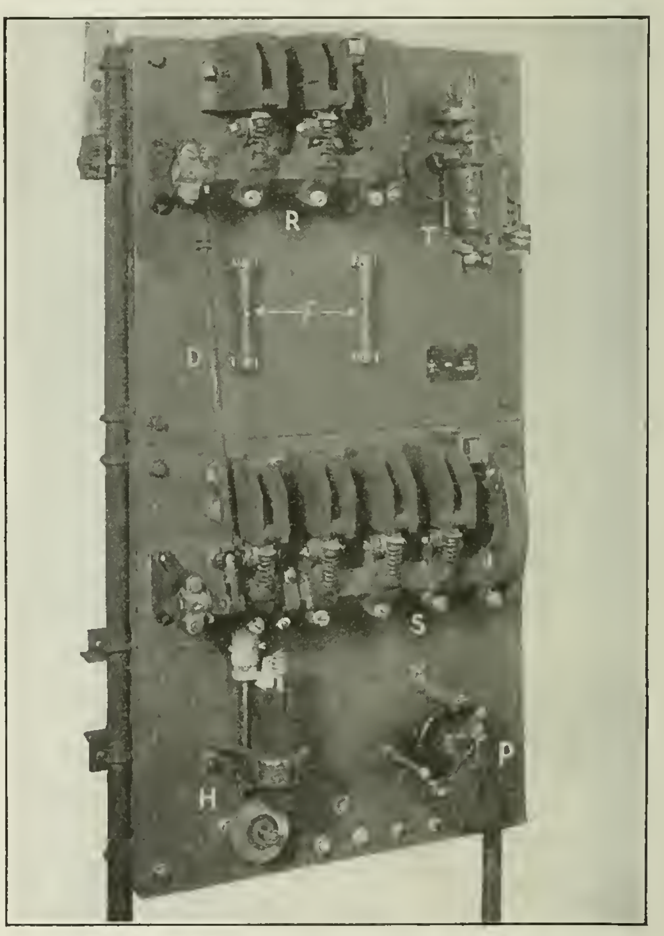


FIG. 1. AUTOMATIC STARTER FOR SQUIRREL-CAGE TYPE INDUCTION MOTOR

Contactor *A* on the four-pole switch is connected to terminal A_3 at the center of one leg of the auto-transformer. This connection gives 65 per cent. normal voltage at the motor terminals at starting. Connecting terminal *A* on the switch to A_4 or the auto-transformer will give a higher voltage, while connecting to A_2 will give a lower starting voltage at the motor terminal.

The circuit to the *A* leg of the auto-transformer is from L_1 on the line switch down to L_1 contactor on the four-pole switch *S*; from here to terminal A_0 on the auto-transformer through the transformer to A_3, then to the accelerating relay coil *H* to contact *A* on switch *S* and down to the *A* terminal on the motor; through one phase of the stator winding to A_1 terminal and up to L_3 terminal on the controller to the L_3 pole of the line switch. Current flowing through section A_5-A_3 of the auto-starter induces an opposing voltage in section A_3-A_1. This opposing voltage causes a secondary current to flow from A_3 through the motor as did the primary current, but instead of passing from L_3 terminal on the controller to the line switch, this current takes the path from L_3 to A_1 on the auto-transformer, thus completing the secondary circuit as indicated by the arrowheads. The circuits for the *B* phase may be traced out in the same way and are indicated by arrowheads. Accelerating relay *H* is adjusted so that the inrush current when the motor is first connected to the line holds contact 2-L_3 open, but as the motor increases in speed and the current through coil *H* decreases, its strength decreases to a point where the contactor is allowed to drop and establish a circuit between points 2 and L_3. This completes the circuit for the transfer-relay coil *T*.

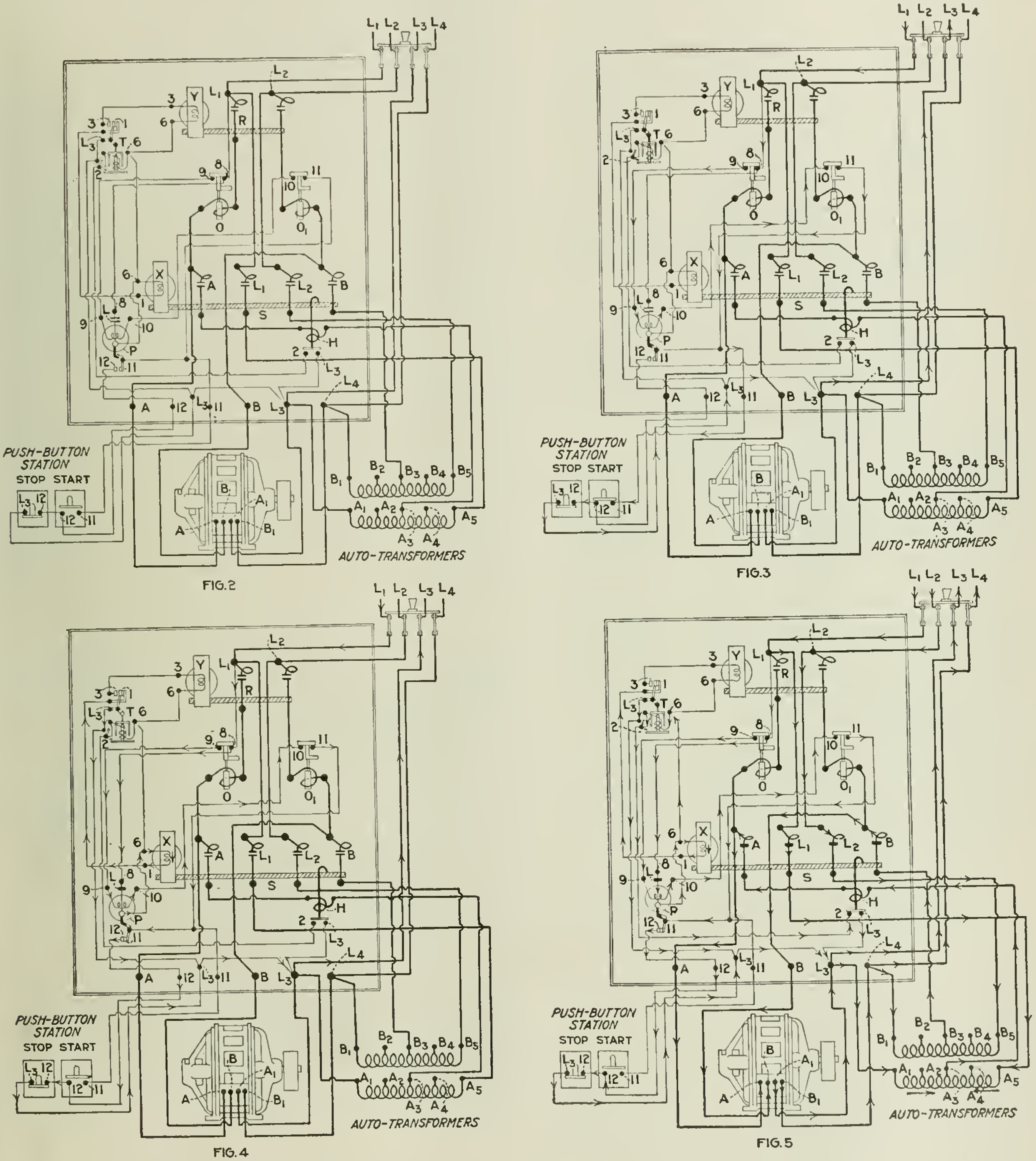


FIG.2 FIG.3 FIG.4 FIG.5

FIGS. 2 TO 5. WIRING DIAGRAMS OF CONNECTIONS FOR THE CONTROLLER, FIG. 1, IN DIFFERENT STAGES OF STARTING A TWO-PHASE, SQUIRREL-CAGE TYPE MOTOR

The circuit for relay coil *T* is from terminal 6 on the coil *X*, through the coil on relay *T* to terminal 2 on the relay down to 2 on relay *H*, to the L_3 terminal of the line switch. The operating coil on the transfer relay *T* being energized, draws up its core and makes contact at point 2 at the bottom and opens contact 1 at the top, and closes contact 3, as shown in Fig. 6. Closing point 2 creates a direct circuit for the transfer-relay coil from 6 on coil *X* to 6 on the transfer-relay coil, to contact 2 up through the core to terminal L_3 and down around to the L_3 terminal on the line switch. This establishes a holding circuit for the transfer-relay coil and shunts out relay contacts 2-L_3 on relay *H*, so that their opening when the four-pole contactor switch *S* opens will not interfere with the operation of the transfer relay.

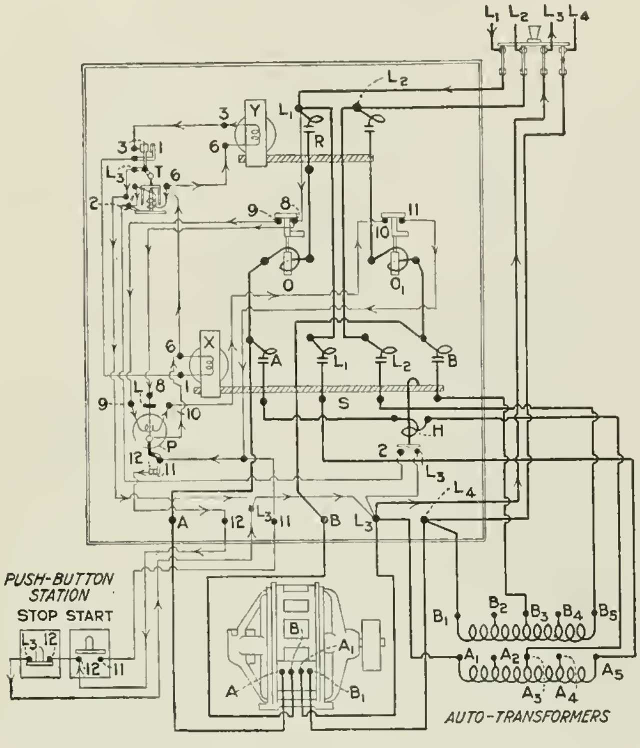


FIG. 6

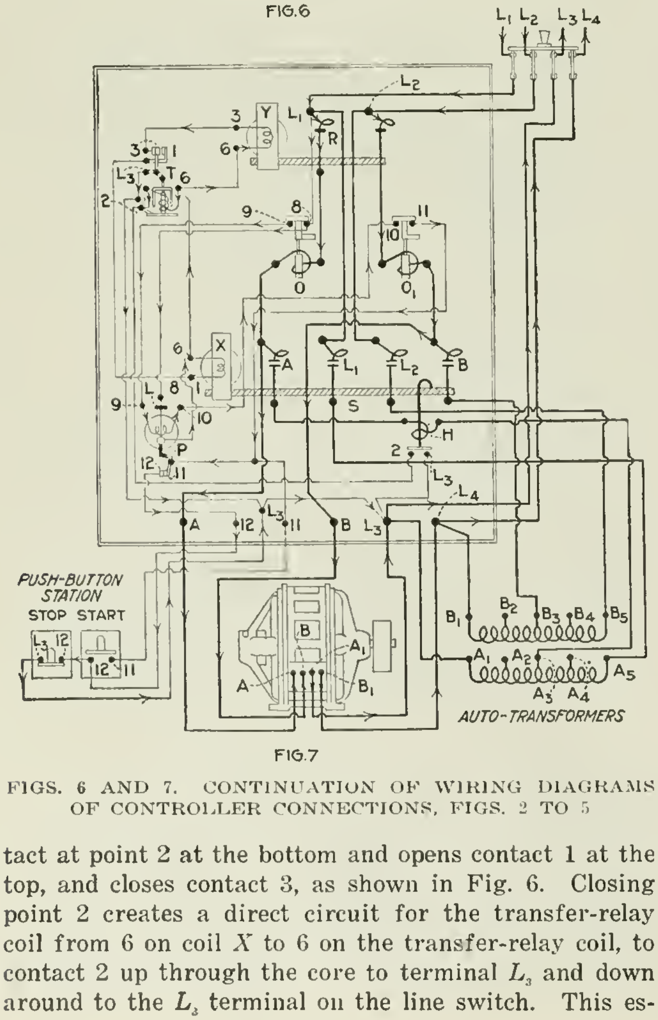


FIG. 7

FIGS. 6 AND 7. CONTINUATION OF WIRING DIAGRAMS OF CONTROLLER CONNECTIONS, FIGS. 2 TO 5

Opening contact 1 on the transfer relay interrupts the circuit of coil *X* on switch *S* and allows the switch to fall open, as shown in Fig. 6. The closure of contact 3 on the transfer relay *T* establishes the circuit for the operating coil *Y* on the two-pole switch *R*. This circuit is from terminal 6 on the transfer-relay coil over through coil *Y* around to terminal L_3 on the transfer relay, and to the L_3 terminal of the line switch. This circuit causes the two-pole contactor switch *R* to close, as in Fig. 7, and connects the motor directly to the line. The circuit through the motor is from L_1 on the line switch down through *A* phase of the motor and back to L_3 on the line switch, and from L_2 down through the *B* phase of the stator winding back to L_4 on the line switch, as indicated by the arrowheads.

Since the circuit of the transfer-relay coil *T* and operating coil of the two-pole contactor switch *R* passes through the no-voltage relay *P* it will be seen that the opening of the no-voltage protection relay *P* will break the circuit, allowing the two-pole contactor switch and the transfer relay to open and remain open as in Fig. 2, until the start button is again pressed.

The pressing of the push-button marked stop breaks the circuit through the no-voltage protection-relay coil, allowing this relay to open, thus breaking the coil circuit of transfer relay *T* and switch *R*, allowing the latter to open and stop the motor. It will also be seen that the operation of either of the overload relays *O* and O_1 will open the circuit that holds the no-voltage protection relay closed, thus opening the circuit through the coil of the main two-pole switch *R*.

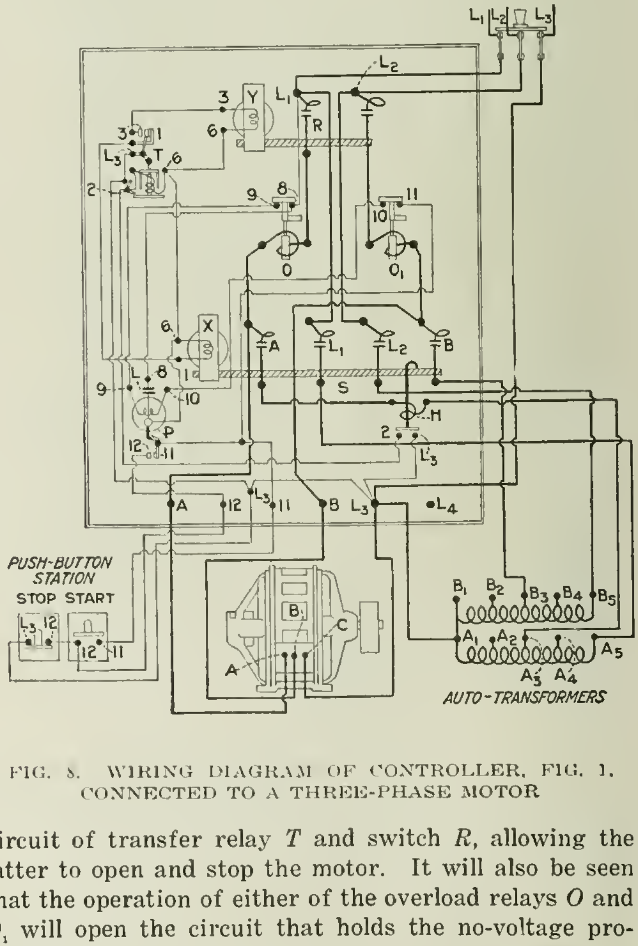


FIG. 8. WIRING DIAGRAM OF CONTROLLER, FIG. 1, CONNECTED TO A THREE-PHASE MOTOR

In general, the operation of the automatic autostarter is the same for either two- or three-phase motors, Fig. 8 shows the connection for a three-phase motor. The principal difference is in the connections; in the case of the three-phase panel line L_3 is used to replace the line marked L_3 and L_4 in the two-phase diagram.

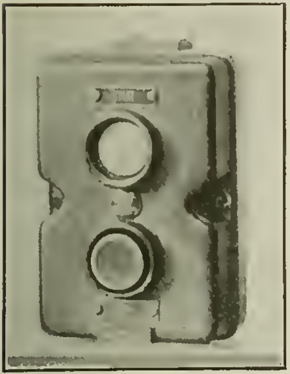


FIG. 9. PUSH-BUTTON STATION

The two contactor switches are mechanically interlocked by the rod *D*, Fig. 1, so that it is impossible for both switches to be closed at the same time. With one type of this controller without the no-voltage protection relay *P*, in case of failure of voltage, the switches automatically open and upon return of the voltage will automatically close again in their proper sequence. This is termed "no-voltage release," and it is satisfactory to use a controller of this kind with a motor driving a centrifugal pump, air compressor, fan or blower. However, on a motor driving a machine tool or a woodworking machine, where unexpected starting up of the tool would render possible injury to the workmen, the controller is equipped with the additional relay *P*, shown in the lower right-hand corner of the panel, Fig. 1, which prevents the switches from closing upon return of power until the master switch or a push-button station is again closed. A controller equipped with this relay is termed as having no-voltage protection.

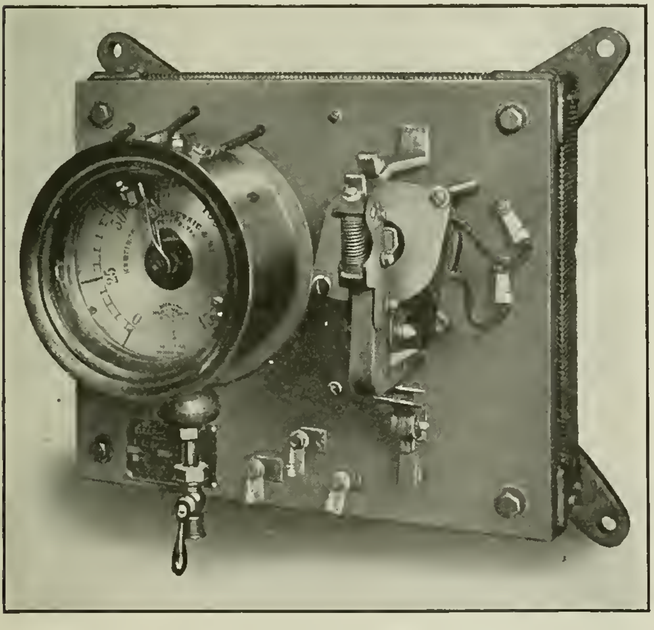
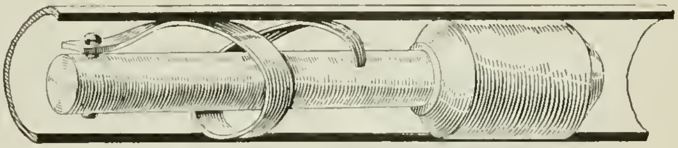


FIG. 10. PRESSURE-GAGE MASTER SWITCH

These controllers may be operated by hand by "start" and "stop" push-buttons, Fig. 9, or automatically by a float-type switch or a pressure-type master switch, Fig. 10. The float-type switch is used in liquid tanks, and the motor is started when the level falls to a certain point and is again automatically stopped at the desired upper level. The pressure-gage master switch is used with a motor driving a compressor or pump emptying into a closed pressure system. The switch makes the connection to start the motor when the pressure falls to a predetermined point and stops it when the desired pressure is reached.

Griffin Condenser-Tube Cleaner

Cleaning condenser tubes is not agreeable work, and with many of the methods employed, considerable time and labor are spent in cleaning them. Several devices for doing this work have recently been described in *Power*. The latest one that comes to our attention is illustrated herewith, and it has been devised by C. M. Griffin, 114 Spruce St., Newburgh, N. Y.



CLEANER IN CONDENSER TUBE

The tool is designed to clean condenser tubes by being forced through them by water pressure of about 100 lb. per sq.in. Its scraper blade is loosely attached to the front end of a central bar, and is tempered and ground to fit the tube, the size depending upon the tension desired. The head or piston at the rear end of the bar is made about 0.04 in. smaller than the tube. The scraper is made with clearance and rake, and retains a sharp edge while being used. Each tool will clean 1000 or more tubes before it is worn out. It is not necessary to provide protection for the tool while being used, and it may be shot against the head of the condenser and dropped to the bottom of the water box without damage.

Although it is not intended that the tool shall revolve by going through the tube, it does make three or four revolutions in passing through an 18-ft. tube, which requires about 3 sec. time, and with 20 or 30 tools at work, two men can clean about 200 condenser tubes per hour.

Automatic Damper Regulation

By C. A. Morris

We may put a force in motion and with a fixed degree of control operate it within a given range and with maximum efficiency, but if the use of this force is not required at the maximum all the time, yet still must be held in readiness to meet any demand within the range governed, then I believe it is necessary to have some method of automatic regulation in order that maximum efficiency may be maintained. If the mind and hand of man through the medium of the eye are depended upon for proper regulation, it is better than no regulation, but a mechanism that will act automatically and at a point not discernible to human senses, it seems to me, will be more efficient and less exacting on the attention of the men in charge of the actual operation of the equipment.

When boilers are operating at a high point of rating against a load that is constantly swinging, frequently as much as 80 per cent., the judgment and action of the human element are inadequate to obtain the highest efficiency, and in this day of conservation we should put the accent on efficiency—not alone for pecuniary benefit to ourselves, but to help in a national crisis.

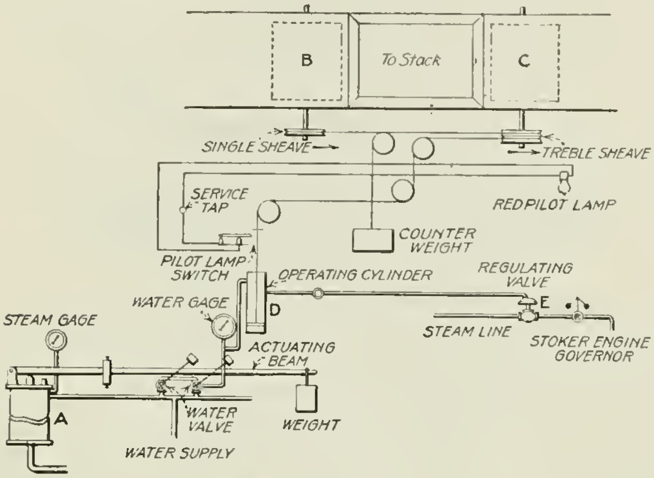


DIAGRAM OF DAMPER CONTROL

We have a station rated at 10,000 kw. with 4000 hp. in normal rating of boilers. The boilers are the Stirling type, eight in number. Two are in disuse owing to the fact that they are equipped with a type of stoker that is not efficient with the kind of coal we use. The other six boilers are served with chain-grate stokers that are driven from a lineshaft by a small engine. It is necessary to operate these boilers constantly at 175 per cent. of rating, and on peak periods they carry 225 per cent., using Indiana screenings and mine-run coal. Steam pressure is carried at 195 lb., with 100 deg. of superheat. Our load is divided about equally between commercial and railway power.

About four years ago the question of higher efficiency in the boiler room was under consideration at our plant, and we installed a system of automatic control of the draft and stokers that has given us continued satisfaction up to the present time at a total maintenance expense of about $12, and we have every reason to believe that it will render good service for years to come. Owing to the finer degree of regulation we were able to secure with this system of automatic control over our old method, our boiler rating was increased with a saving of about 14 per cent. in fuel. The variation of steam pressure was reduced from 20 to 5 lb., and the average CO_2 was increased materially. The boilers now require less cleaning inside and out owing to more complete burning of the coal and to the rapid circulation of the water, and the general expense on the upkeep of our furnaces has been lessened.

Our regulating system consists of a damper regulator *A* attached to two master dampers *B* and *C*, each 10 x 5 ft., which operate vertically in rectangular smoke breechings, one on either side of the chimney, which is 12 ft. in diameter and 225 ft. high. The regulator is actuated by the steam pressure, and the actuating beam releases a water pressure which, acting in a cylinder *D*, closes the two master dampers to the desired point within 30 sec. Simultaneously with the action of the water in the cylinder, the same pressure is transmitted to a special regulating valve *E* on the stoker-engine steam pipe, so that the speed of the stoker is cut to a point in relation to the closing of the dampers, and after hours of operation the fires are maintained at the proper thickness and length without manual effort. It is this particular feature of the equipment that distinctively places it in the efficient class. The design and connections of the master dampers are such that any desired degree of operation can be secured and also the stoker valve can be so adjusted as to be always in true relation to the operation of the dampers.

One of the most important features in connection with this system is a red signal lamp, which is suspended centrally in the boiler room. This signal is flashed the instant the regulator goes into action and remains burning until the dampers are closed again. This lamp is to the firemen what the compass is to the sailor, and without it the system would lose a great deal of its value. Should the light remain on more than two minutes at any period, it denotes that something is interfering with the boilers in meeting the demand for power. The flow meters will indicate whether it is an increase in load or not; if the load is regular, there has been a change in fuel and the proper adjustment is made on the stokers. Low steam pressure permits water pressure to open the dampers, and as soon as the normal steam pressure is regained, the dampers are released from the water-pressure cylinder and counterweights close the dampers.

With the increased load the plant now carries over that which it carried previous to this installation, three boilers in full operation meet all demands, the fourth being used as a buffer. Previous to the installation of the regulator four boilers were required at high service, with the fifth as a buffer. The initial cost of the regulator was met by the fuel saving effected during the trial period.

J. R. S. Low-Grade Fuel Burner

In these days of high-priced fuel and coal shortage throughout the country, manufacturers are turning their attention to perfecting devices that will burn the lower grades of fuel. Among others who have been working on the problem is the Mechanicville Specialty Supply Manufacturing Co., Mechanicville. N. Y., which is manufacturing the J. R. S. Low-Grade Fuel Burner. The object of this apparatus (Fig. 1) is to burn such

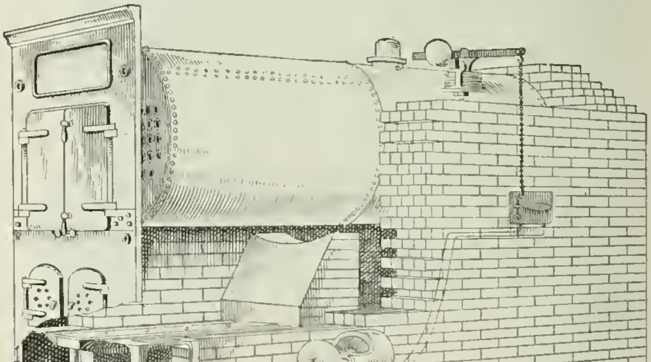


FIG. 1. BURNER AND DRAFT FAN AS APPLIED TO FURNACE

low-grade fuels as coal dust, screenings and buckwheat, both anthracite and bituminous coal, and especially such grades as cannot be burned with natural draft.

The burner is made of cast iron, as are also the "filling-plates." Two burners are usually placed in a furnace, the "fillers" being bolted to them. The burners are spaced so that about half of the width of the furnace is between them, and midway is an ash dump so constructed that it is practically gas-tight when closed. The design of the burner and also the ash dump is shown in Fig. 2.

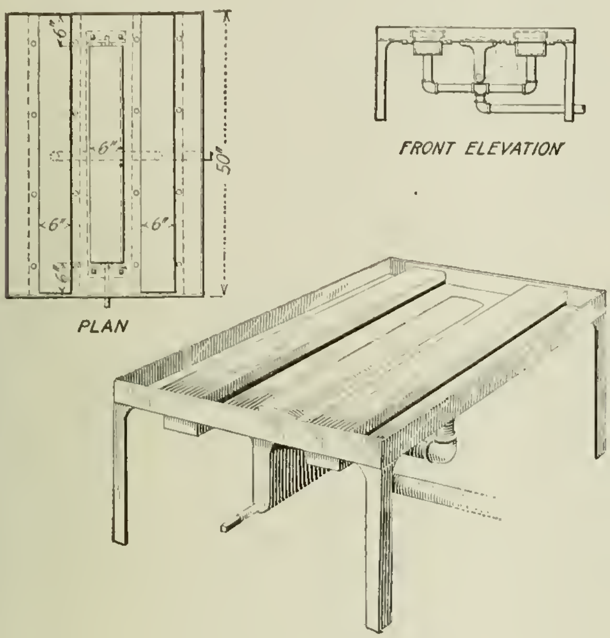


FIG. 2. DETAILS OF BURNER

No grates are used, and the edges of the burners, where they come against the brickwork, are sealed with a noncombustible substance so as to prevent the flow of air from the ashpit into the furnace.

Each burner consists of an air-box over which is a cover plate so separated from the box body proper that there is from $\frac{1}{2}$ to $\frac{5}{8}$ in. opening between them on the sides. In other words, the design is about what would be obtained with an ordinary cardboard shoe box with the cover a couple of sizes too large for it and lifted about one-half inch from the body. Air is supplied to the burner through a bottom connection, as shown. In the case of a double burner the air connection is made as indicated by the elevation in Fig. 2.

The discharge of air from the burner box is underneath the cover plate and along the two sides in a semilateral flow downward, and rebounding under a pressure at the points of discharge into the coal, it is distributed to the fuel surrounding the burner. The air pressure can be carried as high as 12 in. of water, thus enabling the operator to carry a heavy fire as is frequently necessary in plants that are operated at their full capacity. With a clean fire the draft would, of course, be much less than would be necessary with a heavy, dirty fire.

Air is supplied by means of either a direct-connected motor-driven or a belt-driven fan. The operation of the motor is controlled by a diaphragm-pressure regulator. For instance, if the damper regulator is set to control the steam pressure at 100 lb., the motor and blower will supply air to the fire until the steam pressure reaches that point. The diaphragm regulator then operates a switch and shuts down the motor. A drop in the steam pressure causes the regulator to throw the switch again to start the motor.

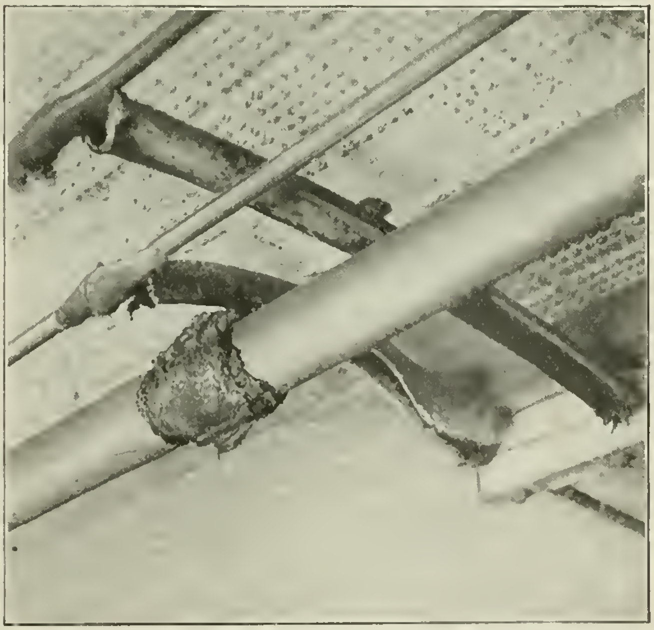
The fuel is fired as with the ordinary grate furnace, and the ashes are discharged into the ashpit through the dumping gate.

Lighting Circuit Caused Water-Pipe Joint To Corrode

By B. A. Briggs

The effects of eddy currents, produced by stray magnetic fields set up by alternating-current circuits, are probably not appreciated as much as they should be. The illustration is an example of what may happen to a pipe coupling where an alternating-current lighting circuit is installed near it. This installation is in a perfectly dry basement that is heated in the winter. The pipe line, which is used for water supply to the building, is only a few inches away from a ceiling covered with plaster boards.

The electric installation has been in use for a period of only about three years; previous to that time the joint was not corroded, neither has any other pipe joint, either gas or water, corroded in the building since the electric circuits were installed. Therefore it appears to be quite evident that the presence of the electric circuit at the pipe joint caused the corrosion. The corrosion had gone so far when this photograph was taken that in some places the threads of the coupling were visible.



ELECTRIC WIRING AND PIPE JOINT

[Although the foregoing is not positive proof that the presence of the lighting circuit caused the coupling to corrode, nevertheless it brings up the question as to the advisability of running electric circuits across a pipe coupling as in the figure. *Power* would appreciate an expression of opinion from interested readers for publication on the foregoing question.—Editor.]

Buying an Ash-Handling System

BY HERBERT E. BIRCH

How to intelligently purchase an ash-handling system to remove ashes from boiler ashpits is a question that is confronting many engineers and is discussed here. It is a timely subject, and there are many ways of solving this apparently simple problem.

TO ONE who is not thoroughly familiar with the effect of ashes on conveying machinery, it seems like a waste of time to give the subject much consideration, but it requires more thought to design or purchase ash-handling equipment than it does a system to convey coal. Any conveyor to handle coal may be installed with reasonable expectations of a minimum upkeep cost, but with ashes it is necessary to proceed cautiously, for there are many points that demand consideration.

Perhaps the first one is whether to install a single conveyor to handle both coal and ashes. The claim in favor of this method is that it avoids a multiplication of machines and driving parts and so reduces the cost of operation and maintenance. Against this, there are the claims of those who prefer a "divorced" system, where the ashes are handled in a conveyor set apart for that purpose only. Briefly, these are that it is often necessary to handle coal and ashes simultaneously, which it is impossible to do with the "one for all" conveyor; that the equipment runs only about one-tenth of the total time to handle ashes, and that it is subject to the wear of the ash grit in the chain joints the remaining nine-tenths; that wet ashes sometimes pack in the buckets and they have to be cleaned out before coal can be handled, and that inasmuch as the conveyor was made heavy and ponderous to resist the destructive effect of ashes, it is foolish to pull this extra load around the boiler room when handling coal.

MOST ENGINEERING FIRMS PREFER "DIVORCED" SYSTEM

These points must be carefully weighed before deciding which system to follow, but in this connection it may be well to state that most of the large engineering firms prefer and the large New York and Philadelphia boiler houses use the "divorced" system.

Assume that it is decided to follow in their footsteps and see just what there is to watch and where there is a probability of being tripped up by the salesmen who present for consideration the various systems on the market. Perhaps the best way to do this is to first look at the ashes—examine their make-up. It is well known how destructive a few grains of grit in a bearing would be. The ashes may be dripping wet, red-hot, dry and dusty, or hard with sharp corners, but they are never just plain ashes.

All of this suggests abrasion. Consider first what effect they will have on the system that is being investigated. Are there any chain joints or other moving parts that are likely to wear out? Perhaps there are no chains. Then do the ashes move in, over, or through anything? It does not make much difference whether they move and the part that wears out is stationary, or whether the ashes are stationary with respect to the moving part; wear occurs in any event, and the result is that the repair bill is high or, as often happens, the outfit is thrown out by someone higher up.

Power requirements often lead to the rejection of a conveying system, for power costs money. Will the apparatus under consideration consume much power? Will it use power at its maximum rate all the while it is in operation, or does it consume energy only while it is actually conveying its full load? Some systems operate under full power while the ashman is lighting his pipe or while it is conveying only at one-half its maximum capacity. Is the power consumption so large that it is necessary to keep 90 or 100 hp. continually floating on the line ready for ash-handling service at any instant? One argument for large power-consuming devices is that ashes are handled only when there is a large head of steam on that would be wasted anyway. Beware, for it is but a snare and a delusion. What is the intelligent engineer doing with so much steam to waste?

BREAKING THE CLINKERS

What size clinkers do the stokers make? Perhaps they are working under an overload and the clinkers are extremely hard. Must these clinkers be broken into small pieces before they can be fed into the conveyor, or can they be put in just as they come from the furnace? Do not let anyone minimize this point by suggesting that it is easy to put a concrete block at each conveyor intake upon which to break any recalcitrant clinker; plant operators are not in the butcher business.

Frequently it is desirable to get rid of boiler-room refuse by means of the ash conveyor. Will it handle firebrick, flue dust, soot, etc.? Do not take the salesman's say-so. Investigate, use common sense and find out.

How about dust prevention? Maybe the plant is at a textile or paper mill, where dust is frowned upon. Will the conveyor under consideration handle a finely powdered material and deliver it to the ash bin without kicking up a cloud of dust? If it will not, can it be wet and then will the conveyor handle it? Will the putty-like mass that is formed clog up the system and will it be necessary to poke it out in order to start the apparatus working again? Or, if it is handled dry and quenched just before it is discharged into the ash bin, is the quenching system subject to freezing in winter? Possibly, where steam is used as the propelling agent, mud will be produced, which is apt to cause trouble at the turns. Consider what happens to the ashes (or mud) in the conveyor when it stops handling them. Is it necessary to poke things clear before it is possible to start up next time? Is the mud likely to settle at the lowest point and cake there, and if it does, how easy is it to find where this occurs?

How about a dirty appearance around your plant? Will it be necessary to drop the ashes from the stoker hoppers and then rake them into the conveyor? An ashman is not apt to be overly clean in sweeping up after he is through, but can he be blamed?

How about safety? Some systems explode occasionally, doing severe property damage. See *Power*, page 468, Apr. 3, 1917. In this accident two men were killed.

The capacity of the system should be of interest also. It is possible that it will take several men to tease the ashes through an intake opening in order to handle the amount that is made. Then there is the distance the system will convey the ashes and the height to which it will lift them. Perhaps if there is a long run in the basement and a good high lift, the power consumption will be enormous.

NOISE A FACTOR TO BE CONSIDERED

Another factor that may influence judgment is the noise the apparatus is likely to make. Some conveyors emit a grinding noise which is extremely disagreeable to those who live close by. At several plants, the municipal authorities prohibit the conveyor working at night, and at least one, to my knowledge, was refused permission to operate on the ground that it was a common nuisance.

Will the proposed installation meet the exacting demands of the *OMIA* formula? This means that operating charges O plus maintenance charges M plus interest on the total money invested I plus the adaptability A of the plant (which can hardly be measured in dollars) must be less than the labor saving effected. Operating cost includes power, labor to operate, oil and such incidentals. Maintenance charges include all repairs of any nature whatever and the labor expended in making these repairs. Under this head is usually included depreciation, which is likely to be high in an ash-handling plant. Conveying-machinery depreciation is figured at 10 per cent., but in some types of ash conveyors, where no machinery is used, the depreciation is likely to be 30 or 40 per cent.

Interest on the investment includes not only the interest on the parts purchased from the manufacturer, but on the cost of labor to install, foundations, and any preparatory work that may have to be done, bunkers built, etc.

OPERATING COSTS

Just a word in passing from this phase to the next. Do not be fooled by the oft-repeated statements of "a few cents per ton to handle ashes." Just figure it out. At 30c. an hour for labor, if 5 tons of ashes are handled per hour with the system, that is 6c. per ton for labor alone. How about power, which is apt to cost 20c. per ton in some systems? The cost per ton to handle ashes is determined by dividing the *OMI* cost per year by the tons of ashes handled. If an ash-handling system is already being operated, sit down right now and figure it out, but be prepared in advance for a big surprise. Instead of 6c. per ton it is more likely to be 30 to 40c. Then perhaps one will wonder just what is the trouble with a wheelbarrow, which has no operating difficulties, interest, maintenance and other charges to speak of. It may be that if an "educated wheelbarrow," with ball bearings and four wheels running on tracks is used, it would prove to be just about the right thing. There will be use for a man anyway, so why not let him push the wheelbarrow?

Speaking of having to have a man is a reminder that there is an opportunity to say just a little about the design of ash hoppers. If the plant runs night and day, the ash hoppers ought to be large enough to take care of the accumulation of ashes during the night and thus avoid a night shift of ashmen. The best condition is where all the ashes can be handled by one shift. It would probably be advisable to figure out how much labor would be saved by rearranging the ash hoppers to accomplish this, and determine what could be spent to do the job. Roughly, an expenditure of about $2200 is warranted for every dollar per day saved.

The engineer who spends his time thinking of such problems as this is the one who grows. Such a man cannot be kept down. Let someone else polish the brasses, or else do away with them, for if a man thinks and acts in such small terms, then surely will the real job, the job worthy of an engineer, be taken from him.

ASH-HANDLING METHODS THAT MAY BE USED

Now to get back to ash conveyors. The following methods may be used to handle ashes:

1. By vacuum systems, which are divided into two classes: (a) Complete vacuum systems, where the vacuum is maintained by exhausting the air from the ash bin; (b) partial vacuum, where the jet of steam creates a vacuum in the conveyor pipe back of the jet, but where the jet itself has a positive action on the ashes ahead of it.

2. Ash drag in a trench in front of the boilers or in a tunnel beneath the ash hoppers. This drag consists of a wide malleable chain running in a cast-iron trough and dragging the ashes with it. It may discharge to another drag conveyor which operates on an incline, or it may discharge to a:

3. Bucket elevator of the centrifugal discharge type, which is usually vertical or but slightly inclined. This bucket elevator may be used in connection with wheelbarrows or a push car.

4. Ashes skip hoist, which consists of a large bucket that runs up steel guides and dumps into an ash bin. This system is usually arranged so that the operator pushes a button and the bucket full of ashes ascends, dumps, reverses and descends automatically, coming to a stop in the loading pit. This skip hoist can operate in a vertical path or on an incline of, say, 45 deg., or anything between these two conditions. The skip bucket may be filled by means of a push car, wheelbarrow or ash drag. In the last case, it becomes necessary to provide an equalizing hopper to take care of the ashes which accumulate while the skip bucket is hoisting a load. (This is always necessary where a continuous conveyor delivers to an intermittent one.)

5. A grab bucket operated by a monorail crane may be used to dig ashes out of a pit where they have been discharged, by barrow, push car, steam jet or ash drag. The pit is then made large enough to take care of storage, thus eliminating the overhead bunker. However, an experienced man is usually required to operate a grab-bucket crane, which is one disadvantage of handling ashes in this way.

6. Cold ashes can be handled on a belt conveyor, but if the clinkers are large the belt must be wide, say 36 in. for large clinkers, unless they can be broken.

This applies to several of the other types of conveyors, where the clinkers have to be broken before they can be teased through a 6-in. hole.

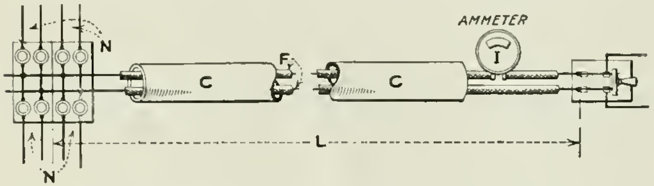
The foregoing are the principal methods used, and although others may exist, they are of minor importance. Even No. 6 could be omitted, but was mentioned to bring out the point about the clinkers.

Get acquainted with the various methods, applying to each the points mentioned in this article and then you will be in an excellent position to recommend the type of equipment to buy. The boss will not be in a mood to accept excuses when it becomes necessary to throw out a bad investment, but you will never be in this position if a little study is given to the subject now.

Conduit and Wire Sizes for Two-Wire Feeders

By T. A. Nash

A table showing what size conductors will be required to carry different numbers of 660-watt branch circuits with a 2 per cent. or a 3 per cent. drop is given herewith. The first column indicates the number of 660-watt circuits in each case. The second column, headed "Amperes," indicates the approximate number of amperes in each case, and the third column shows the smallest size of wire that can be used for the feeder without excessive heating of the wire. The fourth column indicates the normal size of conduit that can be used, assuming double-braided, rubber-covered wires are installed. The fifth and sixth columns indicate respectively the maximum distances to which the currents indicated in column *I* can be carried in the wire size of column *F* with a 2 per cent. drop and with a 3 per cent. drop. An indication of what the table stands for in the circuit is given in the figure; the letters at the top of the columns correspond to those on the illustration.



FEEDER AND BRANCH CIRCUITS

TABLE SHOWING FEEDER AND CONDUIT SIZES FOR 110-VOLT TWO-WIRE SYSTEM

N Number of 660-Watt Circuits	I Amperes	F Size of Feeder	C Size of Conduit for Rubber-Covered Wire	L Extreme Distance for 2 per Cent. Drop	L Extreme Distance for 3 per Cent. Drop
3	18	12	¾	37	55
4	24	10	¾	44	66
5	30	8	1	57	85
8	48	6	1	56	84
11	66	4	1¼	64	97
15	90	2	1¼	76	114
16	96	1	1½	89	134
20	120	0	1½	90	135
25	150	00	1½	91	136
29	174	000	2	99	148
37	222	0000	2	98	146
39	234	250,000	2½	110	165
45	270	300,000	2½	114	171
50	300	350,000	2½	120	180
54	324	400,000	3	127	190
60	360	450,000	3	128	192
66	396	500,000	3	130	194
70	420	550,000	3	135	202
75	450	600,000	3	137	205
79	474	650,000	3	141	211
83	498	700,000	3	144	216
87	522	750,000	3	147	221
91	546	800,000	3½	150	225
95	570	850,000	3½	153	229
100	600	900,000	3½	154	231

Operating Costs of Electric Elevators

By Charles W. Naylor

Chief Engineer, Marshall Field & Co., Chicago; Member A. S. M. E.

The electric passenger elevator has now been in service for a period long enough to enable the engineer to report intelligently on its cost of operation, maintenance and repair. Hitherto, reports on electric-elevator costs have been in a great measure based on tests made at the time of, or very soon after, installation, and the real cost, such as could be shown only by records of years of operation, has in the main been a matter of conjecture. The repair or maintenance side of the ledger, in which cost records are tabulated, shows a marked increase as the machine becomes older, after making due allowance for the advance in the cost price or repairs, which is now so noticeable.

This article will be based on the records for ten years, ended Dec. 31, 1916, for 50 worm-gear, drum-type elevators having a 150- to 230-ft. lift and running in passenger service at a maximum speed, loaded, of 350 ft. per min. The elevators cited are all in one building, operated in a similar manner, doing exactly the same kind of work for equal numbers of hours per day, and cared for by the same set of mechanics, using the same oils, grease, cables, ropes, brushes, etc.

They are all of the overhead drum type, as shown in the figure, overbalanced as to counterweight and equipped with all the standard accessories that go with this make of elevator. They are operated on direct current at about 226 to 230 volts, with magnet control of the usual construction and steel guide rails for cars and counterweights. There are two sets of counterweights, one for the drum and one for the car. All cables are standard, ¾ in. diameter, running over idler sheaves and drums of approximately 46 in. diameter. The car-counterweight cables, two in number, pass directly over the vibrating or idler sheave *A*, while the car-hoisting cables wind on the drum *B* as the drum-counterweight cables unwind, and vice versa.

There are no equalizing or compensating cables or chains. The cars, or cages, of a rather heavy pattern, weigh approximately 4000 lb. each, and the double counterweights about 5000 lb. The drums are driven by double, or fore-and-aft, bronze worm gears meshing with steel worms on an extension of the armature shaft, with the magnet brake installed on this shaft between the armature and the worm. The armature revolves at 850 r.p.m. when on high speed, and the drums make about 30 revolutions during the same period. Of the cars listed, five have a travel, or rise, of 150 ft., forty have 200 ft. and five 220 to 230 feet.

In addition to the overhead type of passenger cars, there are five machines of the basement type, the driving mechanism being at the lower landing, with traveling idler sheaves over the drum. The lift is about 40 ft. For the various items shown in the table the operating costs are about the same. The extra cable wear is in a measure compensated for by the shorter length, the cables wearing out in two or three years as against six to ten years for the longer lifts. There are also 11 freight elevators of overhead type, 220 ft. travel, with a somewhat slower speed and smaller motors. These machines cost 10 per cent. less for all items shown in the table, except for cables, and 50 per cent. less for these. Their speed is 250 ft. per min., and they travel about 6 to 8 miles per day as against 12 to 15 miles each per day for the passenger cars.

The labor shown is for the wages of the maintenance and repair mechanics. Each man cares for 12 cars, oiling, cleaning, adjusting and ordinary repairs. Two extra men care for the heavy and extraordinary repairs such as installing armatures, greasing guides and putting on cables. The increase from year to year is occasioned by some additional help and wages advanced for the old employees.

The item miscellaneous includes leather for brakes, copper rivets, babbitt, bolts, screws, etc. The armature expense is mostly for rewinding and includes a few field-coil renewals. The repair item includes brushes, controller disks, contact lugs, carbons and such material as would naturally be purchased from the manufacturer of the machine, used mostly in keeping up the controller boards. Oil includes engine oil for bearings and guides and castor or castor-machine oil for the worm cases. Cables include the ¾-in. main cables and the ½-in. wire and ⅝-in. manila rope for the governors.

MAINTENANCE COSTS OVER 10 YEARS FOR 50 ELECTRIC ELEVATORS *

	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	Total	Average
Oil	93	93	93	68	68	110	110	78	92	52	857	86
Grease	8	16	16	25	26	34	28	29	31	9	222	22
Repairs	425	1,105	618	465	467	603	119	40	39	96	3,977	398
Armatures	1,060	1,160	461	1,148	935	540	918	580	660	362	7,824	782
Cables		467	188	323	140	174	213	316	360	1,012	3,193	319
Labor	5,000	5,000	5,525	5,525	5,525	6,375	6,375	6,450	6,450	7,650	59,875	5,988
Misc	110	59	307	238	344	170	269	84	270	92	1,943	194
Total	6,696	7,900	7,208	7,792	7,505	8,006	8,032	7,577	7,902	9,273	77,891	7,789
Per car	134	158	145	156	150	160	161	151	158	185	1,558	156

* For simplicity all amounts given to the nearest dollar.

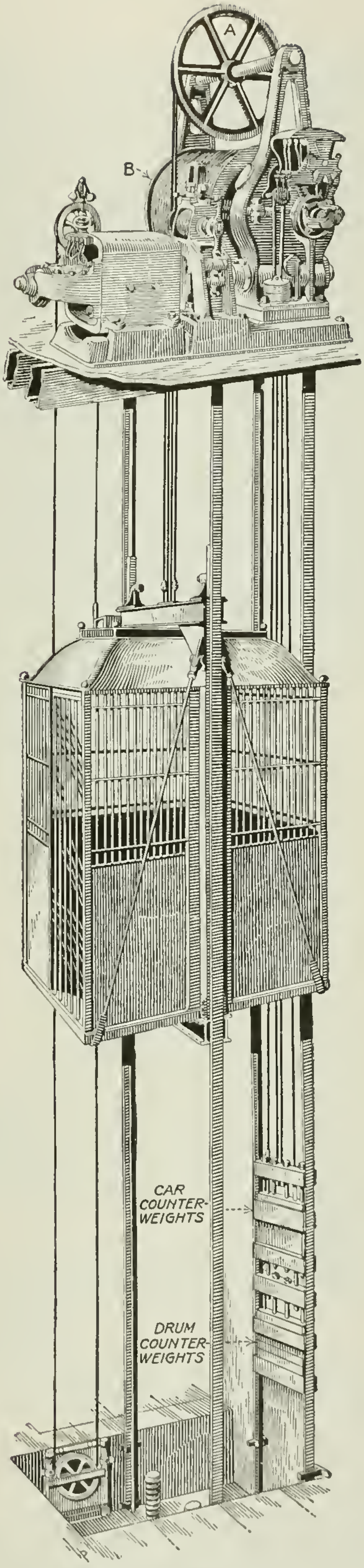
Each passenger car travels about 13 miles per day, and for the year of 310 days, totals 4030 miles. Dividing the average annual cost per car by this mileage gives a maintenance cost of $0.0387 per car mile, of which about 75 per cent. is for labor and 25 per cent. for materials and supplies.

In the same plant are 11 worm-gear one-to-one traction machines having 230 ft. rise in the hatchway, with compensating chains. The cars travel 375 ft. per min., or 14 to 16 miles per day. Maintenance costs at present are about the same as for the old drum types, except for cables, which wear out about twice as fast as they do on the drum machines. These elevators are now only three years old, and it is too early to pass upon their real cost of operation.

There are also five basement worm-gear one-to-one traction machines with compensating cables, having 140 ft. lift and a speed of 300 ft. per min. The ropes on these machines wear out very rapidly.

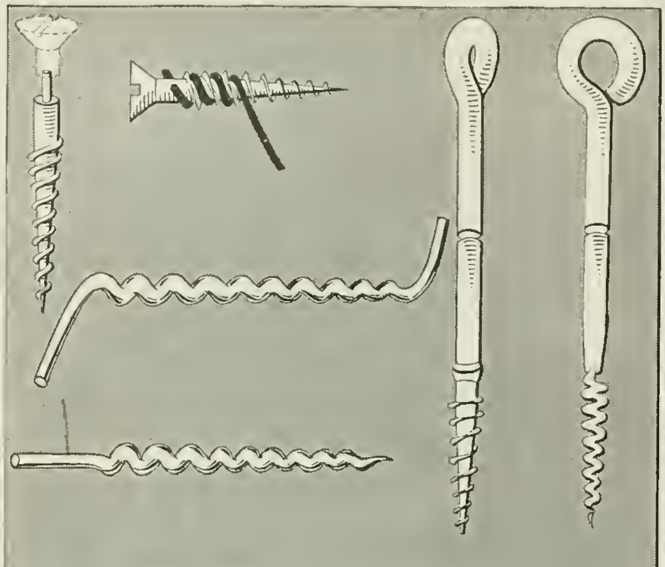
In addition to the foregoing there are eight one-to-one overhead traction machines having 280 ft. lift, 450 ft. speed and equipped with compensating cables and weights. The cars travel about 20 miles per day each, and the cables are wearing out three times as rapidly as those on the old drum machines. These cars having been in use only three years, it is wisdom to defer decision on their operating cost to a later date.

In the plant there are 77 passenger and 14 freight elevators traveling about 1500 miles and carrying from 150,000 to 325,000 passengers per day. The cost per car-mile for current is practically the same for all types. A future article will deal with some of the many operating troubles peculiar to these machines.

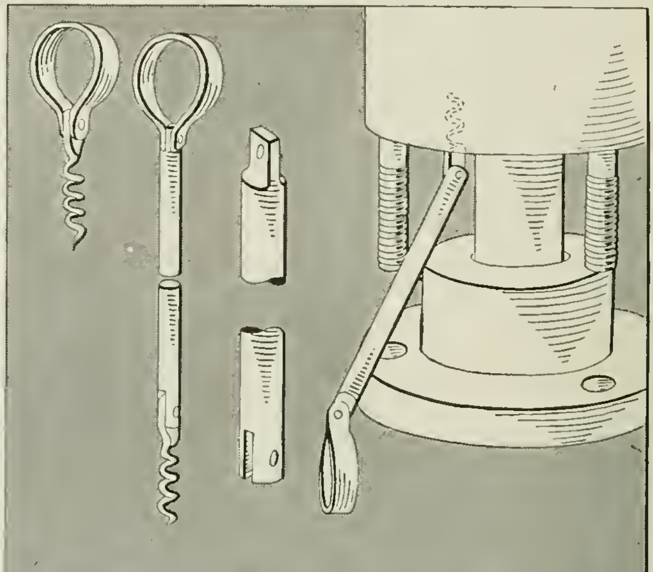


OVERHEAD TYPE ELEVATOR MACHINE

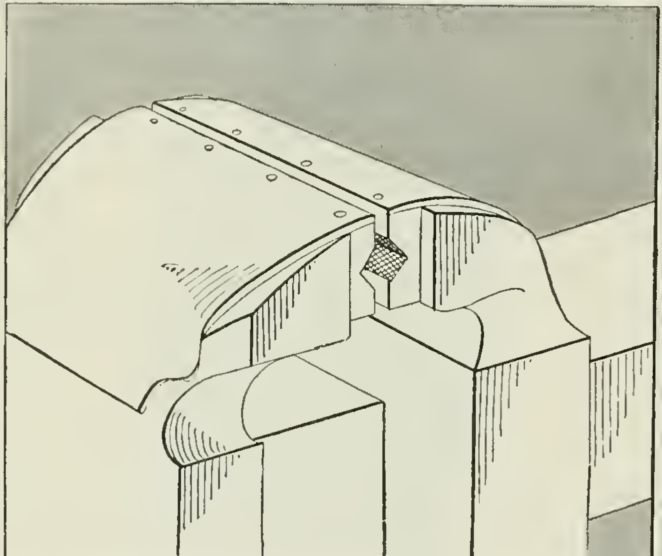
Handy Home-Made Apparatus



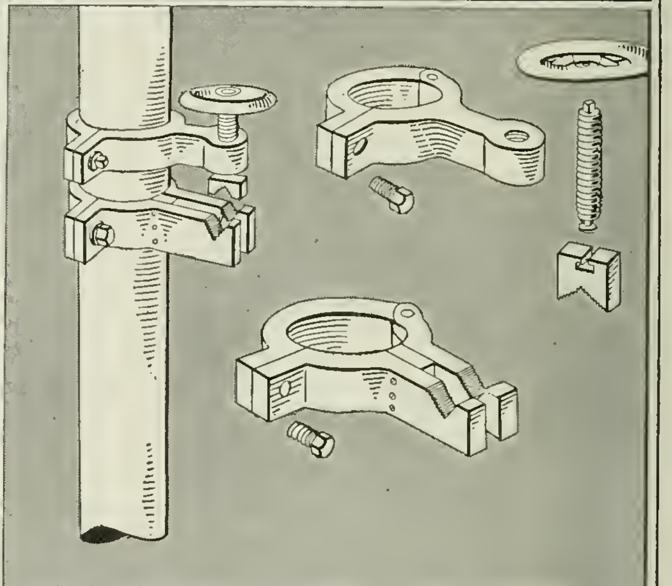
HOME-MADE PACKING PULLER



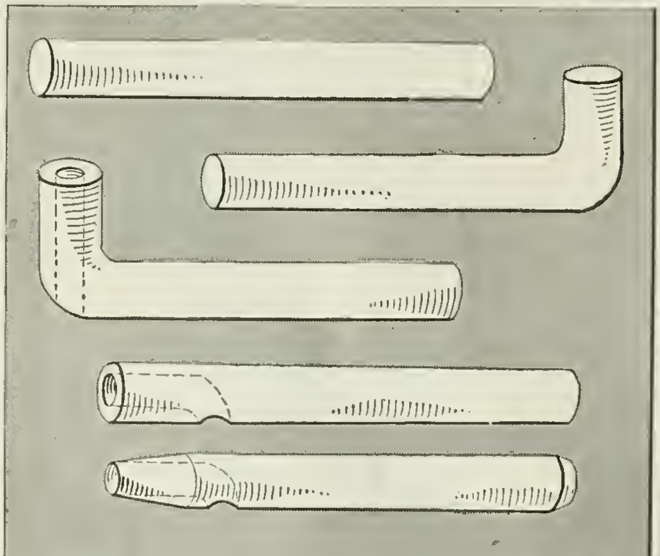
PACKING PULLER MADE FROM CORKSCREW



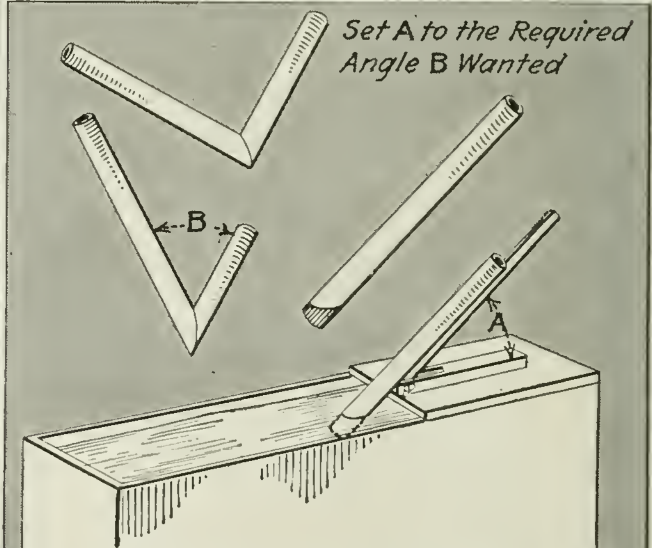
FOUR SETS OF JAWS WILL SUBSTITUTE A BULKY PIPE VISE



VISE CAN BE CLAMPED WHERE NEEDED



HOW TO MAKE A LEATHER PUNCH AND HOW TO DRILL THE CURVED HOLE



COPPER SOLUTION WILL STAIN THE TUBE AT THE DESIRED ANGLE

Editorials

The Fuel Administration Mandate

THE practical suspension of business by the Fuel Administration for five days and for a day each week for seven weeks to come, was one of the largest exercises of governmental authority to which industry has ever been asked to submit. If it effects its purpose, Fuel Administrator Garfield is entitled to a meed of credit proportional to the magnitude of the exigency and the boldness of the remedial act.

The execution of such a measure can be justified only by the existence of a condition of the utmost gravity; its wisdom can be demonstrated only by the extent to which it is effective in mitigating that condition.

In the first place its primary object was not the saving of fuel, but the slowing up of production. Industries, speeded to the utmost, were piling upon the already overburdened railways, goods for transportation to the seaboard. Ships could not be coaled fast enough to take the goods away. Terminals were congested, cars were held up and the roads and sidings were blocked, interfering with the transportation of the coal needed to relieve the situation. The effect was cumulative. Much as some of the goods were wanted, it was bootless to make them simply to be piled up in the cars which might be hauling coal and which were standing in the way of trains that might relieve the coal famine.

Could the railroads have been speeded up enough to overtake the accumulation and at the same time take care of the daily increase? Those who are in the best position to know say that they could not. Could the manufacture or shipping of nonessentials have been suspended? Several days were lost in proving this to be impracticable. And so, in the light of what they know, and what the man on the street does not know, those responsible for results said, "We must stop and let the roads catch up, or go on from worse to worse." To have announced their intention to do this would have aroused such remonstrance and have set into operation so much machinery of opposition as to render it impossible, and would have so speeded up production in the interim as to further swamp the roads and further deplete the diminished coal supply, to say nothing of its effect upon the market.

It had to come, as it did come, like a bolt out of the blue; and before some of our good people could weigh the petty sacrifice that they were asked to make against the supreme sacrifice that those are making to whose support this order ultimately means the most, there arose a storm of indignant protest, which has subsided at this writing to an attitude of quiescent submission, and which we hope as this is read will have changed to one of intelligent appreciation and approval.

The importance of the fuel supply, even to interests to which it seems but remotely related, has been demonstrated this winter as never before. The orderly conduct of the procurement and distribution of that supply is a matter of the utmost concern to the whole people. The organization of a system for such control out of a mass of competing units, with a crippled railway system, in a winter of unwonted severity, and against the covert opposition of those who do not wish to see the practicability of government control successfully demonstrated, is not the work of a week or of a season. Without the Fuel Administration there would have been a coal shortage fully as acute as the present—for the mines now are turning out all that the roads can haul —and prices would have soared unrestrained.

Let us have patience until the machine gets warmed up. Let us not go into hysterics if it skips a stroke now and then. Back up the Administration until it has a chance to put into effect some of the measures now in view and in development, and this year's condition will be pointed to as an example of those which intelligent organization in the interest of over-all efficiency can correct.

The Day of the Recording Instrument

NOT many years ago the recording instrument in the average plant was a rarity. Its use was considered superfluous, and if perchance an instrument of this type did find its way into a plant, its possibilities were not fully appreciated. Considered more in the light of an ornament, there was no great incentive to maintain it in accurate working order, and more often than not the records would be dumped into a drawer of the engineer's desk or perhaps filed away for safe keeping. Those were the days of cheap fuel when a few tons of coal, one way or the other, was not seriously considered. Conditions were not severe, and the indicating instrument did very well. Plants fully equipped did better than those with no precise measuring instruments, and if the meters were read often enough, the time indicated in each case and plots afterward made, a rough approximation of the register of a recording instrument was obtained.

Securing complete operating data in this way and the subsequent plotting were tasks too arduous for the average operator. More than occasional readings could not be expected. Comparison of the value of data obtained in this way and of time records from accurate instruments recording every variation of the quantity measured and transcribing it so that the range over the entire period may be read at a glance, is not difficult to make. With the proper number of instruments simultaneous records giving complete operating data for the station are at hand ready for analysis, and as the records are permanent, comparison with previous performance is easy.

There is no need, however, of championing the recording instrument. It is already with us. Its merit has been proved, and its adoption even in the smaller plants is becoming more general. The war, the urgent demand for coal, the rise in price and the necessity for efficient production have been contributing factors. In these days coal must be conserved for military purposes.

The small plant is working on a closer margin than ever before. It must be fortified in every way possible and must conduct its business intelligently, complete and accurate data being the first essential.

Those plants which have been getting along comfortably in the past with incomplete indications of operating conditions, cannot afford to continue in the old way. The recording instrument offers a decided advantage. There has been a big development in this field. More and better instruments than ever before are available. Coal must be saved. A wise selection of meters, showing the operator exactly what is being done in the plant and where improvement is possible, is the first step.

How Do You Mix Your Fuel?

ONE of the most urgent problems that now confront the engineer is the utilization of the lower grades of coal, such for example, as screenings and culm. It has been supposed that the culm piles were pretty well cleaned out, but the fuel shortage has developed that there are great quantities still available and at a price that makes it worth while to attempt burning it when mixed with soft coal.

There immediately arises, then, the problem of mixing the culm or screenings and the soft coal so that when used in stokers the mixture will be sent to the stoker hoppers in such way that there will not be a segregation of the lumps as the fuel goes to the stokers. Should this happen, it is almost impossible to prevent holes in the fire of so serious a nature as to make combustion not only uneconomical, but difficult to carry on. Obviously, the problem is a local one and the conditions in each particular plant will require different measures for its most successful solution.

Engineers are greatly interested to know how the other fellow is doing it, and *Power* extends an invitation to those who have met this problem to tell how they have met it and what troubles they have encountered in mixing the fine, powdery fuel with the run-of-mine coal. What proportions are found most suitable for particular types of stokers with particular settings and for the various loads? In hand-fired plants it is a simple matter to mix the culm with the soft coal, but where crushers are used and where the coal is conveyed to an overhead bunker and then gravitates to the stoker hoppers, it is not so easy to get the best mixture.

It is quite important that engineers learn how to burn culm and other very low-grade fuels, especially those which are byproducts of mining and which, unless used, may stand for years in huge piles exposed to the atmosphere, thereby suffering deterioration in heating value. The sooner such fuels are used after they come from the mines, the greater their value.

Let us know how you get your mixture and how you crush, convey and feed the fuel.

Alaska's Coal

WHEN Secretary Seward bought Alaska for the United States no man was, perhaps, on the day of the consummation of the sale, regarded as a greater fool than he. But time and research have revealed the wealth of resources that lie buried beneath the chilly surface of our most northern possession. And Seward's judgment is vindicated.

One of Alaska's greatest assets is coal. At this time that sounds inspiring; it is like the answer to a shipwrecked sailor's signal. The Geological Survey estimates that Alaska treasures more coal than did Pennsylvania before that commonwealth's coffers were tapped.

Is not the Seattle Chamber of Commerce then to be congratulated for at this critical time calling attention to the possibilities Alaskan coal offers for supplying the West and Northwest? Think what it would mean to the eastern half of the United States if now the present mines had to supply only the East. Every ton of coal that can be spared is sent to the Pacific Coast via the Panama Canal, and enormous quantities are sent from the East over the rails to the remote West. It is reported that 25,000 cars of coal started for the Lakes, to be shipped by water into the Northwest, arrived after navigation closed and that these bearers of the treasure still lie sidetracked somewhere. Maybe the report is true; but it seems incredible that it should not have been carried on to its ultimate destination by rail or dumped into the Middle West, where coal shortage has driven mayors and at least one governor to extreme measures to get relief.

The oils of the Pacific Coast by no means offer great and continuous supply of that fuel. The country west of the Rockies is growing, and with the growth the demand for coal increases proportionately. The railroad congestion and coal crisis have taught the value of using that fuel nearest the place of consumption. The Government could do no greater service to the nation than to be most reasonable in promoting the development of coal mining in Alaska. Doing so would doubtless lend impetus to industrial growth not only in Alaska, but all down the Pacific Coast and as far inland as that coal can be economically transported.

Why New York Has No Coal

AS THIS issue goes to press there is talk of pooling the anthracite coal for New York City and southern New England. Much of this coal comes in over the rails to Perth Amboy, N. J., from which it goes by barge to the sections of the country where it is consumed.

What pooling the anthracite arriving at this port will do to relieve the critical conditions, provided labor and other vital factors are properly cared for, may be judged by reading the account of conditions at this port as given on pages 178 and 179. There is no need of going into particulars here, as they are given in the article; suffice it to say that conditions there are deplorable.

J. D. A. Morrow, Secretary of the National Coal Association, has been appointed by Dr. Garfield to assume general charge of distribution. This is a most commendable move. Certainly, no part of the whole coal problem is in need of greater and competent attention than that of distribution. Mr. Morrow's experience fits him for his new job. Certainly, it is the hope of all Atlantic Coast sections of the country that Mr. Morrow will not only get the authority he will need to accomplish results, but will use it fearlessly when he gets it. Hampton Roads, New England and the New Jersey ports have plenty for him to do.

The Reason There Is No Coal

That the coal-unloading piers are the key to the critical coal situation in New York City is clearly evident from the following, which is from a recent report of the Coal Conservation Committee of New York State.

THE following are the docks with the railroad serving each: Undercliff, Erie R.R.; Weehawken, N. Y., O. & W. R.R.; Hoboken, D., L. & W. R.R.; Port Liberty, C. R.R. of N. J.; Port Johnson, C. R.R. of N. J.; Port Reading, P. & R. Ry.; Elizabethport, C. R.R. of N. J.; Perth Amboy, L. V. R.R.; S. Amboy, Penn. R.R.; St. George, B. & O. R.R.

Capacities are based on what it is estimated the docks can do under normal weather conditions. The total tonnages of the docks on this basis are 2615 cars per day. Averaging a car at 40 tons, this would amount to from 100,000 to 110,000 tons per day.

The following figures were given as representing a fair average cars per day for the dumpings under normal winter conditions: Undercliff 150 to 160, Weehawken 115 to 120, Hoboken 225 to 250, Port Liberty 60 to 70, Port Johnson 60 to 75, Elizabethport 75 to 100, Port Reading 225 to 275, Perth Amboy 150 to 200, South Amboy 300 to 325, St. George 75 to 100. A total of 1675 cars on the outside figures, or in tonnage a matter of 65,000 to 70,000 tons.

Thawing Facilities—Undercliff: Covered steam house with capacity for 48 cars at one setting; also have spear system with accommodation for 8 cars at one setting, or total of 56 cars. The house is old, having been used for a number of years; the average time required to thaw coal in this house being approximately six hours. Spear system requires about the same length of time by reason of the fact that an insufficient number of spears are applied to each car.

Weehawken: Spear system in use; accommodation for 40 cars at one setting; average length of time for steaming, 4 hours.

Hoboken: Spear system; accommodation for 40 cars at one setting; average time, 4 hours.

Port Liberty: No facilities for steaming.

Port Johnson: No facilities up to this date. One locomotive is being put into operation to furnish steam.

Elizabethport: No steam plant, coal being thawed by use of locomotive. One locomotive can take care of two cars at one setting. The number of locomotives furnished for this purpose is two, thawing out four cars at one setting; one pipe being applied to each car, and average time for steaming forty-five minutes to a car.

Port Reading: House steam equipment for 44 cars at one setting. Time required, two hours on bituminous steam coal, and on anthracite fine sizes several hours.

Perth Amboy: Spear system equipment for 24 cars at one setting, average time of steaming, 3 hours.

South Amboy: House steam, capacity for 40 cars at one setting; average time, 2 to 4 hours.

St. George: No steaming facilities. At St. George a steam plant accommodating 40 cars will be ready for use in a few days.

Perth Amboy: The Lehigh Valley expect to have a new plant ready some time in February which will increase their capacity to 96 cars. This plant was ordered long ago and was originally promised for delivery on Aug. 1, last.

With reference to labor, the following docks are short: Undercliff, Weehawken, Hoboken and Port Reading.

Aside from the question of shortage of labor, most of the piers are handicapped by "green labor."

South Amboy now operating 24 hours, is not operating to capacity by reason of insufficient coal supply. This port could load more tonnage.

Undercliff, which is working on a 10-hour basis, could materially increase its tonnage if put on a 24-hour basis.

In addition to this if steaming facilities could be promptly devised, such as furnishing locomotives, Port Liberty, Port Johnson and Elizabethport could load more tonnage by working 24 hours.

At the pier at Undercliff, Weehawken, on the morning of the 27th, there were available for individual shippers 142 cars of which only 45 cars could be released that day on account of no individual shipper apparently having sufficient coal of proper sizes to make a cargo beyond 45 cars.

It seems that at this time there is ample equipment to take care of the movement of coal from piers to harbor points.

The Conservation Committee recommends to Mr. Wiggin, Fuel Administrator for New York State:

1. That a practical railroad official directly connected with or in charge of each dock, meet at 2:30 Friday at this office and be empowered to coöperate with this committee, to go more fully into this matter, and make any practical recommendations that they think will be necessary to meet this critical situation.

2. It is recommended that all docks immediately arrange to work twenty-four hours daily.

3. That all docks increase their steaming facilities for the thawing of this frozen coal to the maximum immediately.

4. That this committee recommend the pooling of all coal so that no additional time may be lost in switching.

5. That this committee recommend that any culm, silt or any anthracite steam sizes containing material that will pass through a one-sixteenth inch mesh, otherwise dirt, be temporarily eliminated until such time as all the larger sizes of coal be dumped, as it is found upon investigation that the time consumed in unloading a car of this coal materially interfered with unloading other sizes.

6. It is recommended after our investigation that every effort be made to increase labor and the locomotive service at these docks, which is found to be inadequate.

7. That the docks work Sundays and holidays till the present stringency is past.

These recommendations have been in the hands of the national, state and city fuel administrators long enough for action. The conditions are more severe than this report reveals, as will be told on the editorial pages of next week's issue.

Correspondence

Coal Shortage and the Southern Power-Plant Operator

With the demand for coal exceeding the production by thousands of tons, there must of course be less consumed to prevent crippling industries dependent on coal for power. Everything possible should be done to lessen the serious fuel famine in the East, where hundreds of highly necessary industrial enterprises are located, and partially solve the fuel problem. After giving the matter careful thought and after visiting hundreds of power plants in the South, I have come to the conclusion that one solution of the difficulty would be to use wood for fuel. The South has an abundance of various kinds of wood that could be used.

About 50 per cent. of the South's population is rural or in towns up to ten thousand population. In these towns there are power plants which develop from a hundred to a thousand horsepower and consume thousands of tons of coal. Ninety per cent. of the boilers in these plants are of the horizontal type and can easily be converted from coal to wood burners, and at the present prices of coal the change would be economical in many cases, even though the various heat losses should increase. It may seem that the labor cost in stoking would increase, but a close study of local conditions shows that there will be a reduction instead.

January and February are months of little activity with team owners and common labor, so that wood could be cut and hauled in these months at a very low price. Four-foot wood seems to be preferable as it dries quickly and can be handled easily. When trees of from six to twelve inches in diameter are cut, the wood should be quartered and stacked on end. If cut into smaller pieces, the fire burns too fast and the furnace doors have to be opened too often, in firing, to allow a steady combustion; but the larger size can be handled easily, and the fire can be kept burning constantly with a minimum of door manipulation. If the removal of the bridge-wall becomes necessary, it will neither affect the draft nor increase the fuel consumption to any extent. It has been my experience that it is possible to fire both on the grate bars and partly in the combustion chamber with good results. With coal, of course, this would be absurd, but wood will burn well in such a position and not simply char as might be expected. If green wood is being used, one must keep the furnace full so as to produce a drying condition. At each firing the dry wood should be raked from the combustion chamber to the fore part of the grates; in this way the fire will be constantly replenished with dry and partly ignited wood. In stoking one must be careful not to injure the blowoff pipe. To avoid this an iron bar might be placed in front of it to check a blow that might occur.

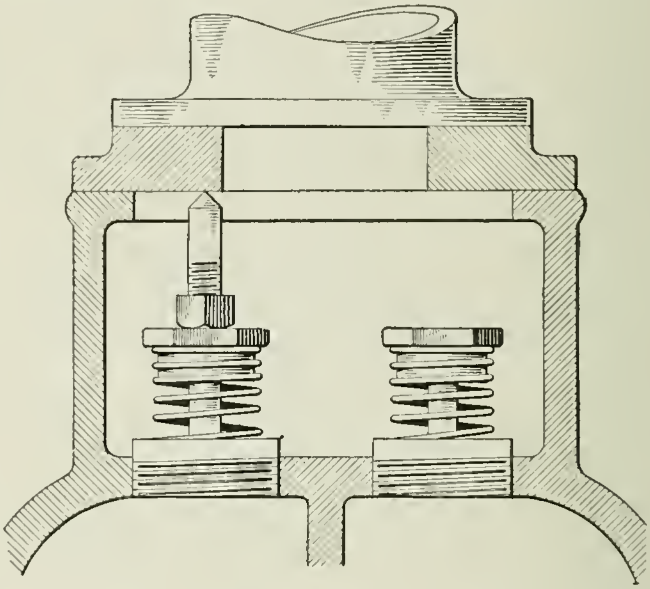
With a careful study, expenses can be minimized and the consumption of wood can be reduced by timing the stoking and feeding the water into the boiler as the intensity of the heat varies. By heavy firing the labor is reduced and one man can stoke just as many boilers as when burning coal. Experience will enable the fireman to work his fire, draft and water in such a way as to keep steam constantly at the desired pressure.

Newport News, Va. G. N. McIlhenny.

An Emergency Pump Repair

When a 12 x 7 x 12-in. duplex pump in our plant failed to supply its full amount of water and began to "cut up capers," it was shut down and the handhole plates were removed from the valve chamber on the water end. One valve seat, valve and spring were found out of place, for the threads had stripped on the valve seat, allowing it to be forced out of place. The pump was urgently needed, so it was repaired temporarily by cutting a piece of $\frac{5}{8}$-in. round iron the right length to reach from the top of the valve stem to the top of the inside of the valve chamber. One end was threaded and a $\frac{5}{8}$-in. nut screwed on the thickness of the nut; the upper end was pointed as shown in the illustration. The valve seat was wrapped and "doped" with red lead. The bolt was put in place and then backed part way out of the nut, forcing the seat down tight into its place and holding it there. The pump was out of service only a few minutes. E. M. Keys.

Montesano, Wash.



IMPROVISED JACK TO HOLD VALVE SEAT IN PLACE

How To Distinguish Iron from Steel Pipe

Those who specify wrought-iron pipe should be able to determine whether the pipe delivered to them is actually iron or not, and in the case of old pipe it is also interesting to know whether it is iron or steel. Four different test methods may be used for distinguishing iron from steel, and these are, in the order of the ease with which they may be made, as follows:

1. Crushing Test: Cut a ring an inch or two wide from a length of pipe and hammer it flat, so as to obtain a fracture. The structure of iron is fibrous, while steel is crystalline. Steel is difficult to fracture, and the fracture is bright crystalline; iron is more easily fractured, and the fracture is distinctly fibrous and of a dull gray tone.

2. Rough Etching Test: Submerge one end of a test piece in a solution of equal parts sulphuric acid and water. After five or ten minutes the end of pipe, if iron, will begin to show a number of fine concentric rings just as though it had been made from a number of sheets of paper pasted together. This appearance is caused by the acid eating away the iron more quickly than the noncorrodible layers of slag popularly referred to as "cinder-rings." Steel has no slag incorporation, therefore will show smooth, without layers. The acid or any other accelerated test is no indication of the rust resistance of metals in service, for the acid dissolves the metal, while corrosion in service is a gradual combination of iron and oxygen, forming rust.

3. Microscopic Examination: The surface of the metal when highly polished will exhibit the structure—the crystalline structure of steel, and in wrought iron, the even grains and slag inclusions in the form of irregular but extremely fine strands or fibers of slag separating the grains of iron.

4. Chemical Analysis: The chief differences are the relatively high silicon and low manganese content of iron, and the analyses will show about as follows:

	Iron Pipe, Per Cent.	Steel Pipe, Per Cent.
Silicon ...	0.15	0.05
Manganese. ..	0.05	0.30
Sulphur ...	0.02	0.05
Phosphorus	0.15	0.10
Carbon	0.04	0.13

The high silicon in iron is due to the slag content, which is actually as high as 6 per cent. (by volume) in iron; but this is not shown in ordinary chemical analysis, as the slag is not chemically combined with the iron. The higher manganese in bessemer steel is the result of overoxidation of the metal and the addition of manganese to the molten mass to make it suitable for rolling and welding.
N. BOWLAND.

Pittsburgh, Penn.

Using a Pitot Tube

The article in the issue of Oct. 23, page 557, by W. V. White, on the pitot tube, impresses me as misleading, as it contains many statements that are incorrect. I have used a standard pitometer for measuring and checking the individual discharge from some twenty-five pumps, rated at 13 to 52 cu.ft. per sec., and probably a brief description of our method will be of value to readers of *Power*.

Our pitometer is shown diagrammatically in Fig. 1. There are two tubes, one within the other, and connected by rubber tubes at the top at *D* and *E*. At the bottom a small opening in each tube allows the outside pressure to be transmitted independently to each tube. These openings stand at 90 deg. to each other, as shown at A_1 and A_2, and when the flow in the pipe is in the direction indicated by the arrow, the pressure in the outer tube is the static pressure or head, and that in the inner tube the static head plus the velocity head, as this aperture receives the pressure due to the impact of the flowing water. These pressures, when transmitted through the hose to the U-tube or differential gage, produce a difference in level of the balancing fluid, proportional to the velocity head. This balancing fluid must, of course, be heavier than water, else there would be a continuous flow from the high- to the low-pressure side. For high velocities we use mercury, and for low velocity carbon tetrachloride, which is about 1.6 times as heavy as water and will not mix with it. By coloring the tetrachloride with a little cochineal, a sharp line of demarcation is produced. This deflection of the balancing fluid shown as H_v does not represent the velocity head. It is partly balanced by a column of water of equal height in the opposite leg of the U-tube. Assuming the specific gravity of the fluid to be S, as compared with water, then the difference in pressure between the two sides would be equal to $(H_v \times S) - (H_v \times 1)$ or $H_v\ (S - 1)$. Theoretically, the velocity would be $V = \sqrt{2gH_v\ (S - 1)}$. But here the formula must be modified. It is found that the actual deflection H_v is more than the actual velocity warrants, owing to the various shapes of the orifices, their positions, etc. Hence

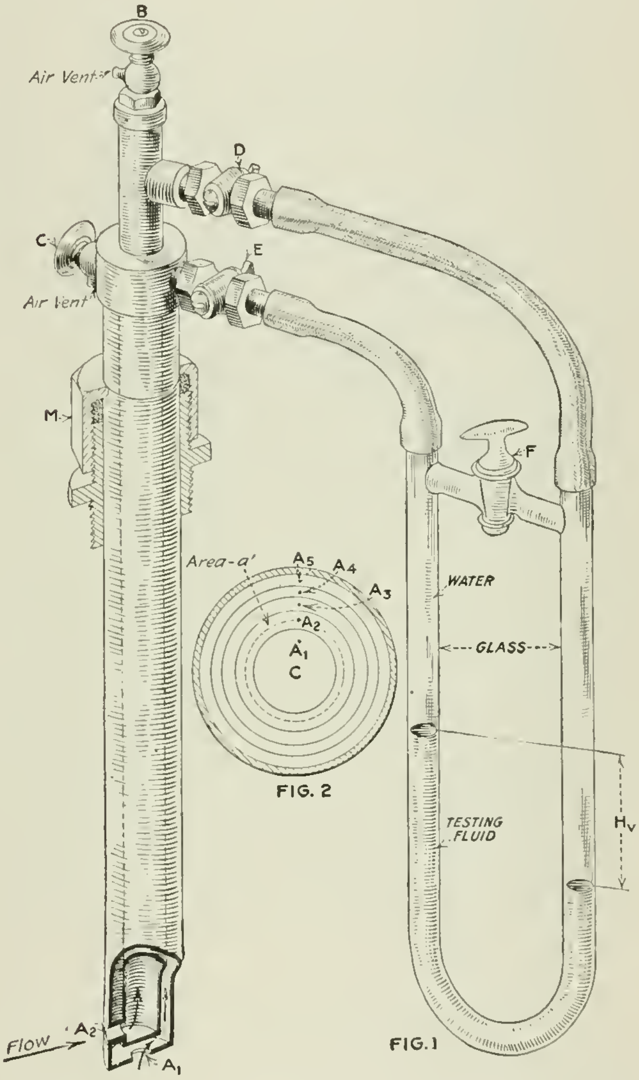


FIG. 2

FIG. 1

PITOMETER FOR DETERMINING FLOW IN PIPES

the value $\sqrt{2gH(S-1)}$ is modified by a constant C called the coefficient of the pitometer. Then the actual velocity would be $V = C\sqrt{2gH_v(S-1)}$. This coefficient is obtained for each instrument by towing the tube through a body of still water at a known velocity and noting the deflection H.

It is worse than useless to assume that any point in a pipe represents conditions of average flow. The point varies with every pipe and may not be in the same place twice in the same pipe, if the delivery is increased or diminished, as shown in hundreds of tests. The only reliable way is dividing the cross-section of the pipe into a number of equal concentric areas, as shown in Fig. 2, and placing the tube orifices at a predetermined point in each ring, both above and below the pipe center. These points must lie on concentric rings which divide the respective rings into two equal areas. The average of these individual velocities gives the average velocity of flow. Note that to obtain the average velocity by using the average deflection would be wrong, as the velocity is proportional to the square root of the deflection. The coefficient of our pitometer is 0.72. We have a 1-in. corporation cock tapped into the top of each discharge pipe. The pipes vary from 15 to 36 in. The end of the pitot tube is pulled up into the recessed nut M, which is screwed on the top of the corporation cock which is then opened and the tube pushed down into the pipe. A stuffing-box at the top of the nut M prevents leakage. By means of a pointer attached to the top of the tube, and a scale, the orifices can be placed at any desired point in the pipe, in a vertical line from the cock. As obtaining the readings of the cross-section of, say, a 30-in. pipe is a matter of half an hour, care must be taken to read the center of the pipe from time to time, to make sure that the flow remains uniform.

The foregoing may create the impression that the use of a pitot tube is a complex matter, while as a matter of fact it is simple after the necessary tables are figured out, and these do not involve more than simple algebra. The chief objection to a home-made tube is its unknown coefficient, which must be determined with some degree of accuracy to make the instrument of any value for test purposes. When checked against a weir, our tube showed a difference of 2 or 3 per cent. W. F. **Brye.**

Patterson, Calif.

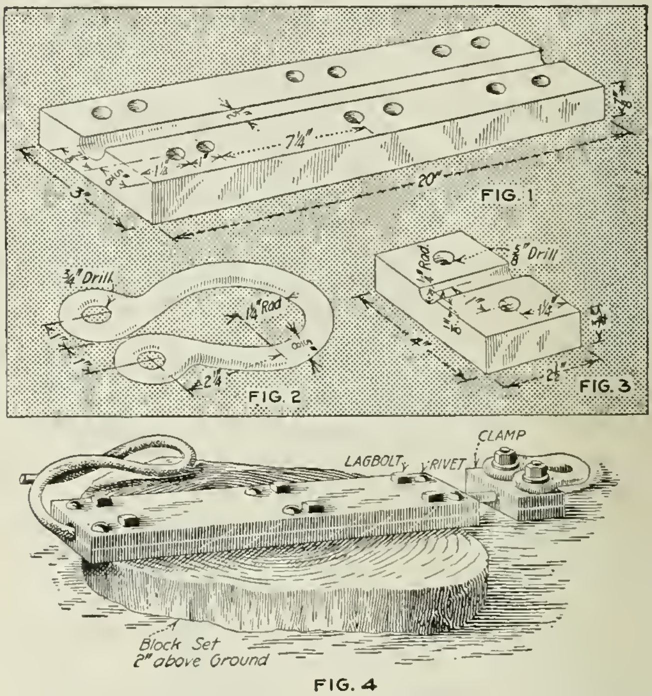
Home-Made Wire Straightener

The article, "Home-Made Wire Straighteners," in the Nov. 27, 1917, issue of *Power*, brings to mind how the straightening of about 6000 ft. of No. 0000 bare-copper wire was accomplished at one of our mines. When we received this wire, it was in bundles containing lengths of from 300 to 500 ft. The rolls were of small circumference, and in several places the wire had sharp bends in it.

At first we tried to straighten the wire by laying it on a wooden block and hammering it with wooden mallets. But this was too slow a process and I set about devising a quicker way of doing the job, the result of which was the straightener shown in the figures. This device is made of two pieces of metal of the dimensions shown in Fig. 1, riveted together and mounted on a wooden block set in the ground as in Fig. 4. The straightening was then done as follows:

One end of a cable was made straight for about two feet and pushed through the straightener; then the clamp detailed in Figs. 2 and 3 was placed on the end of the wire extending through the straightener, as in Fig. 4, and a horse used to pull the bent wire through the straightener. The straightening was then done as fast as the horse could walk. The slots in the two halves of the straightener were made on a planer, as we did not have any drill long enough to drill the hole after the two parts had been assembled. Wire of any size can be straightened by making the hole in the device to fit the wire. The corners at the end of the hole should be well rounded to prevent damaging the wire. I have never tried to use this straightener on insulated or lead-covered insulated wire, but I see no reason why it cannot be done. Thomas J. **Pascoe.**

Norway, Mich.



FIGS. 1 TO 4. PARTS AND ASSEMBLY OF WIRE STRAIGHTENER

Change of Water for Air Pump

Replying to L. F. Forseille's question, "Would change in water for air pump be good or bad," in the Nov. 20, 1917, issue of *Power*, page 703:

The change as indicated by the sketch would not be advisable and if tried would probably result in a loss of 0.5 to 1.5 in. vacuum under full-load conditions. This loss in vacuum would be caused by the warm-water injection for the air pump having a higher temperature than that corresponding to the temperature of the vacuum in the condenser. Some of the water would be evaporated, filling the space that should be filled with air from the condenser; also, the warm water coming in contact with the cooler air from the condenser would cause the air to rise in temperature and increase in volume. This would reduce the efficiency and capacity of the air pump. The air pump and condenser were operating with injection water of the same temperature, when no bad effect was noted with a 75-

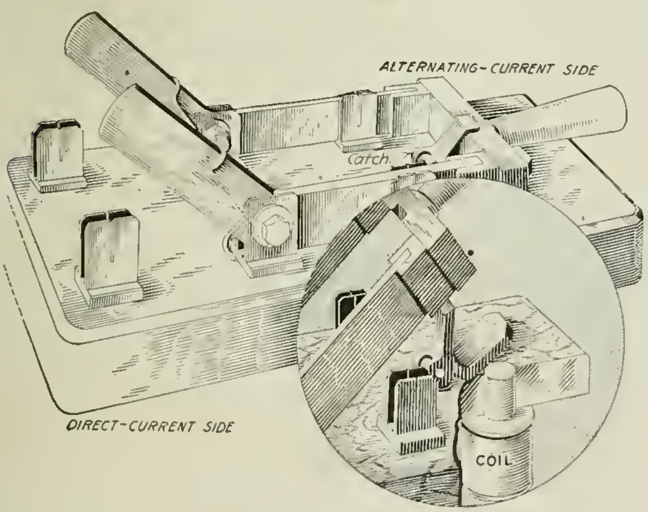
deg. F. rise in the temperature of the injection water. The trouble due to ice obstructing the flow of water through the strainer could be overcome by constructing an air-pump discharge pit. The air-pump injection-water supply would be from the discharge pit. Some arrangement must be made to supply cold makeup water, so as to keep the air-pump injection water within 2 deg. F. of the condenser injection-water temperature. Should this arrangement fail to reduce the work on the pump turbine or fail to get an ample water supply to the condenser, I would suggest that a larger set of nozzle blocks be put in the turbine to increase its capacity and do the required amount of work.

Montgomery, Ala. J. E. CRAVEN.

An Emergency Lighting Switch

Some power plants, in case of a shutdown at night, use lanterns lighted and placed in convenient positions where they can be readily secured in case of an emergency. However, there are many plants that go without any protection against being left in darkness, and others use small gas lights. The method I saw used some time ago in a substation looked to be as about as satisfactory as any for emergency lighting.

The lighting switch for the building was double-throw and of a type shown in the figure. The right-hand contacts were connected to 110-volt alternating current, and the left-hand terminals connected to 112-volt direct current coming from an auxiliary battery used for remote control of the oil switches. The lighting circuit connected to the two middle contacts. Between the studs on the alternating-current side on the back of the switchboard, a magnet coil was arranged as shown in the sectional view and connected across these studs.



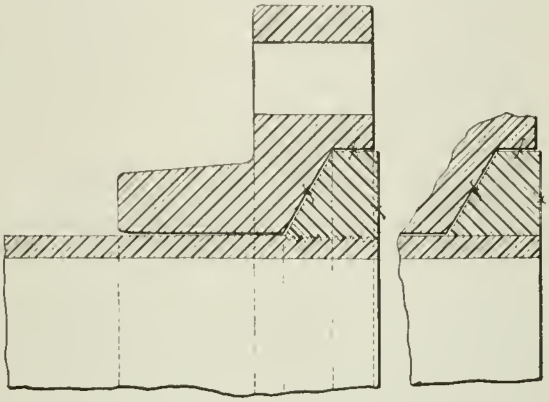
DOUBLE-POLE, DOUBLE-THROW LIGHTING SWITCH

This coil held the switch closed to the alternating-current supply under normal conditions. Springs were placed on the middle studs to throw the switch to the opposite position when released by the magnet coil. In this way, if the alternating-current source failed, the switch was thrown to the battery circuit, thus lighting the station from this source. After the plant was running all right again, the attendant would throw the lighting switch back on the alternating-current side.

New York City. D. R. HIBBS.

Combination Pipe Joint

The need of a pipe joint suitable for any pressure, which can be attached to the pipe, on the job, without expensive equipment, has long been recognized. The combination joint, two types of which are shown in the illustration, was designed by me for use on all lines requiring flanged joints. It consists in attaching a metal collar or band to the pipe by means of ordinary pipe thread, shrinking, welding or a combination of these methods; the collar or band to form the joint or gasket face, followed and held in place by a flange loose on the pipe, similar to the Van Stone type.



MEANS OF ATTACHING FLANGES TO PIPE

This joint can be attached to pipe of any material and gives a wide scope in method of construction, combining a screwed and welded, a screwed and Van Stone, or a shrunk, welded and Van Stone joint, which does not depend entirely on the weld. The joint is somewhat flexible, and the holes can be aligned by turning the loose flange; and in case of cutting a length of pipe the flanges can be used again, which is impossible with a welded flange.

The screwed and peened joint can be made in any pipe shop with ordinary tools and gives the flexibility of the Van Stone type joint. In fact, it has all the good points of the Van Stone joint and does away with the distorting, thinning or the welding on of a reinforcing facing piece to bring the pipe up to original thickness. The collars, or bands, can be machined to form male-and-female or tongue-and-groove joints. In general this joint can be used on all lines in the plant, on pipe of any material and attached to suit conditions.

Midland Beach, S. I., N. Y. HOWARD C. THAYER.

Artistic License

Four *barefoot* men in a row, three shoveling coal into furnaces! What do you think of it? *It cannot be done.* Mr. Weil must have peculiar ideas of a boiler room of a warship, in which men go around in their bare feet. How about cleaning fires? When they pull "the backs out" and "shove the fronts back," do they put on their shoes then? Strange that a picture like this ever got past the censor for an engineering publication like *Power*. J. H. HOCKING.

New York City.

[Regarding the illustration portion of the foreword of Jan. 15.—Editor.]

The Lubrication of Steam Turbines

From papers on steam-turbine lubrication submitted by the following members of the Lubrication Engineers' Association of the Texas Company: W. M. Davis, John H. Young, Jr., H. D. Gohlman, J. M. Prewitt, H. J. Wilson, J. B. Barton, W. O. Kroenke, W. A. Edmondson, H. W. Salbador, J. T. Snow, D. L. Keys, F. J. Davis, J. A. Hansgen, W. G. Craig, G. M. Shanks, S. J. Hunt, W. H. Grose and Walter L. Foster. The article is from "Lubrication," published by the Texas Co.

THE weight of the turbine is small, compared with that of a piston engine of the same horsepower. For this reason and owing to the freedom from reciprocating motion, the foundations required for turbines are of small size and light weight, there being little vibration to be absorbed under proper conditions of aligning and balancing.

Turbine-oil consumption is more than the oil consumption for any other prime mover, the loss of oil being due chiefly to leakage and a small amount of evaporation. Since there is no internal lubrication, the steam is not contaminated with the oil and therefore the condensed steam is immediately available for boiler-feeding purposes without purification; and this re-use of condensed steam effects a large saving in the cost of feed water and in the expense of the maintenance and cleaning of boilers. Again, superheat, as used in the turbine, imposes no restrictions in the choice of lubricants. Finally, the turbine can usually be started and loaded more quickly than the piston engine.

HEAT FROM TURBINE AFFECTS BEARINGS

The rotating parts of the turbine proper are connected to and revolve with the shaft, so that the bearings that support the mainshaft are the only parts that require lubrication. These bearings are on either side of the turbine and are subjected to radiated heat from the steam passing through the turbine. Turbine lubrication is accomplished either by ring oilers or by some form of circulating system. Ring-oiling bearings are used on small types of turbines, the rings dipping into a reservoir of oil and carrying the oil to the bearings to be lubricated. This method has been found satisfactory where the bearings are adjusted so that the rings do not vibrate and are free from sharp edges that may interfere with their free play and, what is of still greater importance, where the reservoir into which the rings dip is of sufficient capacity to permit the oil to rest. Lubrication difficulties are sometimes experienced on certain types of turbines equipped with ring-oiling bearings because of the radiated heat. This affects particularly the governor bearing, which sometimes reaches a temperature of 240 deg. F. Fig. 1 shows an oil-ring bearing.

Larger types of turbines are usually lubricated with a self-contained circulating system which cools and strains the oil before forcing it back to the bearings under pressure. The oil is used over and over again, the relative size of the oil system determining how frequently the same oil is fed to the bearings. With this oiling system the highest temperature is experienced on the governor bearing, the next highest on the inside turbine bearing, the inside and the outboard generator bearing both being lower in temperature. The oil is in constant agitation, frequently with water that leaks past the packing glands, and unless the oil is a high-grade one, it will emulsify. Sufficient oil must be added from time to time to the system to maintain the oil level, making up for what is lost. A section of a typical, modern steam turbine, showing the self-contained oil-circulating system, is shown in Fig. 2. Oil from the various bearings flows by gravity into reservoir *B*, and a small rotary pump *A*, usually driven from the governor shaft, takes this oil and forces it through the cooler *C* and thence through pipes *D* to the various bearings. A spring relief valve *L* bypasses any excess oil back to the storage reservoir. In some systems, instead of using a relief valve *L*, the oil is discharged into an overhead reservoir and allowed to flow by gravity to the bearings. The turbine shown in Fig. 2 has four main bearings, *E*, *F*, *G* and *H*. These are hollow and cooled by circulating water. The oil is fed into the top of the bearing at the center and flows out at each end. It then drops down to chambers in the turbine casing and is collected by the return pipe *J* and returned to the reservoir *B*. A screen *K* is provided in the reservoir to remove large particles of solid matter. There are several places where the water finds its way into the oil, the main one being the packing gland *M* at the high-pressure end of the casing. Turbine manufacturers employ various methods for preventing steam leakage at this point, such as carbon packing held against the shaft by springs, labyrinth packing and water seals, but in spite of these precautions some steam always leaks out and travels along the shaft and, coming in contact with the water-cooled bearing at *E*, condenses and mixes with the oil. When turbines are operated on back pressure, there is also an outward leakage of steam at the gland end on the other end of the turbine. Occasionally, the cooler *C* or the hollow water-cooled bearings will develop small leaks, permitting water to get into the oil. A drain pump *P* is provided in the bottom of the reservoir *B* for drawing off the water that collects at this point, and should be drained off regularly. As the oil passes rapidly through this small tank, there is not sufficient time for complete separation of the water, especially when it is considered that the water and oil are thoroughly churned in passing through the rapidly moving bearings. Furthermore, steam-turbine bearings are usually run very hot and the cooking process through which the oil passes in coming in contact with the leaking steam and hot water makes an intimate mixture of oil and water. Taking these points into consideration, it is evident that it is necessary to provide something more than the coarse screen *K* to thoroughly purify the oil.

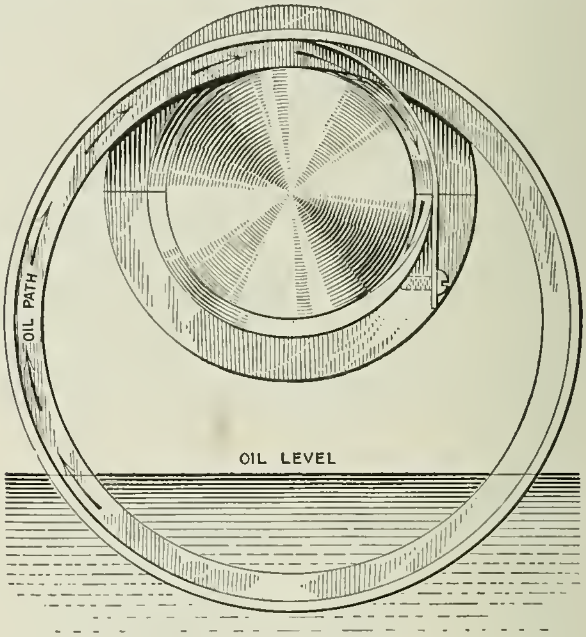


FIG. 1. OILING RING

Where a separate filtering system is used, considerably more oil is in circulation, it has more chance to rest and the water and impurities in it are removed, thus prolonging the life of the oil. One of the important advantages of a filtering system when used with the oil-circulating system is that it makes it possible to keep the cooler tubes clean. Unless a filtering system is used, the dirt that forms in the oil, due to water and foreign matter and, with some oils, to oxidation on account of high temperatures, the solids in the oil will collect in the coolest part of the turbine oil-circulating system, which is the cooler. As this dirt collects, the walls of the tubes or pipes of the cooler get a thicker coating on them and their conductivity decreases so that the full benefit of the cooling water is not realized. As this process goes on, the cooling effect in time is lost and oil will be circulated at a very high temperature. Moreover, dirt in the oil will eventually find its way to the bearings and in time, if the water that collects is not taken out, a mixture of water and oil will be fed instead of oil. Steam-turbine oiling and filtering systems may be classified as follows:

1. Continuous circulating systems in which oil used on the bearings is continuously passed through the system which filters all or part of the oil. In Fig. 3 is shown a gravity cooling and filtering system especially designed and adapted for the lubrication of steam turbines. Oil from the bearings is drained into the oil reservoir in the turbine, from which it is delivered to the filter by a pump geared to the turbine. The first filtering process precipitates the water, the oil overflowing into the filtering compartment. The speed of oil circulation is such that it would be impracticable to filter all the oil, but the heaviest and dirtiest portions are, by virtue of their greater weight, compelled to pass through the filter. The clean part escapes the filtering operation, but all the oil is compelled to pass through the cooling compartment before it reaches the vertical oil-storage tank, from which the lubricant is fed directly to the bearings. This vertical tank is placed immediately adjacent to the cooling compartment of the filter.

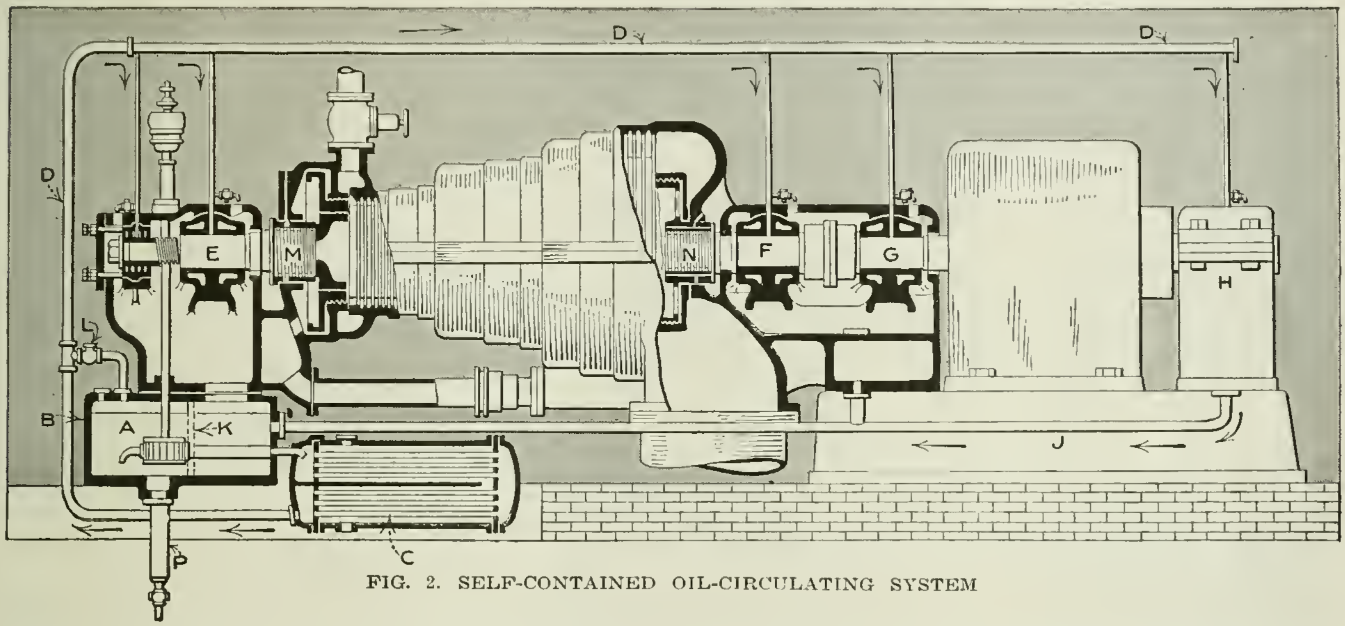


FIG. 2. SELF-CONTAINED OIL-CIRCULATING SYSTEM

2. Batch filtration, in which all the oil contained in a turbine-oiling system is removed and purified, the turbine being supplied with a fresh batch of clean oil to permit it to operate while the dirty oil is being cleaned. With this system the oil in one turbine after another can be filtered and the oil from the clean-oil compartment of the filter may be pumped into the turbine from which the dirty oil has been removed. This is the system ordinarily used where filtering systems have been introduced. In partial filtration, which was described in an article in an earlier issue of *Lubrication*,[1] part of the dirtiest oil is continuously removed from the circulating system, passed through a filter and returned to the system by a steam pump automatically controlled by the head of oil in the clean-oil compartment. In forced-feed systems which have been used in the lubrication of the Curtis vertical turbines, where the weight of the revolving parts has to be supported by hydraulic pressure, a tank large enough to contain all the oil and fitted with straining devices and cooling coils, where connected with a separate filter, is situated at a suitable level for receiving oil by gravity from all points lubricated. The oil is drawn from this tank by a pump which delivers it at a pressure about 25 per cent. in excess of that required to sustain the weight of the turbine in the step bearing. A spiral duct is situated between the source of pressure and the step bearing, and this regulates the oil supply and renders the flow more uniform. This source of pressure is also connected through a reducing valve to the upper oiling system of the machine, where a pressure of about 60 lb. is maintained. This system, which includes a storage tank partly filled with compressed air, operates the hydraulic governor mechanism and supplies oil to the upper bearings. The regulation of oil to these bearings is effected by means of adjustable baffles. Pipes from the upper bearings and from the hydraulic cylinder and release valves all discharge into a common chamber, in which the streams are visible, so that the oil distribution may always be under observation.

Previous to the adoption of turbines, it was generally believed that only fatty oils would emulsify with water, and that a mineral oil would separate from water. But it was soon discovered that the speed of the turbines was so great and the churning action so violent, that a petroleum oil that was not properly manufactured would form a permanent emulsion with any water with which it came in contact.

As an illustration of a severe case of emulsification with a paraffin oil, the case of a lead mining and milling plant in Missouri, a few years ago, may be cited. This occurred in the lubricating system of two vertical Curtis turbines fitted with a larger filter of several barrels' capacity.

The chief engineer complained that he had found it necessary to add several barrels of new oil to the system every month, and since no leaks could be found, he was at a loss as to the cause of the rapid consumption. Upon careful examination it was found that the water in the filter and settling tank was milk white, and the engineer explained that he had to draw off the water several times a day to avoid an overflow. By way of explanation he opened the drain pipe and allowed some of the water to run off. A large glass jar was filled with some of this waste water, and after it had settled there was a layer of oil found on top of the water and the water still remained a milk-white color, indicating the presence of oil still held in suspension.

With paraffin oils the peculiar conditions encountered in the bearings and the system generally may cause a partial separation of the oil and paraffin, and the subsequent contact of the oil with the cooling coils of the system results in a deposit of the paraffin, thus interfering with the proper functioning of the coils.

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[1] Turbine Oil Filtering Systems, by Edwin M. May, "Lubrication," Vol. 3, No. 11, September, 1916.

In a previous issue of *Lubrication*[2] the conditions which have to be met by a turbine oil were stated as follows:

The demands made upon an oil in a turbine are exceedingly severe. The oil must circulate at high speed through innumerable valves, pipes and bearings, subjected first to high and then to low temperatures, and to many variations in pressure. It is thoroughly mixed with air, so much so that foam is quite frequently found on top of the oil in the settling or sump tank. Air bubbles can always be seen as the oil flows from the bearings. Frequently it must operate with a percentage of water which leaks through the stuffing-boxes or with water that leaks in from an imperfect or damaged cooler coil; or, in the case of marine installations, salt water can sometimes get into the system from overboard. At times the oil in the bearing in close proximity to the stuffing-box is actually cooked by the live steam. The steam carries with it boiler impurities or chemicals used for boiler-water treatment, and very often these chemicals in connection with the water and air cause the oil to form very bad emulsions. Any oil that has a tendency to form an emulsion is rather dangerous for use where the churning, heating and boiling with water and boiler compounds are carried on to such an extent as in a turbine lubricating system.

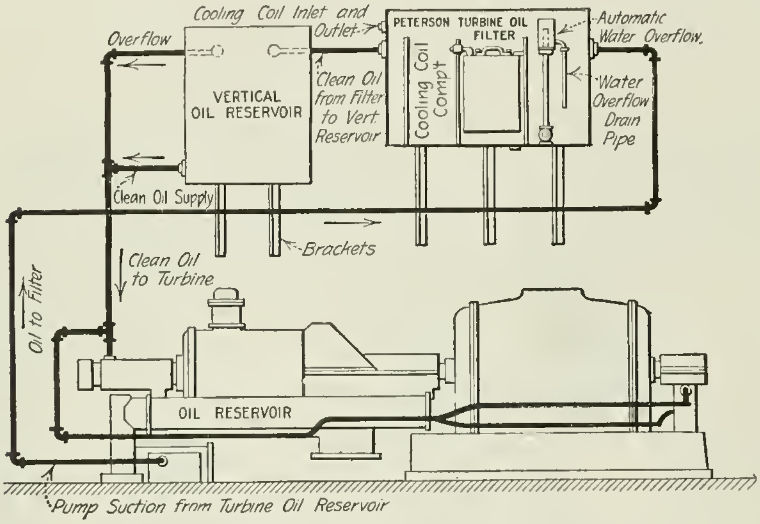

FIG. 3. TURBINE OIL CONTINUOUS COOLING AND FILTERING SYSTEM

Much damage has been done to turbines because of the tendency of certain oils to emulsify. Some oils will throw down a hard emulsion which, under conditions which prevail in the turbine, will cake in such a way as to actually stop up the pipes and oilways to the bearings. Other oils carry the water in suspension and are of such a nature that the water will drain off only with great difficulty. The best turbine oils, of course, are those that under all conditions will allow whatever water gets into them to drain off and will produce a minimum amount of emulsion, this emulsion being of such a nature that it will not form a hard deposit. The perfect oil is one of high lubricating body which will separate freely from any amount or any kind of water after it has been thoroughly agitated and even boiled and which will leave absolutely no permanent emulsion.

Next in importance is the question of viscosity. At one time the American oil manufacturers used the very lightest distillates for turbine work, the theory being that these lighter oils separated easily from water and formed less objectionable emulsions. The factor of safety, however, was exceedingly small with these light oils. The many mechanical difficulties experienced while these low-viscosity oils were in use resulted in the demand for heavier oils, until in some turbines doing very severe work, very heavy oils are now being used with complete success. The majority of turbines, however, can best be lubricated by a medium-bodied oil.

The following extract from the Terry Steam Turbine Co.'s "Instruction Book on Bearings and Lubrication" indicates the attitude of the turbine manufacturers on the subject of viscosity:

The viscosity of the oil used in any case must be suitable for the service. We are listing below oils recommended by several refiners for turbine work, in three ranges of viscosity roughly classified as light, medium and heavy. The approximate viscosity of each oil is given with its trade name. All viscosities are in seconds at 100 deg. F. by Saybolt Universal viscosimeter. These oils are tabulated for the convenience of the turbine user as being standard brands. If any oil named is found unsatisfactory for the purposes stated, please advise us for our information as soon as convenient.

a. Light oil, viscosity 130 to 200 sec., is best for turbines without reduction gears, either ring or forced feed oiling.

b. Medium oil, viscosity 200 to 350 sec., is used for turbines with reduction gears and either ring or forced oiling. It is better than a light oil for turbines subject to vibration either from within or from an external source. It will also allow slightly greater bearing clearances. Bearings may run a few degrees warmer with heavy oil than with the lighter grades.

c. Heavy oil, viscosity 350 to 500 sec., is useful in cases of bad vibration or of gears heavily loaded or causing noise. Many times gears can be successfully operated with heavy oil which would be noisy or show rapid wear with lighter oil. Heavy oil works well in turbine bearings except in places where exposure to cold sometimes makes the oil too sluggish. This applies especially to forced oiling units. When using heavy oil, more attention must be given to the oil when starting, to be sure that all rings run freely and that bearings are not flooded by the forced oiling systems.

The purpose of an oil is to form a film between the surfaces to be lubricated to minimize friction and to act as a cushion or dashpot to prevent vibration or pounding between the journal and the bearing or between adjacent gear teeth.

The lightest oil that will do this with certainty will give the lowest running temperature and usually the lowest cost per gallon. The best oil for a particular unit depends on operating conditions to a large extent, but in general the safe and economical oil to use is a grade slightly heavier than the lightest oil on which it will operate smoothly and quietly. [For an interesting article setting forth the formation, maintenance and function of the oil film in a journal bearing we suggest to the reader the following from *Power*: "The Lubrication of Bearings and Cylinders," Dec. 7, 1915. The Editors.]

INSTRUCTIONS TO ERECTING ENGINEERS

In the August, 1916, issue of *Lubrication* the turbine-oil recommendations of the Westinghouse Machine Co. and Allis-Chalmers Manufacturing Co. were given. The following is quoted from the instructions of the Westinghouse Machine Co. to their erecting engineers:

So far as mere lubrication of the turbines is concerned, almost any oil at all has lubricating properties sufficient for the bearings to run cool, so that the fact of the bearings running cool and nice is no criterion of the suitability of the oil.

A large quantity of oil is in circulation in the turbines at a temperature of from 100 to 120 deg., or thereabouts, which temperature is conducive to any chemical reaction should the necessary elements be present. It is therefore important that the oil be an absolutely pure mineral oil, free from acid. Sometimes mineral oils are adulterated with animal fats, which will in the course of time decompose, forming acids, corroding the shaft, and even eating up the bearing metals.

The following is quoted from the recommendations of the Allis-Chalmers Manufacturing Co.:

We have found it generally true in steam-turbine lubrication that, while one oil may be suitable in the majority of cases, there are from time to time, turbines that seem to require either a heavier or a lighter oil and this makes it inadvisable to issue a fixed specification governing this one class of work.

A suitable oil for the lubrication of steam turbines must have certain general characteristics which, in the order of their importance, are as follows:

The oil must be so made and of such a nature that it will separate freely from water, and that water of any nature or any temperature being agitated with the oil in any amount will not form an emulsion; even if the conditions require the oil and water to work together so that a

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[2] "Lubrication of Steam Turbines with Recommendations of Turbine Manufacturers," by W. F. Parish, in "Lubrication," Vol. 3, No. 10, August, 1916.

mechanical mixture of the oil and water is secured, the combination must not be permanent, but upon resting and being subjected to a heating temperature of not over 175 deg. F., the water must separate. Preference should always be given to the oil separating the most quickly after being agitated with water that will be used for boiler purposes at the plant where the turbine is located. Tests should be made by shaking 50 per cent. of oil and 50 per cent. of water in a bottle or by mechanically stirring this mixture in a suitable container for, say ten minutes, and noting the separation of water after ten minutes and after twenty-four hours.

Any oil that in the above tests, or in practice will throw down a deposit, should under no conditions be used for turbine lubrication, as this deposit may, under severe conditions, interfere with the flow of the oil to the bearings.

Oil in order to meet the above conditions, must be free from acids, free from all fixed oils such as vegetable and animal oil, and should be properly refined.

The leading manufacturers of lubricating oil have introduced the practice of determining a property known as "viscosity." To determine the body, or viscosity, of an oil a standardized viscosimeter is used, by means of which the time occupied in the flow of a measured quantity of oil through a small orifice at a given temperature is measured. The Saybolt Universal viscosimeter is commonly used for this purpose by the large producers and refiners of lubricating oil in this country, the sample of oil being maintained at a temperature of 100 deg. F. and the time occupied in the flow of the measured sample of oil through a small orifice being measured in seconds. This time reading represents the relative viscosity of the oil which, in the majority of cases for steam-turbine lubrication, should be about 200 sec. at 100 deg. F. Saybolt Universal.

Should it be desired to operate the turbine with a very slight reduction in temperature of the bearings, oil as light as 150 sec. viscosity for the majority of turbines can be used. On the other hand, should the mechanical conditions require oil of heavier body, an oil as heavy as 750 sec. at 100 deg. F. Saybolt machine, can be used. All these oils, however, irrespective of the body or viscosity, should conform absolutely to the separation from moisture or water tests. All other tests, such as gravity, flash, fire and color, have no bearing whatever for this class of lubrication, but it might be well to be more explicit in regard to these particular tests. . . . .

TEMPERATURE PROPORTIONAL TO VISCOSITY OF OIL

The temperature of a bearing in a turbine working on a forced-feed system is in proportion to the viscosity or body of the oil; that is, if a very heavy-bodied oil is used, the partially resulting bearing temperature can be reduced to certain limits by the use of a lighter-bodied oil. There is a limit to the lightness of the oil, which, in the majority of cases, should not be less than 150 sec. viscosity on the Saybolt Universal machine. The temperature of a turbine bearing, however, is not a point of the greatest value in turbine lubrication. The oil heavy in viscosity has the very valuable feature of staying on the surface of the bearing after the turbine has come to rest, so that in starting, the surfaces are well lubricated. Further, heavy-bodied oils will take up bigger clearances and operate with rougher bearings and shafts without danger, whereas, under these abnormal conditions, light-bodied oils would invariably lead to trouble, as the oil would not have sufficient thickness of film to keep the high points of the surfaces apart.

The actual mechanical frictional difference, or the effect upon the mechanical efficiency of the turbine, between the use of a heavy and a light oil on a turbine having two or three bearings is infinitesimal.

Water is the main deteriorating element to the life of a turbine oil, therefore special attention should be given to keep water out of the circulating systems and out of all filters. The system should be a dry one, and daily inspection should be made to see that water is not getting in. The oil that will meet the water test can be used indefinitely in a turbine by being added to from time to time.

The following list of oils which have been used in our steam turbines and found satisfactory, is to be submitted by you, without recommendation, to any of our customers who request information regarding the kind of oil to be used in our steam turbines; the selection of the particular brand to be left to them . . . .

L. E. STROTHMAN, Manager,
Steam Turbine Department.

Follow directions. Today the direction is to save two slices of bread, an ounce of meat, an ounce of sugar, a snitch of butter. Tomorrow as conditions change there will be new directions. FOLLOW DIRECTIONS.

Engineers for the New Merchant Marine

Plans now being matured by the Recruiting Service of the United States Shipping Board reveal a system of preparation in connection with manning the new merchant marine that for thoroughness will not suffer by comparison with any known example of German efficiency.

After securing chief engineers for service on the new-type, fast cargo ships now being constructed under its direction, the board will give the men an exceptional opportunity to learn all there is to know about the engines they are to operate by sending them to the Westinghouse works, where the engines, of the geared-turbine type, are being built. Each chief will follow his own engine through the process of construction and then to the shipbuilding yard, where he will supervise its erection on board the ship, and will take charge of it as chief engineer when the vessel goes into commission.

The Board probably will first call for 125 chief engineers for this work. While on this special duty a chief will receive both pay and an adequate allowance for board. On board ship he will receive the standard pay for his grade in the merchant marine, which is high, and a bonus for war-zone voyages.

The demand thus created for the services of chief engineers is expected greatly to stimulate activity among first assistant engineers who wish to become chiefs. To assist any men of this grade, or of lower grades, to secure promotion, the Shipping Board invites them to its free schools in Marine Engineering, where they may brush up on technical matters, from a week to a month, as they may choose. There are eight of these schools, located respectively at Massachusetts Institute of Technology, Cambridge, Stevens Institute, Hoboken, The Bourse, Philadelphia, Johns Hopkins University, Baltimore, Case School of Applied Science, Cleveland, Armour Institute, Chicago, University of Washington, Seattle, and Tulane University, New Orleans.

Shadowed!

—By Darling, in the N. Y. *Tribune*

JUST ABOUT ONE MORE FALSE MOVE AND—

Convention of the N. M. E. B. A.

The National Marine Engineers' Beneficial Association held its forty-third annual convention at Baltimore, Md., during the week beginning Jan. 21, with headquarters at the Belvedere Hotel. It was necessary for the convention committee to remove the meeting from Washington, D. C., this year, owing to the lack of hotel accommodations.

There were upward of eighty delegates in attendance, representing 134 votes. The several sessions of the convention were held in the banquet hall of the hotel. Because of the large amount of business to be transacted, it was necessary to hold night sessions. At the opening meeting the delegates were addressed by James H. Preston, Mayor of Baltimore, who cordially welcomed the visitors. A charter offered by the American Federation of Labor was voted upon and accepted. At the afternoon session on Tuesday the delegates were addressed by Andrew Furuseth, International President of the Seamen's Union, who told of the labor conditions existing in the Navy and War Departments. The reading of the treasurer's report finds the organization on a sound financial basis.

On Wednesday evening, the delegates and their friends were entertained by local association No. 5 at its rooms on Baltimore St., and a pleasant evening was spent. The entertaining feature was the smoker on Thursday evening tendered to the convention by the Supplymen. There was a first-class vaudeville show, and pipes and tobacco were distributed to the auditors. On this evening the ladies were escorted to Ford's Theater.

The election of national officers resulted as follows: William S. Brown, Buffalo, N. Y., president; Thomas L. Delahunty, New York City, first vice president; John S. Fisher, Galveston, Tex., second vice president; William H. Hyman, Baltimore, Md., third vice president; George A. Grubb, Chicago, Ill., scretary; Albert L. Jones, Detroit, Mich., treasurer; William J. DuBois, Charles S. Follett, Fred H. Krueger, John S. Fisher and Charles N. Sheplar, form the executive committee. William Kelly was chosen for the board of trustees, and C. N. Vosburg was the installing officer.

The Supplymen elected its officers as follows: George F. Monroe, Garlock Packing Co., president; J. J. Cizek, the Leslie Co., vice president; Charles A. Wilhoft, New York Belting and Packing Co., secretary-treasurer. It was decided to leave the selection of the next convention city to the discretion of the executive committee.

January Meeting of the A. I. & S. E. E. and A. I. E. E. at Pittsburgh

The regular monthly meeting of the Pittsburgh Section, Association of Iron and Steel Electrical Engineers, was held at the Hotel Chatham, Pittsburgh, on Saturday evening, Jan. 18, jointly with a meeting of the local section of the American Institute of Electrical Engineers. Dinner was served before the meeting.

With Chairman C. A. Menk of the association and F. E. Wynne of the institute presiding, the meeting was opened with a paper by R. A. McCarty, engineer, Westinghouse Electric and Manufacturing Co., on "Methods of Power-Factor Correction." An abstract of this paper will appear in an early issue of *Power*.

Under the title, "A General Description of the Electrical Installation at the McDonald, Ohio, Works," B. A. Cornwell and B. W. Gilson, of the Carnegie Steel Co., presented an account of the transmission line, substation and distribution system at this new plant. Power is generated at the company's Ohio works, five miles distant, in a plant containing 18,000 kw. in gas-engine-driven 25-cycle alternators, at 6600 volts. It then passes through three 8000-kv.-a. oil-insulated self-cooled transformers and is stepped from 6600 to 44,000 volts. These transformers can carry the load on two units connected in open-delta in case one is taken out of service. The transmission line carries two three-phase circuits of No. 0000 wire on steel towers to a substation at the McDonald works, where the voltage is reduced from 44,000 to 6600, for roll and roll-train motors and motor-generator sets, and to 220 volts for other motors. The total line loss at full load is about 4 per cent.

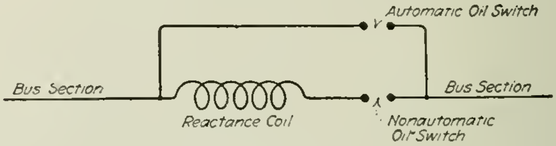
When completed, this plant will contain the following mills:

No.	Name	H P. Main Motor	Speed Variation Above or Below Synchronism Per Cent.
1	18-in. band	2,500	20
1	8-in. bar	1,000	10
1	10-in. bar	1,500	20
1	14-in. bar	2,500	20
1	12-in. hoop	2,500	20
2	10-in. hoop	3,000	20
2	8-in. hoop	2,000	10
9		15,000	

At present only the 18-in. band mill is running, and the others are scheduled for completion at the rate of one every two months.

Opening the discussion, G. C. Hecker, of the Duquesne Light Co., asked why two circuit-breakers in series are used at each end of the transmission line and what the relay arrangement is. Mr. Gilson replied that two are used for safety reasons; that each has its own equipment of current transformers, overload relays and control panel, the relay setting for one being slightly higher than the other. There is no interlocking between the circuit-breakers; one is used for normal operation, and the other is held in reserve. No reactance coils are used.

E. Friedlander, electrical superintendent of the Carnegie Works at Bessemer, suggested the advisibility of connecting a reactance across one circuit-breaker which should be the first to open, thus dividing the current to be interrupted due to a short-circuit between both breakers, instead of requiring the first one opening to rupture the entire current. On the other hand, gas-engine-driven alternators will not deliver the heavy short-circuit current, that a turbo-generator would, on account of their less inertia. He considered it better practice to install reactances between the large motors and the high-tension bus in order to prevent trouble on one motor tripping the main circuit-breakers.



Mr. Hecker said that the Duquesne Light Co. used a reactance in series with a nonautomatic oil switch between sections of its station busses; the sections were also tied by an automatic overload breaker as in the figure, so that trouble on one section would automatically cut in a reactance between that section and adjoining ones; if the trouble did not speedily clear itself, the operator would open the nonautomatic breakers and isolate the section.

Many favorable comments on the arrangement of the McDonald plant were made by those who had visited it, and it was hoped that the association might visit it in a body.

Coal Shortage in New England Still Serious

The critical shortage of coal in New England has precipitated some drastic action by Fuel Administrator Storrow. What Boston hails as a master stroke by the Fuel Administrator is the purchase with his own credit of considerable coal. After the purchase he secured priority for its shipment from Mr. McAdoo, so that this coal may now come direct to Boston and there be distributed by the Fuel Administration.

Five minutes spent in that part of the State House used by the Fuel Administration would convince even the most doubting that the Garfield order created more than havoc in and around Boston. Despite the fact that there is a considerable number in the personnel of the administration, the lobbies and halls and waiting rooms were crowded with protesting and exemption-seeking fuel users.

Mr. Storrow is convinced that there is no possibility of giving New England coal enough by means of rail transportion, as the requirements are 130,000 tons per week and half of this amount is not arriving and cannot be made to arrive over the already overloaded rails. As a matter of fact this amount is not now arriving either by rail or by water or both.

The charge is now made that during all last year there never was a shortage of boats to carry coal to New England when coal was available at the loading piers at Hampton Roads. It is further said that while the Government did take over some ships of the fleet used to carry coal to New England, those boats left were often lying idle for want of coal at the loading points. It is further reported that some of the transportation companies claim that there were times during the scarcity of coal when their tugs were hunting for barges to tow. It is quite generally conceded that inasmuch as two-thirds of the supply for New England must come by the water routes, the fleet should be increased so that a considerable more than two-thirds of the coal may come in by water and thus relieve the already seriously congested railroads. The charge is made further that great quantities of coal were sent to the West and Northwest after the lakes had frozen over and there was no means of conveying the coal by the water routes into the Northwest region. This has tied up thousands of cars loaded with coal, which have remained, as many yet remain, east of the Northwest region. Mr. Storrow has managed to head some of these cars New Englandward, but most of the coal still lies on the tracks where it was stalled weeks, perhaps months, ago, according to the latest report.

The all-rail shipment of coal ties up, it would be difficult to tell, how many cars. Because of all-rail shipment, the cars are compelled to travel many times farther than the distance between the mines and tidewater, as they do under normal conditions.

Rhode Island is in a rather serious condition, owing to the fact that the rail deliveries of coal are very low and because ice has repeatedly closed Narragansett Bay. The Navy has been busy breaking the ice and towing delayed barges to their docks.

Getting a perspective of the whole situation by viewing it here and viewing it there, one is convinced that it will be a long, long time before the rail and the water transportation systems, together with the fuel requirements and coal reserves, will again become normal.

American Society of Heating and Ventilating Engineers

The 24th annual meeting of this society, held Jan. 22, 23 and 24, at the Engineering Societies Building, 29 West 39th St., New York, proved to be one of the best in the history of the society. President J. Irvine Lyle congratulated the members on the interest that was manifested by the large attendance, even though many members living at a distance who had expected to be present, were unable on account of difficulties of traveling due to unusually severe winter weather, while a large number of the society's most active members, represented by the 38 stars of the society's service flag, had gone into the naval and military service of the country, and on the very eve of the meeting unusual demands had been made on the services of members engaged in every branch of the heating business by the extraordinary limitations placed on fuel consumption.

The Membership Committee's report showed that with all allowances, the net increase of the society's membership was 74; that would bring the membership up to about 800. A communication from the National District Heating Association stated that it had decided not to hold its meeting in June and therefore it would not be able to consolidate technical sessions with those of the A. S. H. and V. E. summer meeting of the present year. The committee working in conjunction with a committee of the Navy Department on the ventilation of battleships and submarines reported that progress had been made that will almost revolutionize the designs of some classes of ships. Committees working in conjunction with the Council of National Defense on improvement of the sanitary condition of factories engaged in the manufacture of munitions, and also the other committees that had been appointed to coöperate with various departments of national defense, reported progress. The report of the auditing committees showed that the society is in good financial condition and the recommendation was unanimously adopted that during the period of the war all members in the service of the army or navy shall have dues remitted without curtailment of privileges.

The Committee on Research Bureau recommended that a director of research work in the science of heating and ventilation should be appointed to take charge of technical investigations in behalf of the society in conjunction with a department of Government or institution of learning provided the director is selected in a manner acceptable to the society after provision is made for his salary by popular subscription providing for not less than $2500 nor more than $3600 per annum. After full discussion the subject was referred to the council with power to carry out the recommendations if found practicable.

Officers elected for the ensuing year were: President, Fred. R. Still, secretary and chief engineer of American Blower Co., Detroit, Mich.; first vice president, Walter S. Timmis, consulting engineer, New York City; second vice president, Dr. E. Vernon Hill, Department of Health, Chicago, Ill. Treasurer Homer Addams and Secretary Casin W. Obert were reëlected.

The Drying Session, Tuesday evening, Jan. 22, was occupied by an address by H. C. Gore, chemist of Department of Agriculture; a paper on "High Temperature Drying," by B. S. Harrison, and a paper by W. H. Carrier on "The Temperature of Evaporation."

Wednesday afternoon's session, devoted to fuel conservation, was enlightened by an address by Prof. L. P. Breckenridge, representing the United States Fuel Administrator. Professor Breckenridge's address was replete with interesting information on the subject of coal distribution, production and consumption, graphically illustrated by lantern slides. George W. Martin presented a paper on "Fuel Conservation," in which he stated that "the recent drastic order of Fuel Commissioner Garfield has brought to the attention of everyone the fact that serious shortage exists in the supply of coal available for domestic and power purposes."

A paper on "Economy in Fuel" was presented by Perry West, and one on "Fuel Conservation" by William M. Mackay. Wednesday afternoon's session was rounded out by a free discussion on the subject of different methods of economizing fuel and was made especially interesting by interchange of personal experiences of those present with a view of sounding the practicability of regulation of domestic fuel supply per room or per capita. The results of these comparisons showed wide variations and that it would be extremely difficult to devise a system of fuel apportionment for American residences without working serious hardship upon those whose homes could only be adapted to an average supply of fuel at great sacrifice to the owners, while to many a stringent average would be a surfeit.

"What We Do and Don't Know About Heating" was the subject of a paper by Prof. John R. Allen read at the Wednesday evening's session which will be printed in a future issue of *Power*. The report of the Committee on Code for Testing Low Pressure Boilers was received and discussed and the code was adopted as recommended in the report of the committee that was printed in the October issue of the society's Journal. The committee was continued to revise and interpret the code as may be required.

The fifth session, held Thursday morning, was given over to Furnace Heating and included the delivery of an address by D. R. Richardson, and papers: "The Engineering of Warm-Air Furnace Heating," by M. W. Ehrlich; "Answering Fuel Needs With a New Gas Heating System," by G. S. Barrows; and "Dust—Its Universality, Elimination and Conservation," by E. R. Knowles.

The professional sessions were closed Thursday afternoon by papers: "The Preservation of Hot-Water Supply Pipe," by F. N. Speller and R. G. Knowland; "The Relation of Hot-Water Service Heating to Various Types of Buildings," by H. L. Alt.; "Calculations and Analysis of a Compound

Gravity Low-Pressure Hot-Water System," by A. J. Wells; and "Measurements of Low-Pressure Steam Used for Heating the Buildings of the University of Michigan," by J. E. Emswiler.

SOCIAL ENTERTAINMENT

The programme for ladies included assemblage with the ladies' reception committee in the main lobby of the Engineering Building and luncheons and theater parties on Wednesday and Thursday, and on Thursday evening the twenty-fourth annual meeting was brought to a close by members, guests and ladies participating in a dinner and dance at the Hotel Astor.

Boston Welcomes President Main

The Boston Section of the American Society of Mechanical Engineers gave a reception to Charles T. Main, of Boston, the newly elected president of the society, on Tuesday evening, Jan. 22. The reception was held at the Engineers' Club and was preceded by a dinner, arranged by the section committee, Harry Ashton, W. G. Starkweather and F. L. Fairbanks.

Among those who spoke was John R. Freeman, of Providence, who reviewed some of the engineering achievements of Mr. Main. Mr. Freeman emphasized the Pacific Mills (textile) designed by Mr. Main, also the part the new president played in the Big Creek water-power development. Prof. Lionel S. Marks, of the Massachusetts Institute of Technology, recalled the illustrious presidents the society had had and who were New Englanders; chief among these were E. D. Leavitt, John R. Freeman and Dr. Ira N. Hollis. Prof. George C. Whipple, president of the Boston Society of Civil Engineers, spoke of Mr. Main's work in that field, and Prof. D. C. Jackson, of the Massachusetts Institute of Technology, acknowledged the indebtedness of the electrical engineers to Mr. Main for his assistance in the development of the electrical industry.

Calvin W. Rice, secretary of the American Society of Mechanical Engineers, told of the society's work in the war, claiming that considerable was yet to be done and urging upon the engineers to give their services to the Government. R. A. Hale, of the Essex Co., Lawrence, emphasized the value of the civic services rendered by Mr. Main to his home city. Desmond Fitzgerald, one of Boston's old and distinguished citizens, was most entertaining in his portrayal of Mr. Main's life, so full of experience, so simple and so accomplished.

Those in attendance then listened to W. R. Balch, war editor of the Boston *Transcript*, tell of events in Europe during the war. Mr. Balch laid particular stress upon the great social, moral and economic changes sure to come out of the war. Unfortunately he had to cut his address to a half hour on account of Fuel Administrator Storrow's order closing all public places at 10 o'clock.

Proposed Law Allows Expansion of Municipal Power Plants

The borough officials of Madison, N. J., in coöperation with neighboring municipalities, have drafted two interesting bills to be presented at the present session of the State Legislature, covering extended powers for municipal-lighting plants. These bills relate to two distinct phases of station operation, the first dealing with service combination between two or more municipal plants for greater efficiency, particularly with reference to fuel conservation, and the second to cover the sale of electric energy generated by municipal stations outside of the city or borough limits. These measures are the result of recent decisions of the Board of Public Utility Commissioners in holding that such proposed conditions of operation would make the plants subject to the jurisdiction of the board, to be considered under the head of regular public utilities.

The first-noted bill provides for the granting of authority for municipal plants in neighboring sections to coöperate and combine, where desired, for the rendering of proper service. Under this law a municipal plant would be privileged to furnish service to another community, and without falling within the domain of the state utility board in the features of bond issues, franchises, rates for light and power, etc.

As a concrete example of operation under this law the boroughs of Madison and Chatham desire to combine the service of the municipal electric plants of each municipality. In this it is proposed that the larger plant, located in Madison, furnish service for the late afternoon and night load, when the demand is heavy, in both boroughs, covering both street and private lighting, while the plant at Chatham would be employed at other periods of the day and under light-load conditions. The systems would be tied in together and the plants operated practically under one head.

By the other measure it is proposed to grant municipalities the right to sell electric current for light and power purposes outside of the municipal limits, all lines and equipment beyond the city or borough limits to be under the control of the Board of Public Utility Commissioners, but exempting the electric stations from this jurisdiction, as well as the furnishing of service strictly within the boundaries of the particular municipality.

The Madison power plant recently endeavored to supply electric energy in Chatham Township, but was compelled to discontinue service or become a regular public utility, in accordance with a ruling of the utility board. The service in this section is now being supplied by the Morris & Somerset Electric Company.

Federal Funds for Vocational Education

Recent Federal grants of money for vocational education totaling more than $240,000 have been allotted by the Federal Board for Vocational Education to eight states, each of which has complied with the terms of the Smith-Hughes law and has agreed that a sum of money equal to the amount of its grant shall be publicly raised by the state or local community. These states are Connecticut, Idaho, Illinois, New Hampshire, North Dakota, Missouri, Maryland and Vermont. The payments of Federal money are made through state boards for vocational education and are divided into three general classes—money allotted on the basis of rural population for the salaries of teachers, supervisors or directors of agricultural subjects; money allotted on the basis of urban population for the salaries of teachers of trade, home economics and industrial subjects; and money allotted on the basis of total population for the maintenance of teacher-training courses in all subjects. There are 47 states now enjoying the benefits of the Smith-Hughes act. Rhode Island has not yet accepted its provisions.—*Commerce Reports.*

Coal (?) Fifty-Five Cents a Ton!

The inventive genius of a people is said to thrive best in an atmosphere of pressing necessity. This fact possibly accounts for the amazing discovery—according to a brief newspaper note—of a method of making coal out of ashes. Making ashes out of coal is a comparatively simple and common performance. Reversing the process is remarkable, not to say miraculous. Yet it is none the less feasible, if we are to believe the statements of the secretary-treasurer of the George W. Loft Co., New York City. Says he:

> Our firm has been burning 55-cent coal for some time. We take the ashes after the furnace is done with them—just plain, ordinary ashes—and your five gallons of kerosene over about a ton of them. Then we feed the mixture into the furnace. From five gallons of oil, at 1c. a gallon, we get as much steam as we could from a ton of $8 or $10 coal.

If five gallons of kerosene, containing a total of about 700,000 B.t.u., will, when mixed with ashes, produce as much steam as 2000 lb. of coal, containing approximately 27,000,000 B.t.u., there are, in the despised ashcan, virtues of which none of us ever dreamed!

Poster Competition

Under the Auspices of the
Smoke and Dust Abatement League of Pittsburgh

1. The Smoke and Dust Abatement League desires a poster design which will express in simple form the relation of smoke abatement to fuel conservation.

2. The Committee in charge of the competition offers the following outline of the smoke abatement problem as a basis for poster ideas:

During 1917 some 500,000,000 tons of bituminous coal were consumed in the United States. Of this amount about 20 per cent., or 100,000,000 tons, were lost through imperfect combustion—the visible sign of which is black smoke.

Black smoke is an indicator of waste and inefficiency. A streamer of black smoke is the black flag of a pirate confiscating a part of the nation's resources.

Black smoke in time of peace means a great waste and a pollution of the atmosphere, which destroys building materials, retards the growth of vegetation, cuts off sunlight and daylight, prolongs fogs, is injurious to comfort and health, and is costly both to the smoke maker and to the public. In time of war it means all of that and more. Coal is a sinew of war. Coal is a food for fighters, and he who unnecessarily reduces the country's available supply curtails the nation's energy in the great industrial conflict.

The elimination of smoke requires knowledge, care, attention and some investment of money. There is no use minimizing these requirements. They are not too much to ask for the benefits resulting.

The dividends on the investment of knowledge, care and attention are self-respect, a citizen doing his duty by his fellows, and a better place in which to live and work. If the investment of money has been made with the same caution and advice as other investments, the dividends in money are nearly always sure, adequate and may be as large as speculative ventures.

3. The competition is open to all residents of the Greater Pittsburgh District.

4. The design is limited to three colors and black.

5. The size of the work is to be 15 x 24 in.

6. The seal of the league—the seal of the City of Pittsburgh with the inscription "Smoke and Dust Abatement League of Pittsburgh" encircling it—is to appear in the design. The seal is to be about three inches in diameter.

7. The designs must be handed in before noon on Feb. 16, 1918.

8. The designs are to be left at the Civic Club of Allegheny County, sixth floor, Keenan Building.

9. The name and address of contestant must be placed on the back of design.

10. The prizes are to be as follows: First prize, $50; second prize, $20; two prizes, $5; four prizes, $2.50; ten prizes, $1.

11. The first four prize-winning designs are to become the sole property of the league upon payment of the prize money. The league is to have the privilege of exhibiting all of the poster designs.

12. The judges for the competition will be announced at a later date.

13. Additional information concerning the competition may be secured from the secretary of the Smoke and Dust Abatement League, John O'Connor, Jr., Mellon Institute, University of Pittsburgh; Telephone, Schenley 897.

Committee: John O'Connor, Jr., Chairman; Mrs. Isobel A. Bowers, Miss H. Marie Dermitt, Mrs. William D. Hamilton, C. J. Taylor.

Obituary

Lieut. Gordon D. Cooke, who, prior to entering the service of the country, was a member of the field-service department of the McGraw-Hill Co., died of pneumonia at the base hospital, Fort Bliss, Tex., on Jan. 10. He was a graduate of the University of Michigan and was 24 years old.

Personal

B. J. Denman, formerly chief engineer of power plants of the Detroit Edison Co., and for the last few years vice president and general manager of the Tri-City Railway and Light Co., Davenport, Iowa, has been elected president of the company.

Miscellaneous News

A Steam Pipe, used for an exhaust through the firebox, broke and caused an explosion in the boiler room of the Alamito dairy, at Omaha, Neb., on Jan. 11, killing the fireman.

A Tube Blew Out of one of the boilers at the power house at Fayette station, Connellsville, Penn., on Jan. 13, painfully scalding five men and crippling the West Penn power system for an hour.

A Large Furnace Boiler Exploded in the subcellar of the new building occupied by Bowles lunch on Main St., Buffalo, N. Y., on Jan. 21, killing the engineer and turning the furnace room into a mass of débris. The force of the explosion shook the building and threw patrons in the lunch room into a panic. The boiler was a new one, having been installed a few weeks ago. The cause of the explosion is unknown.

Red Cross Wants Tracing Cloth—To help meet the enormous problem of securing a sufficient quantity of white goods for the manufacture of surgical dressings, the Red Cross is asking architects, manufacturers and draftsmen to contribute their discarded tracing cloth. If anyone having such material will call up one of the large laundries of his city, he will find them glad to send for such cloth as he can give them. The laundries will wash and bleach the material and forward it to its proper destination.

A Boiler Explosion at the Wishkah shingle mill, Aberdeen, Wash., on Jan. 18, killed one man, seriously injured another, and completely wrecked a portion of the plant. Both men were thrown fifty feet by the explosion, their bodies falling into the river, and bricks surrounding the boiler were thrown more than 300 yards. The concussion was felt in stores 500 yards away. A piece of the boiler weighing several hundred pounds was hurled through the air for 150 yards. The cause of the explosion is unknown.

The Navy Department Announces that men will be soon selected for aviation service. Men of suitable qualifications who report now to the Navy recruiting offices are eligible for examination for commissions and ratings. The rates of pay and duties assigned in this aviation work in the Navy will make this opportunity highly attractive to mechanical engineers and to draftsmen, mechanics and others who are experienced in gasoline-engine design or operation. Full information may be obtained at any Navy recruiting office.

Merger of Electrical Plants—The Mohawk Gas Co., understood as being controlled by General Electric Co. interests, has filed intentions with the Public Service Commission and the Schenectady County Clerk a plan to merger all plants that generate electric power from the Hudson River west to Herkimer County, which would include the Spier Falls and Schaghticoke hydro-electric plants and which would indirectly control the electric-power supply of the City of Albany and the cities and towns of Albany, Rensselaer, Fulton, Schoharie, Montgomery County and part of Herkimer County. Application has also been filed with the Public Service Commission to combine the Schenectady Illuminating Co., Schenectady Power Co. and the Mohawk Gas Co., under the name of the Mohawk Gas Co.

Power-Plant Courses in Wisconsin—The University of Wisconsin, University Extension Division, is now prepared to give, by correspondence, a course in practical hand firing, which will take up methods of making a good fire, fuel supply, tools, size of coal, effect on smoke, boiler stresses, effect of clinker, draft regulation and feed water problems, and the care of boilers. The University is having considerable success with this course, particularly in plants which are face to face with coal shortage. The following steam-engineering courses have been prepared for firemen and engineers who desire to increase their efficiency and prepare for promotion and increased earnings: Steam Boilers, Part I; Steam Boilers, Part II; Steam Engines, Part I; Steam Engines, Part II; Heat—Part I, Principles; Heat—Part II, Application, Fuel, Refrigeration, Heating and Ventilation. Those desiring further information should address the University Extension Division, University of Wisconsin, Madison, Wis.

Massachusetts Teaches Power-Plant Economics—In the hope of preventing the great wastage of fuel that occurs in steam-power plants, due to inefficient management more than to equipment or to the ability of the plant to use the fuel efficiently, the State Board of Education of the Commonwealth of Massachusetts has organized a class in power-plant economics, the first lecture being Monday evening, Feb. 4, at Room 109, State House, Boston. The idea of the classes is the dissemination of easily understood information of how to obtain the full worth of every pound of fuel used in the industry. J. A. Eames, instructor in mechanical engineering, in the Department of University Extension of the Massachusetts Institute of Technology, will give the course, which will be in the form of lectures and discussion on modern power-plant problems. The subjects include power-plant location, boiler plans, equipment, methods of firing, arrangement of heating surfaces, and specifications for the purchase of coal by contract. There is no charge for tuition, but the student is expected to buy his textbooks.

Business Items

The Liberty Manufacturing Co. has removed its offices from Susquehanna St. to the Frick Building, Pittsburgh, Penn.

The Elliott Co. has disposed of its office building on Susquehanna St., and taken offices in the Frick Building, Pittsburgh, Penn.

The Esterline Co., Indianapolis, Ind., announces the appointment of the F. R. Jennings Co., 616 Ford Building, Detroit, Mich., as its sales representative for graphic instruments for the state of Michigan. Mr. Jennings will handle the entire state for the Esterline Co., with the exception of the northern peninsula, which is taken care of by the Milwaukee office.

The National Tube Co. is sending out an interesting circular illustrating seven instances of the remarkable ductility of "National" pipe. In Biblical times seven was a number signifying completeness; the furnace in which the three Hebrew children were placed was heated sever times hotter than usual. Also in profane history we read of the Seven Wonders of the World, the Seven Wise Men of Greece, etc. Therefore, out of the many instances of the ductility of "National" pipe seven was the number appropriately chosen for illustration.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual [1]	
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b, Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual [1]	
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$6.50—6.75
Buckwheat ..	4.30—5.00	2.75	5.50—6.00	6.00—6.25
Rice	3.75—3.95	2.20	4.50—5.00	4.50—5.00
Barley	3.25—3.50	1.95	4.00—4.25	3.25—3.75
Boiler	3.50—3.75	2.20	....	....

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).................	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918		One Year Ago
Buckwheat ...	$3.15-3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65-3.65	1.25	3.65	2.15	3.35
Boiler	2.45-2.85	1.10	3.55	2.00	....
Barley	2.15-2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.35-2.75
2-in. lump..	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Steam egg ...	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Mine-run ...	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Russellville—The Alabama Power Co. is having plans prepared for the extension of its transmission line from here to Sheffield and Muscle Shoals. W. N. Walmsley, Birmingham, Gen. Mgr.

Conn., Norwich—City plans to install new electric equipment including a 300-kw. turbine with a 500-hp. boiler in its gas and electric plant. Estimated cost, $200,000.

Conn., Thamesville—(Norwich P. O.)—The Eastern Connecticut Power Co. is having plans prepared by H. M. Hope Eng. Co., Eng., 185 Devonshire St., Boston, for the erection of a power plant. R. W. Perkins, Treas. Noted Dec. 4 under "Norwich."

Ga., Americus—City plans to build an electric-lighting plant. J. B. Ansley, City Engr.

Ga., Savannah—City is considering a proposition made by the Savannah Lighting Co. to install electrical turbine pumps in its water department.

Kan., Chardon—City voted to issue $25,000 bonds for the erection of an electric-lighting plant.

Mich., Menominee—The Menominee Electric Manufacturing Co. will soon award the contract for the erection of four 1-story additions to its plant. Estimated cost, $60,000.

Miss., Wiggins—City plans to improve its electric-lighting and water-works system.

Mont., Redstone—City plans to rebuild its electric-lighting plant.

N. J., Camden—Warren Webster & Co. has notified the Public Utility Commissioners of an increase in its capital stock from $150,000 to $450,000; the proceeds will be used to build additions and improvements to its plant.

N. Y., Brooklyn—The Bureau of Supplies and Accounts, Navy Department, Wash., will soon receive bids for furnishing at Navy Yard, Brooklyn, under Schedule No. 1669, 12-in. desk and bracket fans; under Schedule No. 1670, 630,000 ft. incandescent lamp cord, 11,500 ft. rubber-insulated, lead-covered wire, duplex, single-conductor, rubber covered wire, 120,000 ft. rubber-insulated telephone wire and 130,000 ft. twin conductor wire; under Schedule No. 1671, leaded and armored, interior-communication cable and 145,000 ft. plain, single-conductor wire.

N. Y., Brooklyn—The Interborough Rapid Transit Co., 165 Bway., New York City, plans to build a 1 story, 50 x 100 ft. transformer station on Livonia Ave. Estimated cost, $40,000. G. H. Pegram, New York City, Ch. Engr.

N. Y., Buffalo—The Oldman Boiler Works, 38 Illinois St., is in the market for new equipment including punching machinery, blowers, motors, a 25-ton crane and riveting machinery for its boiler shop.

N. Y., New York—The Weyant Electrical Co., 111 Broad St., has increased its capital stock from $5000 to $15,000; the proceeds will be used to build additions and improvements to its plant.

Okla., Bartlesville—The Crystal Ice and Storage Co. plans to rebuild its plant which was destroyed by fire.

Okla., Bristow—City plans an election soon to vote on $25,000 bond issue for an electric-lighting plant. T. B. Gibson, City Clerk.

Okla., Prague—City plans an election to vote on a bond issue for improvements to its electric-lighting plant.

Penn., Philadelphia—The Philadelphia Electric Co. plans to build a large power house on Beach and Palmer Sts. Estimated cost, $8,000,000. A. K. Coe, Secy.

Tex., San Angelo—The San Angelo Ice and Power Co. plans to expend about $10,000 in improvements to its plant. A. L. Lair, Mgr.

Va., Suffolk—The Virginia Ry. and Power Co. plans to issue $950,000 bonds; the proceeds will be used for extensive improvements to its plant, including the erection of an electric transmission line from here to Petersburg.

Wash., Davenport—The Washington Water Power Co. plans to build a 65-mile high tension transmission line from its Long Lake plant in Lincoln Co. to a point 12 miles south of Odessa. Estimated cost, $100,000. C. F. Uhden, Spokane, Ch. Engr.

W. Va., Switchback—The Appalachian Power Co. plans to rebuild its central power plant which was recently destroyed by fire.

W. Va., Wheeling—The Beech Bottom Coal Co. plans to rebuild its power station, which was destroyed by fire. Loss, $40,000.

Wis., Beaver Dam—The Wiscinsin Power, Light and Heat Co. plans to build a transmission line here. J. D. Roberts, Supt.

Wis., Madison—The Di-Electric Manufacturing Co., incorporated with $40,000 capital stock, plans to build a plant. E. W. Smythe, Jr., Vroman Blk., and E. K. Frautschi, incorporators.

B. C., Nelson—The Swanetta Power Co., incorporated with $500,000 capital stock, plans to build a large hydro-electric plant on the Pend d'Oreille River, south of Nelson.

Ont., Stayner—J. Knox is in the market for a 30-hp. and 3-hp. 220-volt, 60-cycle, 3-phase A.C. motor.

Que., Montreal—The Canadian Pacific Telegraph Co., 4 Hospital St., is in the market for a 25-volt, 60-ampere motor generator. W. D. Neil, Supt.

Sask., Yorkton—A. M. McNicol, Box 526, is in the market for a 250-gallon vertical centrifugal submerged pump and a vertical 40-hp. A. C. 3-phase, 60 cycle, 550-volt, direct drive motor.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T. fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			⅜-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T .P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	..
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$21.50
No. 16 cotton twisted	29.00
No. 18 cotton parallel	24.00
No. 16 cotton parallel	36.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	39.40
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No 18 cotton Canvasite cord	21.75
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$10.50	$12.50	$15.00	$23.50
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	50.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	223.60	....
000	....	....	271.24	....
0000	....	....	332.40	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$10.90	$15.15	$27.25	$11.30	$13.37	$26.08	$15.00	$17.90	$36.80
10	23.70	27.05	49.35	23.16	26.34	....	29.00	34.30	67.60
8	33.60	37.35	74.45	32.32	35.96	....	39.90	46.85	....
6	....	57.15	....	....	62.92	....	58.95	74.60	....
4	....	81.70	....	....	88.20	....	97.20	106.55	....
2	....	121.80	....	....	127.38	....	154.50	163.00	....
1	....	158.50	....	....	167.80	....	197.45	209.50	....
0	....	189.40	....	....	192.00	....	276.00	285.50	....
00	....	298.05	....	....	245.78	....	317.00	330.00	....
000	....	362.15	....	....	300.00	....	414.40	428.00	....
0000	....	448.50	....	....	364.32	....	508.00	516.00	....

LOOM—Price per 100 ft., in coils:

	Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$69.70	$74.80	$0.1672	$0.1786	$0.0616	$0 0658
¾	92.00	98.90	.22	.235	.088	.094
1	136.00	146.20	.3256	.3478	.1144	.1222
1¼	184.00	197.80	.4185	.4496	.1581	.1698
1½	220.00	236.50	.558	.5994	.1953	.2098
2	296.00	318.20	1.023	1.10	.2604	.2797
2½	468.00	503.10	1.674	1.80	.372	.3996
3	612.00	657.90	4.464	4.79	.558	.5994
3½	763.60	818.80	9.86	10.59	.744	.7992
4	926.50	991.90	11.39	12.23	.93	.999

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$70.00	$4.59	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B—Watts	Plain	Frosted	No. in Package	Mazda C—Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 net up allow a discount of 17% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb
Rubber tape, ½-lb. rolls	45c. per lb
Wire solder, 50-lb. pools	45c. per lb
Soldering paste, 1-lb. cans	50c. per lb

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2⅝-in.	75c. per ft.
Common, 2½-in.	40%

Air

	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.55	$0.30	$0.25

Steam—Discounts from list

First grade	30%	Second grade	30-5%	Third grade	40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50%	Best grade	20%
Standard	35%		

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	35%
Denver	40%	35%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.77
Asbestos for high-pressure steam	1.54
Duck and rubber for piston packing	.88
Flax, regular	.66
Flax, waterproofed	.99
Compressed asbestos sheet	.99
Wire insertion asbestos sheet	1.21
Rubber sheet	.55
Rubber sheet, wire insertion	.88
Rubber sheet, duck insertion	.44
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided, and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.65 to .70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		5% off
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5¼	6.1	8½	10
Fiber or sponge	8	6	6.4	15	15
Transmission	7	6	6.4	10	15
Axle	4½	4	3.3	3	5
Gear	4½	4½	6.5	5½	5½
Car journal	22 (gal.)	3½	4.6	5	5

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Jan. 30, 1918	One Year Ago		
White	11.00 to 13.00	13.00 to 15.00	16.00	12.00 to 13.00
Colored mixed	8.50 to 12.00	10.00 to 12.00	12.50	10.00 to 12.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13¼	$35.00	13¼ x 20½	$45.00

In Chicago they sell at $30@33 per 1000.

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Jan. 30, 1918	1 Year Ago	Jan. 30, 1918	1 Year Ago	Jan. 30, 1918	1 Year Ago
Raw per barrel	$1.31	$0.96	$1.35	$1.00	$1.32	$0.98
5-gal. cans	1.41	1.06	1.50	1.10	1.45	1.08

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Jan. 30, 1918		1 Year Ago		Jan. 30, 1918	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50	10.50
12½-lb. keg	11.75	11.25	10.75	11.25	10.75	10.75
100-lb. keg	11.25	11.50	11.00	11.50	11.00	11.00
1- to 5-lb. cans	13.25	13.00	12.50	12.50	13.00	12.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	30%	35%	40%*
Tinned	30%	35%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York	$7.00	Cleveland	$5.85	Chicago	$5.50

Coneheads, same sizes:

New York	$7.10	Cleveland	$5.95	Chicago	$5.60

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$50.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	....
Magnesite brick, per net ton	135.00 to 145.00	....
Chrome brick, per net ton	135.00	....
Deadburned magnesite brick, per net ton	85.00 to 90.00	....
Special furnace chrome brick, per net ton	60.00 to 70.00	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $50.

Birmingham—Fire clay, $25 to $30; Denver, $23, per 1000.

Chicago—Second quality, $25 per ton.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	5c.	5½c.
Mexican heavy, 12-14 Baumé	7c.	None

Note—There is practically no fuel oil in Chicago at present time.

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Jan. 30, 1918	One Year Ago
New York	$15.00	$8.00
Cleveland	15.30	7.50
Chicago	15.00	6.00

In coils an advance of 50c. usually is charged.

Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft.	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft.	7.40	6.60	6.60	5.80
7 in. by 35 ft.	10.70	9.60	9.60	8.55
8 in. by 35 ft.	12.20	10.90	10.90	9.65
7 in. by 40 ft.	12.35	11.00	11.00	9.75
8 in. by 40 ft.	13.75	12.15	12.15	10.65
8 in. by 45 ft.	18.20	16.20	16.20	14.30
8 in. by 50 ft.	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$6.00
12-in. butts, 6-in. tops, length 30-40 ft.	8.50
12-in. butts, 6-in. tops, length 41-50 ft.	9.50
14-in. butts, 6-in. tops, length 51-60 ft.	17.00
14-in. butts, 6-in. tops, length 61-71 ft.	18.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
BUTT WELD					
¾ to 3	49%	35½%	¾ to 1½	33%	17%
LAP WELD					
2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			
BUTT WELD, EXTRA STRONG PLAIN ENDS					
¾ to 1½	47%	34½%	¾ to 1½	33%	18%
2 to 3	48%	35½%			
LAP WELD, EXTRA STRONG PLAIN ENDS					
2	40%	28½%	2	27%	14%
2¼ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

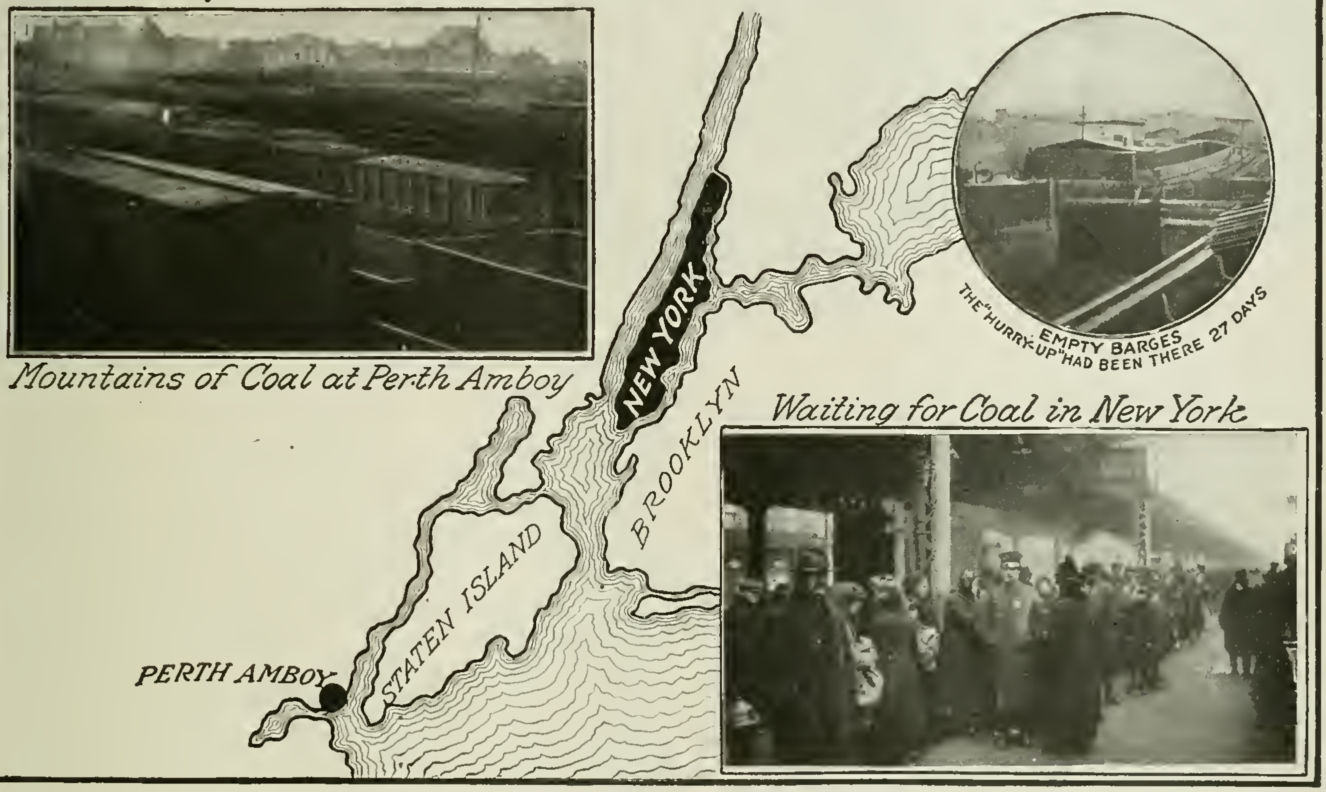
	Per Net Ton		Per Net Ton
1 in.	$340	1¾ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

POWER

Vol. 47 NEW YORK, FEBRUARY 12, 1918 No. 7

Why New York has no Coal



Mountains of Coal at Perth Amboy

Waiting for Coal in New York

THERE are thousands of tons of coal at the tidewater piers that supply New York City. Yet lines of people a block long wait hours to buy a hundred pounds each at 50 cents. Homes and offices go unheated and pneumonia makes new death records.

For want of barges? No, scores of them wait for days, aye weeks, at each of the piers. Ice? No, the Kill is free now. Labor shortage? No, hundreds of men are available at a fair wage.

Then with the coal, the barges, the men and a free channel, why does the city freeze?

Because the eight piers, operated by the railroads, supplying the city are unloading but 1335 cars per day average, against 1800 last year.

Because the piers are undermanned and the men paid 35 cents an hour, while almost in the shadow of the piers laborers in Government employ get twice as much.

Because the piers are worked 10 hours or so a day instead of 24 hours.

Because the thawing facilities, at one Perth Amboy pier at least, are worked at less than 10 per cent. capacity, while there are not enough facilities at others. Because this pier unloads but three cars at a time instead of a possible 28. Because it employs 26 men instead of a hundred.

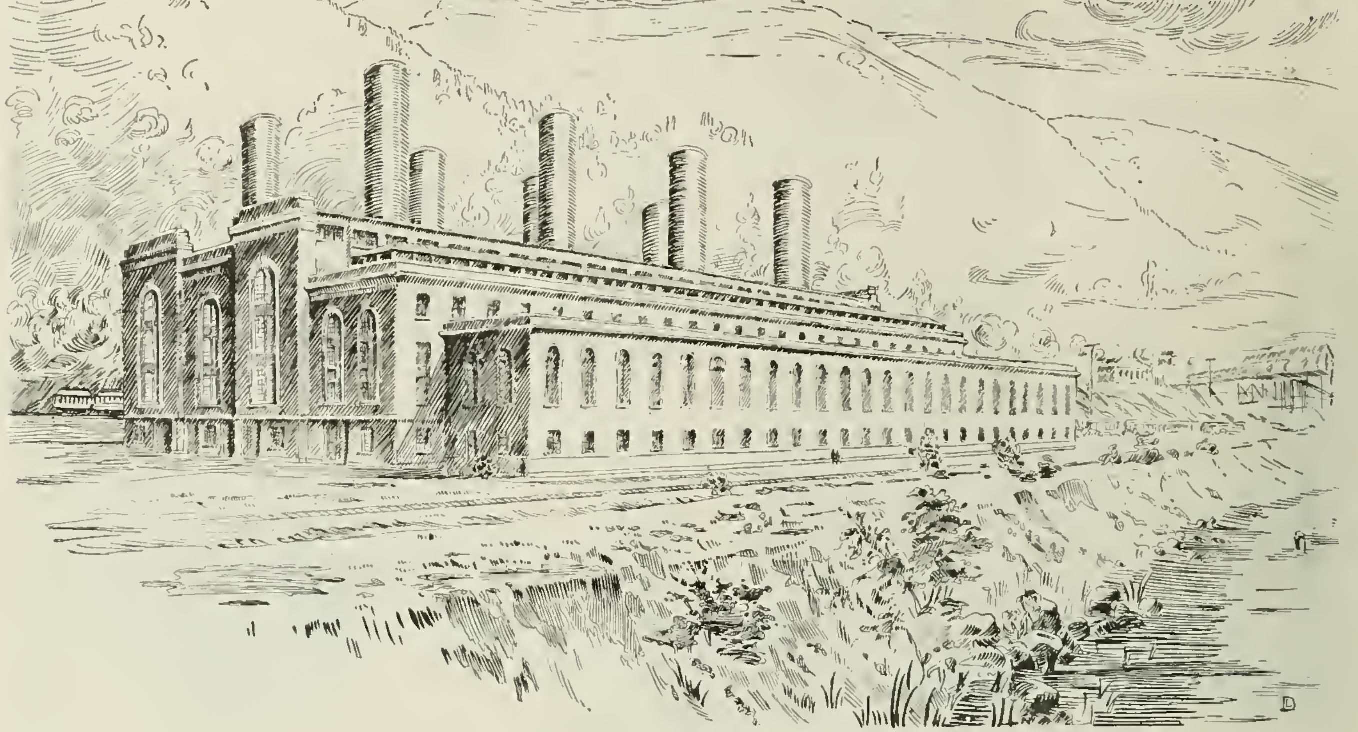
Because a gang of six men spend two days unloading one car of frozen culm.

Because, at this writing, anthracite is not pooled, causing switching and waiting of cars, decrease of coal production and astounding delay of barges.

The miners blame the railroads, who say they are through when they land the coal at tidewater; the pier management blames the shipper for delaying the arrival of his barges. Thus "the buck is passed next door."

(See editorial pages.)

THE WINDSOR POWER STATION



Features in the location, design and equipment of a huge plant located at a coal mine in West Virginia to produce bulk energy for its joint owners, the American Gas and Electric Co. and the West Penn Power Co. Commercial power was first put on the line to Canton, Ohio, Aug. 28, 1917.

WHEN it is looked upon in retrospect, the construction of the $10,000,000 Windsor (W. Va.) plant of the American Gas and Electric Co. and the West Penn Power Co. will probably be seen to mark a new epoch in the central-station industry. Far-seeing engineers and central-station executives now view it as a pioneer station; they see it as one of an interconnected group of great plants strategically located to produce large quantities of energy so cheaply that it may be economically transmitted over wide areas to serve one of the greatest industrial districts in the world. True, plants have been built at coal mines before; but this is a pioneer station in the respect that it is the first coal-burning bulk supply station of any considerable size. Before another year lapses, the station will rank among the world's largest steam plants. It is the initial step toward carrying into actual practice in a broad way what has proved to be successful on a smaller scale in the Middle West with steam and in the Far West with hydro-electric power.

As a bulk supply station the Windsor plant has an enviable situation. Being on the Ohio River, it has an adequate and dependable supply of good water. Fig. 2 is a view of the station at its present state of completion. It is being continued for the second section at the left of the illustration. It is but 2000 ft. from a coal mine that produces fuel running around 13,500 B.t.u. per lb. It is on the Pittsburgh, Wheeling & Kentucky branch of the Pennsylvania R.R. The 58 acres of real estate purchased around the plant site was not expensive. It lies between the Eastern and the Central time belts and receives, therefore, those advantages of diversity which come from serving loads thrown on systems at different times by reason of the arbitrary shifting of clocks as the meridian is passed. Moreover, it lies in what is practically the load center of the eastern Ohio, western Pennsylvania and Wheeling (W. Va.) industrial district which it will serve. This location for a large station possesses the further advantage of serving a territory in which the general run of boiler-feed water gives enough troubles to isolated plants to induce them to central-station service. This water, taken from small streams, is contaminated to a considerable extent by water from the mines. In fact, this exact site was chosen after a thorough search extending on both sides of the Ohio River from Steubenville to Wheeling.

The ultimate rating of the station as it is now laid out will be about 200,000 kw. in six units. Of the first 60,000 kw. of this rating in two machines now in operation, one 30,000-kw. unit was put into commercial service Aug. 28, supplying Canton, Ohio. Two additional units will be completed in 1918. The last two units will probably be installed shortly thereafter. For each turbine there are four boilers, each with 12,625 sq.ft. of heating surface. No. 2 unit of the two now installed is shown in Fig. 1. Each boiler is equipped with a separate economizer and induced-draft fan set over the boiler. Forced draft is also applied under the underfeed stokers. The boilers are arranged on both sides of a wide room, along the center of which is a large concrete coal pit into which fuel is delivered directly from the mine by special transfer cars. From this pit coal is delivered to individual hoppers in front of each boiler.

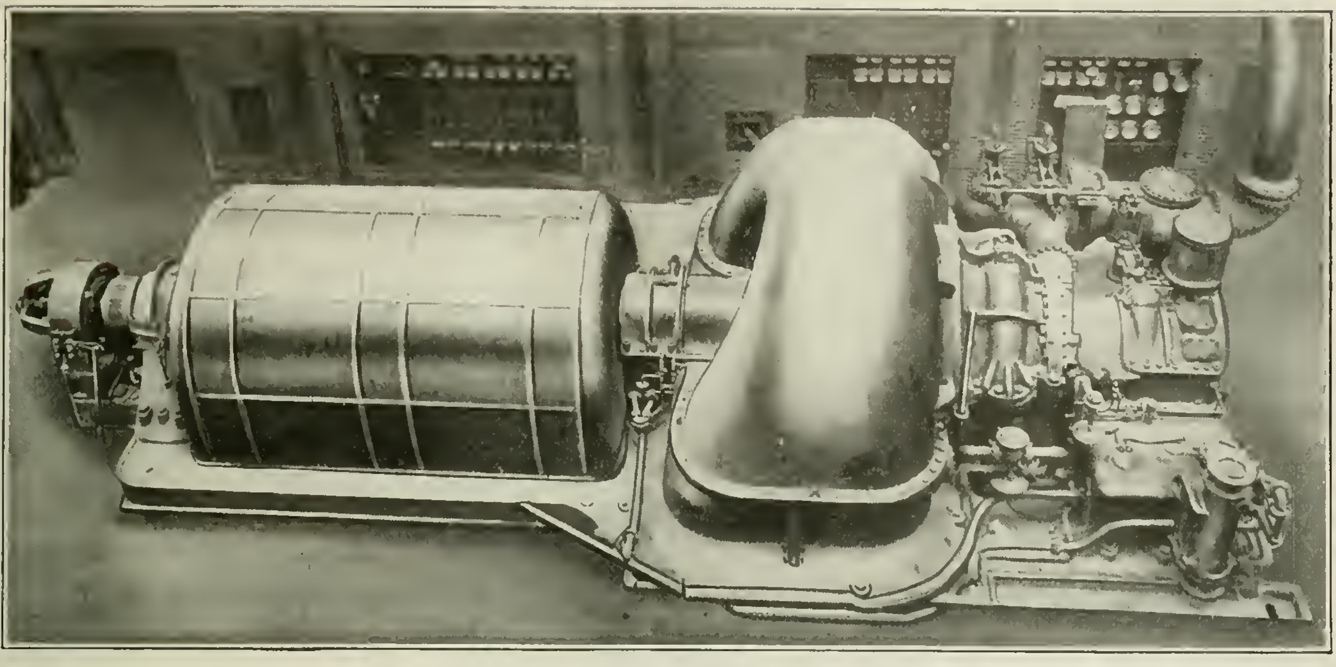


FIG. 1. ONE OF THE 30,000-KW. TURBINE UNITS

In the turbine room the machines are set in a single line with their axes parallel to the firing aisle of the boiler room. The units are grouped in pairs with the steam ends of each pair adjacent to each other and directly over a single condenser pit. This places the operating ends of each pair of units, as well as the condensing equipment of each pair, close together for convenient operation. Between each pair of turbines is a condenser pit 74 ft. deep, the walls of which form the foundation of the turbines (see Fig. 3). This pit contains two horizontal surface condensers each of 50,000 sq.ft. cooling surface, together with the auxiliary condenser motor-driven pump. Details of the condenser design, auxiliaries and intake and discharge arrangement will be published in a following article.

All tracks run into the station on trestles, owing to the elevation by the station above the high-water level of the river. Although these were costly at the outset, the space beneath them will be used for ash dumps for several years to come, providing an economical means of disposing of ashes.

The over-all dimensions of the plant with the six units completed, exclusive of the high-tension yards, will be about 295 x 280 ft. The operating floor is on one floor level, and in a plant of such size this will add greatly to the convenience of operation. Because it is necessary to radiate quantities of heat from the large units, the design has been made especially liberal as regards light and air. The radiated heat from the turbines is conducted from the generators to the basement of the boiler room, where it is taken up by the stoker fans and delivered to the furnaces.

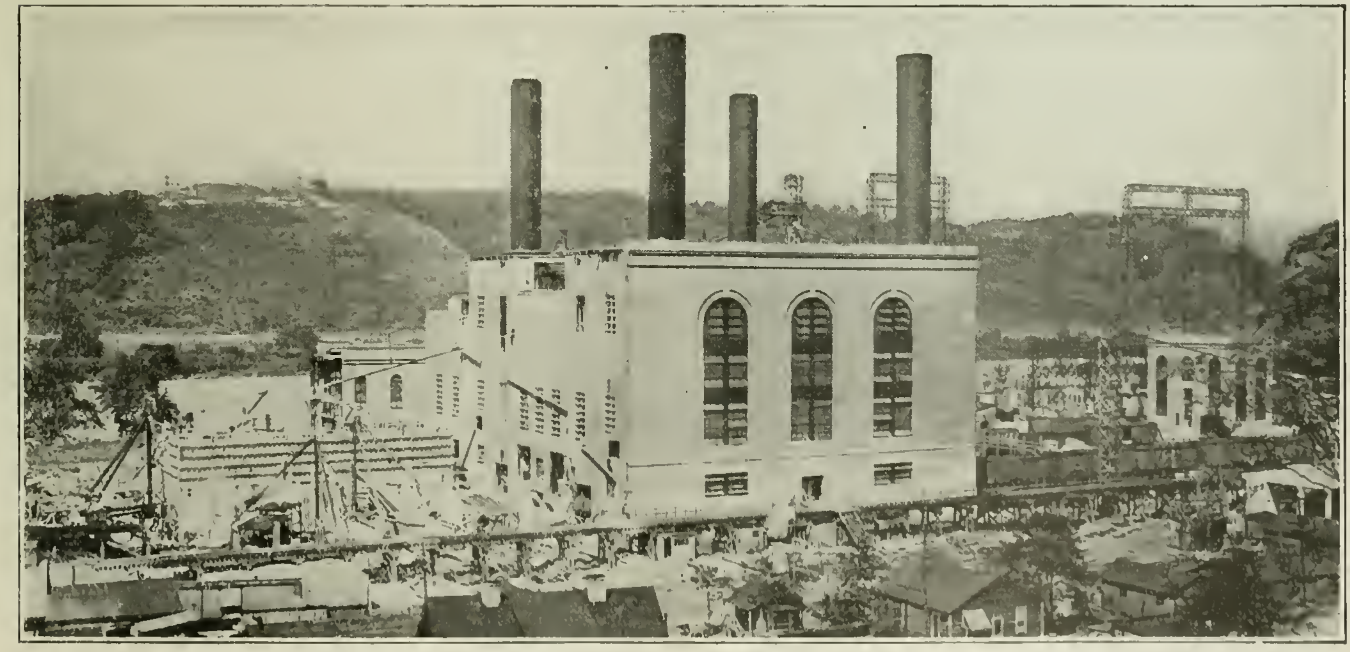


FIG. 2. COMPLETED SECTION OF THE WINDSOR POWER STATION

To get the proper perspective on the electrical end of the plant, it should be viewed in two units; namely, the low-tension or generator-voltage equipment and the high-tension equipment. Control of all low tension and high tension is centered in an operating room, between the original section of the generator room and the switchhouse. The switching of all circuits operating at the generator voltage is accomplished in this switchhouse, which is built parallel to the length of the generator room. The energy is generated at 11,000 volts, and arrangements are made so that ultimately all units in the station can operate at this potential on a ring-bus system with reactors between each two bus units.

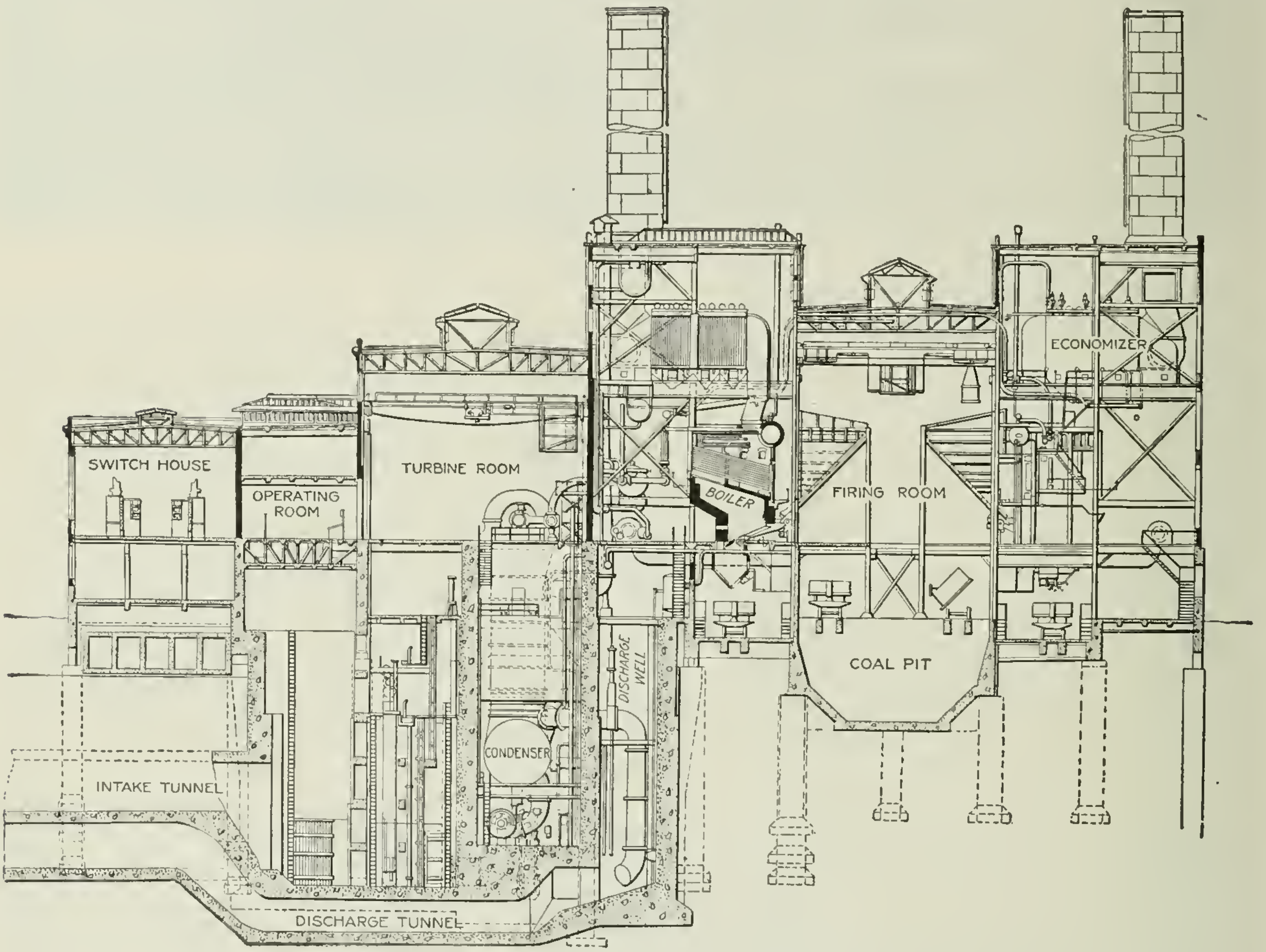


FIG. 3. ELEVATION OF THE WINDSOR PLANT

From the switchhouse the energy is distributed to two separate high-tension yards owned individually by the joint owners of the station. From these yards the electricity is transmitted to distributing companies at four different potentials.

In the building itself are several features of interest. The problem of getting a solid footing under the boiler room and switchhouse was solved by sinking caissons, but the necessity for carrying out this method under the remainder of the station was eliminated by utilizing the walls and foundations of the condenser well and intake crib to support the superstructure. The construction of the boiler-room foundations, generally speaking, consists of seven rows of concrete piers built up from depths below the surface that vary from 28 ft. to 52 ft. Still another interesting feature is the utilization of the space over the intake well for the switchboard operating room. This room is supported on 6-ft. steel trusses that span the space between the turbine-room wall and the wall of the switchhouse. The trusses do not interfere with access to the intake well, which the operating force must have for cleaning it at intervals. The 6-ft. space occupied by the trusses has proved of still further value, since it was inclosed and was used as a spacious conduit chamber for all lines leading to the switchboards in the operating room. By dividing the operating room horizontally with a floor, it has also been possible to provide offices for the chief engineer and the load dispatcher on the second floor.

The coal-handling facilities at the plant are noteworthy in several respects. Coal is secured under a long-term contract from a mine owned by the Richland Coal Co., approximately 2000 ft. from the power house. It is hauled into the station in side-dump transfer cars on a standard-gage track. All this railroad equipment is owned by the central station. It is considered important that the track is of standard gage, because in an emergency this will permit the shipment of fuel from other mines without inconvenience. At the plant the transfer cars are dumped into a concrete pit which is approximately 35 ft. wide and runs the entire length of the boiler room beneath the firing aisle. From this pit, which will hold more than 2500 tons of coal, the fuel is lifted in a 3-cu.yd. grab bucket operated from an overhead crane. After being weighed by a device on the crane, it is dropped into the individual hoppers that serve each boiler. This indirect but effective method of handling coal inside the boiler room permits a rather large quantity of fuel to be carried inside the plant without great expense, since it was possible to construct the coal pit of concrete instead of steel. A large coal-storage yard will be provided near the plant in the future.

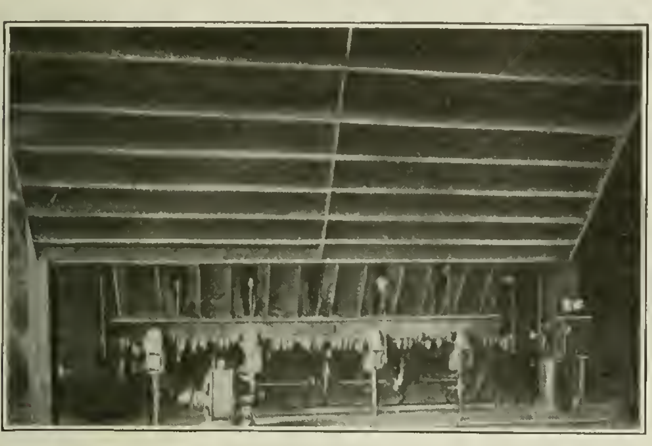


FIG. 4. FRONT VIEW OF ONE OF THE STOKERS AND COAL HOPPERS

From the hopper the coal goes by gravity to underfeed stokers with fourteen retorts per boiler (Fig. 4). These stokers are each arranged with a blast, a 100-hp. motor-driven fan being provided for each boiler. Stokers of the underfeed type were chosen for this service because they have proved efficient in burning West Virginia coal and have possibilities of high capacities.

The four boilers which serve each turbine are of the water-tube cross-drum type. Each one has 12,625 sq.ft. of heating surface and supplies steam at 250 lb. pressure and 250 deg. superheat. All settings are incased in steel to prevent air leakage. The four boilers which form a unit to serve each turbine are arranged in banks of two facing each other, on opposite sides of the firing aisle. Each bank of boilers is connected to a manifold, which in turn is connected to the steam pipe running to the turbine. Leads from the separate boilers are cross-connected. A feature of the boiler settings is the fact that the center line of the drum is 26.5 ft. above the firing-aisle floor. This arrangement provides an extra-large furnace and insures good combustion of the fuel.

As the gases leave the boiler, they are taken through economizers, Fig. 5. One 8625-sq.ft. economizer is set directly over each boiler. The economizers, which are of the high-pressure type, are arranged in two divisions, 8 tubes wide by 36 tubes long. This arrangement, it is believed, provides for the maximum heat transfer. It also allows the space between the two sections to be utilized for a bypass duct and permits a neat arrangement of the duct to the double-suction induced-draft fan. Moreover, arrangement of the economizer in this manner makes the section narrower and hence more accessible for repairs and cleaning. Dampers are provided in the uptake and are so arranged that in one position they close off the economizer and in the other position the bypass duct. From the economizer the gases pass through a 60-hp. motor-driven fan to a smoke flue which connects three boilers to a 13-ft. by 146-ft. steel stack. The gases are thus actuated by both induced and forced draft and practically a balanced draft condition is maintained over the fire. The stoker-blast equipment is designed to give a pressure equal to 6.5 in. of water. The operation of the induced-draft fans in connection with the forced draft will permit the furnaces to operate almost without pressure in the firebox. Hand regulation is employed to give proper relation of fuel and air. The ash from the furnaces is disposed of by dropping into pits, from which it can be dumped into the same transfer cars that are used for bringing coal to the plant. A plan view of the plant is shown in Fig. 6.

Because the boilers are equipped with economizers and since the large units permit the production of energy at low cost, most of the auxiliaries are motor-driven. In connection with each condensing equipment, there are two hydraulic air pumps driven by 200-hp. motors and two hotwell pumps driven by 100-hp. motors. The hydraulic air pumps are set on the gallery adjacent to the condenser, making a very short suction connection. The hotwell pumps are located on the floor of the condenser well under the condenser. The pumps, which are operated in connection with the condensing equipment, including the 50,000-gal. circulating pumps, are motor-driven.

The condensate, after passing through the condenser, is pumped through a primary heater in the upper part of the condenser up into a feed-water heater of the open type, which is set on a platform immediately over the feed pumps. These pumps and one service pump are the only steam-driven auxiliaries in the plant. There are two feed pumps on each unit, one of these pumps each on two units being motor-driven and three steam-driven.

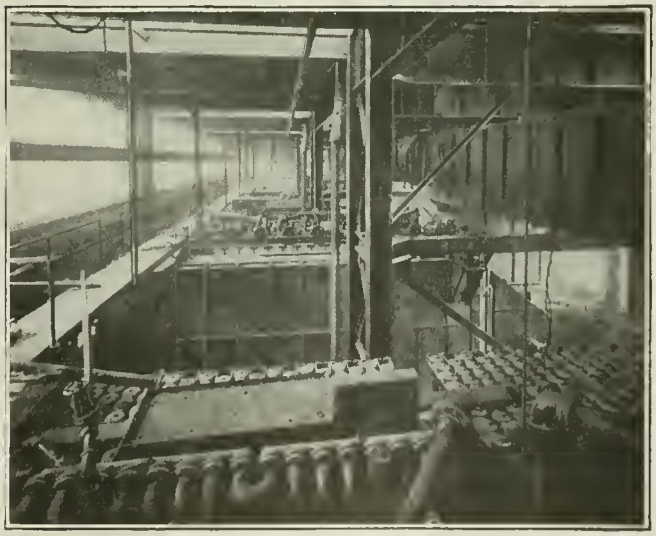


FIG. 5. VIEW ABOVE THE ECONOMIZERS

Besides those auxiliaries which are attached to each separate unit, there is one motor-driven and one steam-driven turbine service pump located in the condenser well. These units are connected to a steel service tank under the boiler-room roof. This supplies all service and all makeup water, the latter being run through a settling tank and quartz filter before going to the feed-water heaters. No other water-treating equipment is necessary. From the feed pump water is taken to the boilers through a double-feed system, the main feed being arranged to take water through the economizers and the auxiliary feed being arranged to deliver the water to the boilers direct.

On account of the fact that the condenser well is deep and a large part of the auxiliary machinery is under the condenser, an electric push-button elevator operates between the turbine-room floor and the condenser pit for the convenience of the operators.

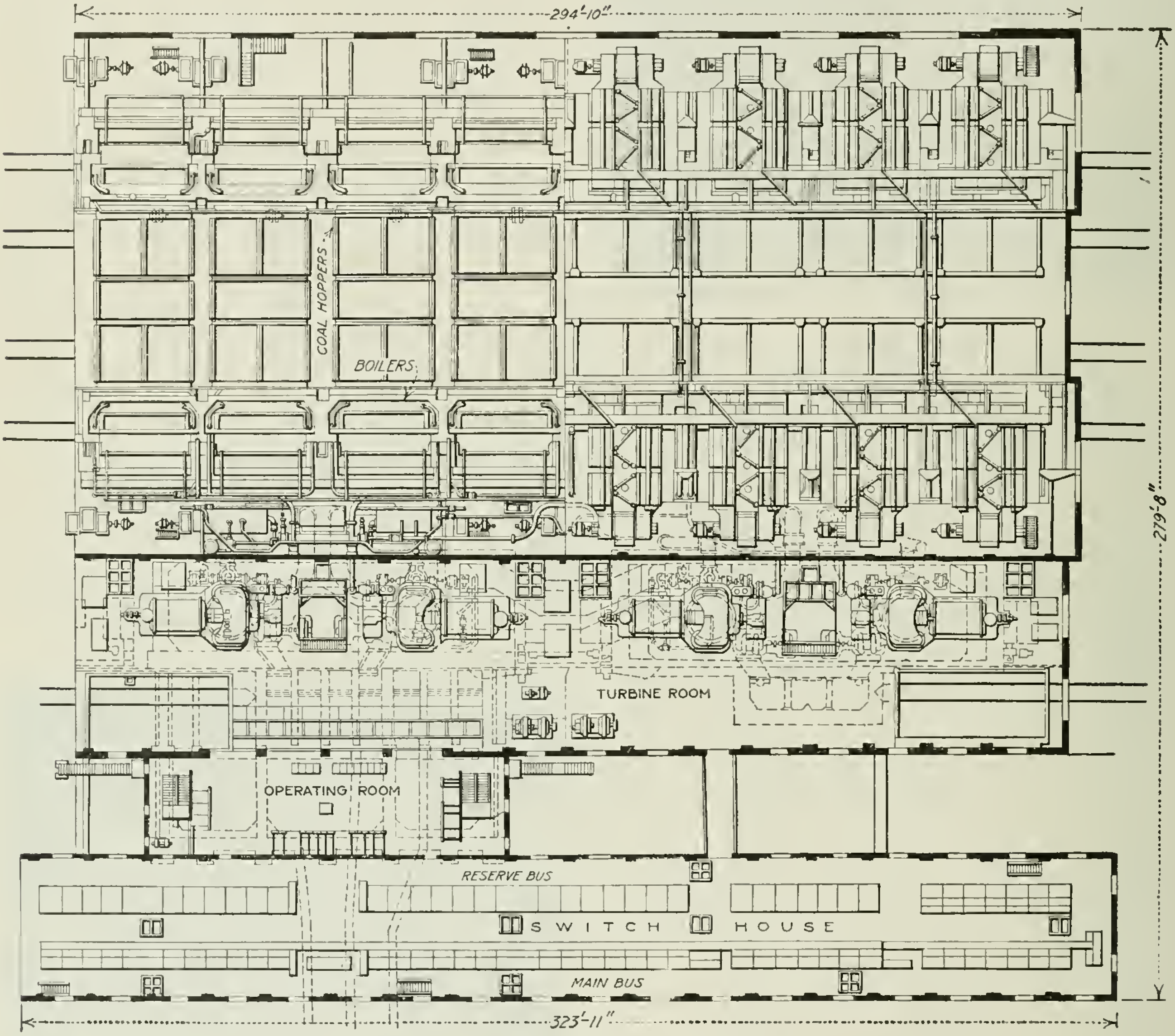


FIG. 6. PLAN VIEW OF THE STATION

In the ultimate layout the six 30,000-kw. 11,000-volt three-phase 60-cycle generators will be arranged for connection to a double-bus system composed of a main bus and a reserve bus parallel to it. The main bus will operate on the ring system, and although the reserve bus will not be operated as a ring at present, space has been left to install the ring connection at a later date if it is thought advisable. For each station unit there is a bus unit so designed as to limit the possible interchange of power between bus sections to an amount well within the guarantee of the oil-switch manufacturers. Between each bus section there is a 5 per cent. reactor, which may be placed in or taken out of the bus by opening or closing a reactor short-circuiting switch. When the generators are paralleled on the bus, they are separated by these current-limiting reactors. In this connection a unique automatic control feature has been worked out. The control circuit for operating the generator switch on the main bus and the reactor short-circuiting switch are electrically interlocked so that when the generator switch is closed, the reactor switch is open and vice versa. This prevents generators being placed on the bus without reactors between them. Provision is made for independent operation of these switches when necessary. Fig. 7 shows a single-line diagram of the main electrical connections of the plant.

The 11,000-volt cables from the turbines are arranged for connection with the 11,000-volt busses in the switch-house through either of two 2000-amp. oil switches. The busses and switch cell structures are on the turbine-room floor level. The reactors, potential transformers, current transformers, cable terminals, lightning arresters, switch gears and storage batteries which are also in the switchhouse are on the floor below. Beneath this lower floor are cable tunnels which extend out into the high-tension switchyard, carrying power cables in fiber conduit laid in concrete and control cable in iron conduit on racks.

Each turbine is provided with its own direct-connected exciter, the rating of which is sufficient to carry two generators in an emergency. The rating of each exciter is 210 kw. and the energy required for the maximum field of one machine is 140 kw. Further provision for emergency excitation was made by the installation of a 250-volt exciter bus running the full length of the station. Arrangements are made for connecting all machine exciters and all machine fields to this bus. The bus is also served by a 150-kw. motor-generator set, which was installed with the first two units. Space has also been reserved for an excitation storage battery which will be installed later. There is a voltage regulator on each machine exciter and on the separate motor-driven exciter which supplies the excitation bus.

Each unit is provided with an 1800-kv.-a. three-phase transformer to step down the potential from 1100 to 550 volts to drive the motors of its own auxiliary equipment. The electrical requirements of auxiliaries attached to one unit are about 1500 kv.-a. The stoker motors are not included in this aggregate since they are direct-current machines and are operated from 600-volt motor-generator sets which also supply cranes, hoists, automatic elevators and coal-mining equipment. Two 1800-kv.-a. station auxiliary transformers, in addition to the one attached to each turbine, are operated from the 11,000-volt bus section, and supply motors about the station which are not directly connected with any particular unit. They also supply energy for operating the motor-generator sets which furnish energy for the direct-current auxiliaries.

The feeders leaving the station can be divided roughly into four groups: The 11,000-volt feeders which supply local industries; 25,000-volt feeders which supply a network of the West Penn system; 66,000-volt feeders which supply some of the lines of the American Gas and Electric Co.; 66,000-volt feeders, which will ultimately operate at 130,000 volts and which serve a part of the West Penn system; and 130,000-volt feeders serving the longer lines of the American Gas and Electric Co.

All the feeders leaving the station are laid out on the radial system, arrangements being made for parallel operation of two lines in case of emergency. It is understood by operators, however, that radial operation is preferred and that parallel operation is an emergency measure.

Each of the 11,000-volt feeders is equipped with a 3 per cent. current-limiting reactor. These 3 per cent. reactors, like all other reactors in the plant, were not arbitrarily chosen, but were selected to limit the current that might flow into a short to a value well within the rating of the smallest oil switch in the circuit.

All of the 66,000- and 130,000-volt transformers are wound so as to be interchangeable. Furthermore, the 66,000-volt units are arranged so that they may be operated later at 130,000 volts. To provide further flexibility, arrangements have also been made for connecting together the 66,000-volt busses in the high-tension yards of the two companies.

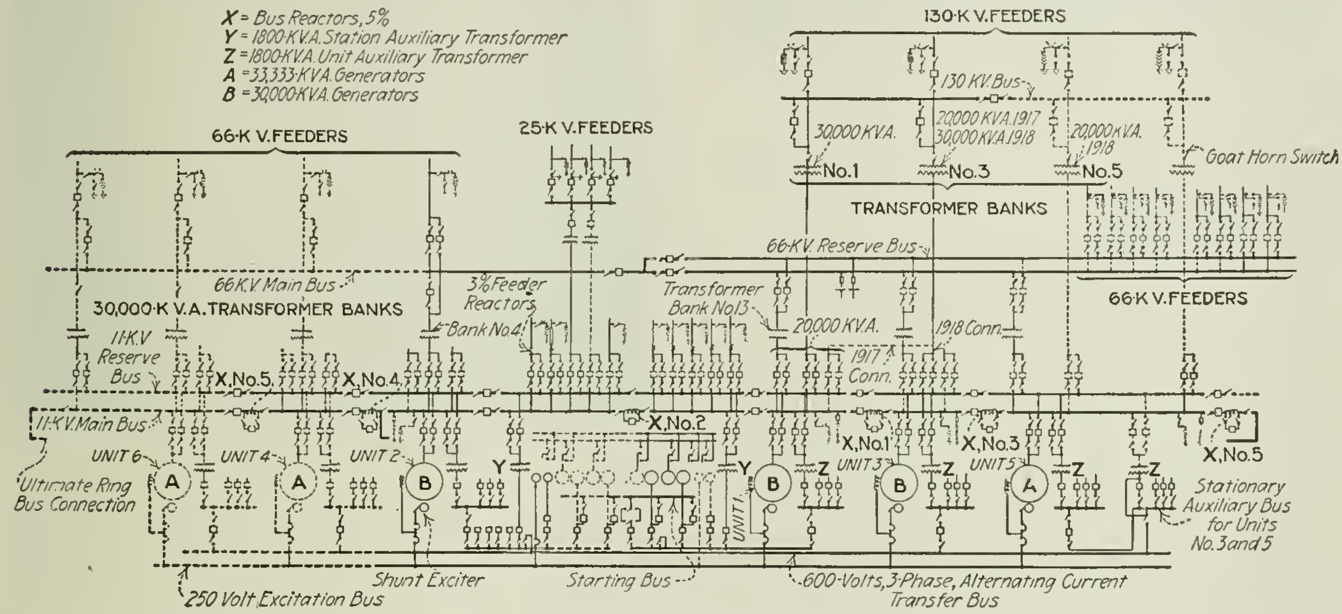


FIG. 7. SINGLE LINE DIAGRAM OF THE MAIN ELECTRICAL CONNECTIONS OF THE WINDSOR PLANT

From the main 11,000-volt bus the energy which is to be transmitted at 130,000 volts leaves the station through 30,000-kw. banks of transformers, the low-tension switches for which are located inside the station, Fig. 9. In the 130,000-volt yard the transformers are tied in solid on the low-tension side. Here a high-tension transfer bus is provided, so that the load from any outgoing 130,000-volt line can be distributed over other operating banks of transformers in case it is necessary to shut down one bank.

In the 66,000-volt yard of the American Gas and Electric Co., a double 66,000-volt bus has been provided; it is at present supplied by a bank of 20,000-kv.-a. transformers, and all outgoing 66,000-volt feeders are connected to this bus. Provision is made for the future installation of a bank of 66,000-volt transformers when the load conditions require it.

In the West Penn high-tension yard the 66,000-volt bus is normally only a transfer bus, the energy being supplied through a bank of 30,000-kv.-a. transformers. The same provision for flexible operation is made in the yard as obtains on the 130,000-volt bus of the American Gas and Electric Company.

The control of turbines, exciters and auxiliary transformers is centered on a benchboard so located in the operating room that the operator faces the turbine room while handling the equipment, Fig. 8. A glass partition between the operating room and the turbine room permits a view of practically the entire floor of the latter. Outgoing feeders are controlled from a vertical switchboard at the opposite side of the room from the benchboard. Voltage regulators and curve-drawing instruments are located on pedestals at the center of the room. The 600-volt direct-current board and the watt-hour meter board are at opposite ends of the operating room. This arrangement places the switchboards requiring the most attention at the most convenient location for the operator. It was also thought advisable to place the battery-charging equipment and panels in an alcove off the operating room, where they are readily accessible to the switchboard operators. One of the unusual features in this room is a provision for reading the temperatures of transformers in the high-tension yard and the temperatures of important parts of the 30,000-kw. generators. Alarm bells and lamps are also placed here to warn operators of any interruption in the flow of cooling water to the high-tension transformers.

FIG. 8. PARTIAL VIEW OF THE OPERATING ROOM

The 11,000-, 25,000-, 66,000- and 130,000-volt feeders are all equipped with induction-type inverse time-limit relays. The transformers are protected by definite time-limit relays. The 25,000- and 66,000-volt relays are given a minimum setting of two seconds. The 130,000-volt relays are set for three seconds. The transformer relays have a minimum setting of three seconds. The 11,000-volt feeders will supply only local territory.

The design and construction of the station, including the high-tension yard of the West Penn Power Co., were carried out by Sargent & Lundy, consulting engineers, Chicago. The high-tension yard of the American Gas and Electric Co. was handled by the Electric Bond and Share Co. The subcontracts for the building foundations, the high-tension yard foundations and the railroad foundations were all awarded to the Foundation Company of America. The Riverside Bridge Co. was awarded the contract for the steel.

FIG. 9. A BATTERY OF OIL SWITCHES

PRINCIPAL EQUIPMENT OF THE PRESENT WINDSOR, W. VA., POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Turbines	Steam, horizontal	30,000-kw., 80 per cent. power factor	Main generators	11,000-volt, 3-phase, 60-cycle, 1,800 r.p.m., 230 lb. steam, 200 deg. superheat	General Electric Co.
8	Boilers	B. & W. water-tube	12,625 sq ft. heating surface	Main steam generators	250 lb. pressure, 250 deg. superheat	Babcock & Wilcox Co.
8	Cleaners	Soot		Boiler tubes	With steam pressure	Diamond Power Specialty Co.
8	Stokers	Front inclined underfeed	14-retort	Boiler furnaces	Motor-driven, silent-chain drive	Westinghouse Elec. & Mfg. Co.
8	Motors	Direct-current	35-kw	Driving stokers	600-volt d.c., variable-speed	Westinghouse Elec. & Mfg. Co.
8	Economizers	High-pressure	8,256 sq.ft. heating-surface	One with each boiler	Placed above the boilers	B. F. Sturtevant Co.
8	Fans	Multivane, double-suction		Induced draft	290 r.p.m., placed above boilers	B. F. Sturtevant Co.
8	Motors	Induction	60-hp	Driving induced-draft fans.	290 r.p.m., 500 volts, 3-phase, 60-cycle.	Westinghouse Elec. & Mfg. Co.
8	Fans	Conodial, double-suction	3,500 lb. air per min.	Forced draft	Placed back of boilers, motor-driven	Buffalo Forge Co.
8	Motors	Induction	100-hp.	Driving forced-draft fans.	500 volts, 3-phase, 60-cycle	Westinghouse Elec. & Mfg. Co.
4	Stacks	Steel, brick-lined	150 ft. high. 13½ ft dia	Three boilers per stack	With forced and induced draft.	
2	Condensers	Leblanc, surface	50,000 sq.ft	With main turbines	29.2 in. vacuum expected with 75-deg. water	Westinghouse Electric & Mfg. Co.
2	Pumps	Double-runner	50,000 gal. per min	Circulating water to condensers	350 r.p.m., motor-driven	Worthington Pump & Machinery Co
2	Motors	Induction	600-hp.	Driving circulating pump.	350 r.p.m., 550-volt, 3-phase, 60-cycle	Westinghouse Elec. & Mfg. Co.
2	Heaters	Open		Feed-water heating	Takes water from primary heater	Warren Webster & Co.
4	Pumps	Turbine	6-in	Boiler feed	One motor, three turbine-driven	Worthington Pump & Machinery Co.
1	Motor	Induction	300-hp	Drives 6-in. boiler-feed pump	1,750 r.p.m., 500-volt, 3-phase, 60-cycle	Westinghouse Elec. & Mfg. Co.
3	Turbines	Horizontal	300-hp	Drives 6-in. boiler feed pumps	Direct-connected	Westinghouse Elec. & Mfg. Co.
2	Pumps	Turbine		Station service and makeup water	One motor, one turbine-driven.	Worthington Pump & Machinery Co.
	Screens	Revolving		Condenser intake	Continuously	Chain Belt Co.
	Cranes, traveling, for turbine and boiler rooms					Whiting Foundry and Machinery Co.
	Oiling system					Richardson-Phenix Co.
	Equipment for American Gas & Electric Co.'s high-tension yard					General Electric Co.
	Equipment for West Penn. Power Co.'s high tension yard					Westinghouse Elec. & Mfg. Co.

Effect of the War on Engineering Education

By C. R. Mann

The engineer, not the banker, the real power behind the throne. He is vitally involved in the control of credit, in the interpretation of the daily news and in the organization of industry and commerce. There must be closer coöperation between school and industry. The war has revealed a profounder appraisement of human values and costs and has hastened the transformation of the individualistic man into a community man willing to do his best for the common welfare. The day of the real industrial university is at hand.

THREE years ago most of us thought that a world war could not last long because, however much kings and kaisers might wish to continue, the banker would stop it. But the financiers have not come up to our expectations in this matter, and we have therefore been compelled, unwillingly perhaps, to recognize that money is not the ultimate measure of national strength. National credit is the result and not the cause of intelligent industrial production; the engineer, not the banker, is the real power behind the throne.

This fundamental fact now seems so simple and self-evident that it is rather hard to remember the time when we thought otherwise. But though the rugged outlines of this fact are now sharply silhouetted against the ruddy dawn of the new age, the details of its meaning are but dimly discernible through the haze of speculation over the significance of the struggle. Naturally, the engineer is intensely interested in the development of the details of the picture, for on him devolves the duty of interpreting the coming conceptions in terms of materials and organizations of men. And if education makes men, engineering education must be the first to feel the thrill of the dawning day.

Three Elements Can Be Perceived

Three elements in the picture can now be plainly perceived. These indicate that the engineer is from hence forth vitally involved in the control of credit, in the interpretation of the daily news, and in the organization of industry and commerce to make goods cheap and men dear.

In performing the first of these new functions the engineer becomes the partner of the banker to determine which projects are worthy of financial support and which not. As the engineering spirit is more and more infused into this dispensing of credit, public service rather than excess profit becomes the inspiration for enterprise; intelligence in production becomes the best security for loans; ability to deliver the goods becomes the sure basis of financial success; and the control of tools gradually passes from the hands of those who own them legally into the hands of those who can use them effectively.

Newspapers and periodicals already sense the expansion of the engineering spirit in the struggle to make the nation strong. The distribution of wheat, the supply of sugar, the transportation of coal and the price of bread are now subjects that occupy an amount of space in the daily press that only a Thaw trial could formerly command. The public has never before realized how vital and how interesting factories, freight cars, warehouses, terminals, trucks and ships really are. Some faint conception of the necessity of organization for the common project of liberating life by winning the war seems to be taking shape; while an impelling desire to serve and to subordinate personal preferences to community interests appears to be dimly developing. These faint feelings of fraternity may grow into driving impulses if editors continue to extol engineering enterprise rather than private profit in their interpretations of the daily news.

Engineers Have Organized To Build Up Business

In many communities chambers of commerce or groups of engineers have organized to build up business and boom the town. Through their efforts living conditions have been improved and many a city is being made a better place for homes. But the progress has always been hampered by the vested rights of individuals and of corporations, so that none has yet dared to envisage an entire community as a single working plant for the purpose of organizing it for the most intelligent production of human wealth. This can now be done. The war is opening many hitherto blind eyes to see that each gains more than he loses when he merges his strength with the might of all in an organization that is constructed for the purpose of releasing creative energy by giving each the work he is best qualified to do.

The time has come for such an organization in every community and every state, because the Federal Government is struggling to shape the nation into an organization of this type. Only so may the nation be strong; only so many communities add their utmost to the nation's strength. The responsibility for this work must finally be shouldered by engineers who are both masters of the mechanic arts and molders of men.

For many years this country has been drifting toward the realization of these requirements. The war has but accelerated the process and precipitated conclusions that were bound to come, otherwise men trained by experience to meet the present crisis could not now be found. Continuity demands that the same conclusions remain valid long after the war is ended. Therefore, engineering schools will render service in proportion as they grasp the implications of these conclusions and express them effectively in the daily work of instruction.

Closer Coöperation Between School and Industry

The possible conclusions for engineering education are many and complex, but two stand out in bold relief; namely, there must be closer coöperation between school and industry, and there must be more attention to the appraisement of values and costs.

The essential feature of the coöperation with industry is not the skill, the knowledge of workmen, or the feel of the machines which the student acquires from shop experience. Important as these are, they cannot compete with the spirt of investigation which must develop if the coöperation between school and industry is real and vital. There are thousands of unsolved problems in even such rough shopwork as freshmen are permitted to do. The boy should be trained to discover these unsolved problems and to bring them back to school for discussion and solution. By making shopwork in industrial plants the source of problems for solution in school, and by relating the class and the laboratory work in some degree to the problems raised, conditions most favorable to the self-development of the student may be realized. As he progresses, the problems become more and more intricate; until in his last year, if he has shown real engineering ability, he may be assigned as helper in industrial research, either at the plant or in the school laboratories. After such a training in defining and solving problems, closely coördinated with instruction in science and drill in mathematics, he should be able on graduation to take a responsible position without serving several years as an apprentice as is usual under present conditions.

To the faculty this type of coöperation with industry brings incentives for creative work in production and in education. For coöperation makes the school the source of solutions of industrial problems, not only with respect to the technique of manufacture, but also concerning the correlation of the community's productive processes with the training of its citizens as intelligent workers. Hitherto manufacturing companies have stood aloof and regarded one another with suspicion—and the Federal Trade Commission discovered that 200,000 of them are not paying expenses; but now they are ready to coöperate. Similarly in education, many manufacturers are supporting corporation schools to train their own help, while more than half the children in the entire country quit school at the sixth grade without being trained to earn a living; but they too are now ready to coöperate. If the men who are teaching in engineering schools rise to the responsibility and organize for the systematic study of community production, they could soon create a true university, with its feet firmly planted in industry and its soul consecrated to the task of utilizing science and literature to liberate the creative energies of men.

Appraisement of Values and Costs

While close coöperation between school and industry gives that practical experience which is essential for mastery of the mechanic arts, it is not in itself sufficient to enable the schools to meet adequately the fundamental requirements of engineering in the new epoch. The Germans are technically well trained in the mechanic arts, yet they are but brutally strong. In order to strengthen the nation by infusing the engineering spirit in the control of credit, in the interpretation of the daily news and in the organization of industry for the production of human wealth, the engineer must have sound judgment in the appraisement of values and costs. This requires not only an understanding of finance and the meaning of money, but also a sympathetic appreciation of the things humanity holds to be most worth while. Even a practical project like building a bridge is ultimately controlled by some man's decision that the resulting value is worth the cost; and this decision is more difficult and subtle when it concerns profoundly the production of human wealth and the appraisement of human values and costs. The engineer is too often obliged to be only the employee of the bank, the corporation or the state commission, because he believed that engineering is wholly a matter of technical skill; when control in this, as in everything else, is really vested in the decision of the question whether the game is worth the candle.

The training in the appraisement of values and costs does not require the addition of formal courses for that purpose, but rather the injection of this point of view into every branch of school work. For example, experiments in chemistry need not always be of the type, "Analyze this baking powder." The project, "Make baking powder and find out if it is cheaper and better than any you can buy," is vastly more effective as a training exercise. Presented as a personal effort to appraise the human values and costs in life's experiences, literature fascinates engineering students. Economics delights them when it is a critique of proposed solutions of the social problems defined by their daily coöperation with labor. Such exercises also foster the development of those homely virtues which always make the working people the bulwark of a nation's strength—the sense of justice, feelings of neighborly kindliness, devotion to right and respect for God and man.

Opportunity of the Industrial University

Thus because the war has revealed a profounder appraisement of human values and costs, and because the war has hastened the transformation of the individualistic man, selfishly seeking his own personal profit, into a community man willing to do his best for the common welfare, the ideal that was set for the engineering schools in the passage of the Morrill Act in 1862 may now be achieved. For many of the first schools founded under that act were called "Industrial Universities"; but they soon dropped the "industrial" from their titles, fearing lest they lose caste in academic councils. But now, if they gladly grasp the opportunity opening before them, they will claim with pride their abandoned surname and proceed to demonstrate that the engineer, the creator of a new earth, is also the prophet of a profounder philosophy of life.

Carbon-Monoxide Gas Poisoning

Breathing of furnace gas, smoke in burning buildings, the "afterdamp" of explosions of coal dust, etc., has caused many deaths due to poisoning by carbon monoxide. How this kills is described in the Journal of the American Medical Association.

Carbon monoxide has an avidity for hemoglobin, the red coloring matter of the blood, with which it forms the same combination as does oxygen, only 250 times as powerful.

It is, however, a misapprehension to suppose that this combination is permanent. A man brought out to the fresh air, or, better still, to whom air mixed with oxygen can be administered, will generally recover if exposure is within the following limits.

As a rough estimate, it may be stated that usually a man will die who has breathed 0.2 per cent. of carbon monoxide mixed with air which is in other respects normal, for four or five hours, or 0.4 per cent. for one hour. With from 2 to 5 per cent. of carbon monoxide death follows almost as quickly as in drowning.

The Electrical Study Course—Commutator Construction

The construction, methods of insulating and different materials used for insulating commutators for direct-current machines are described.

In a previous lesson it was shown that if a single coil is connected to rings R_1 and R_2, as in Fig. 1, and revolves between the poles of a magnet as indicated, an alternating current would be caused to flow in the external circuit *C*. It was also shown that this alternating current could be changed into a current that flows in one direction—that is, a direct current—by connecting the ends of the coil to a divided ring S_1 and S_2, as in Fig. 2. This divided ring represents the simplest form of what is called a commutator on a direct-current machine. Fig. 2 also represents the simplest form of an armature, one that has only one coil revolving in a two-pole field. In the commercial type of direct-current generators a large number of coils, depending upon the size of the machine, are arranged on the armature and connected to a commutator.

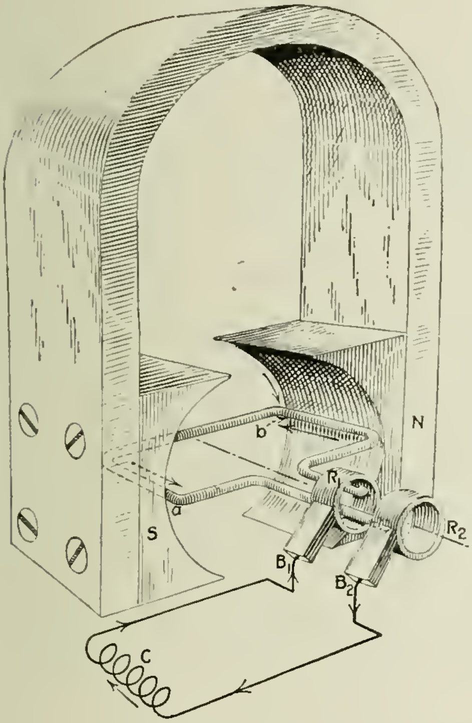


FIG. 1. ONE-COIL ALTERNATING-CURRENT GENERATOR

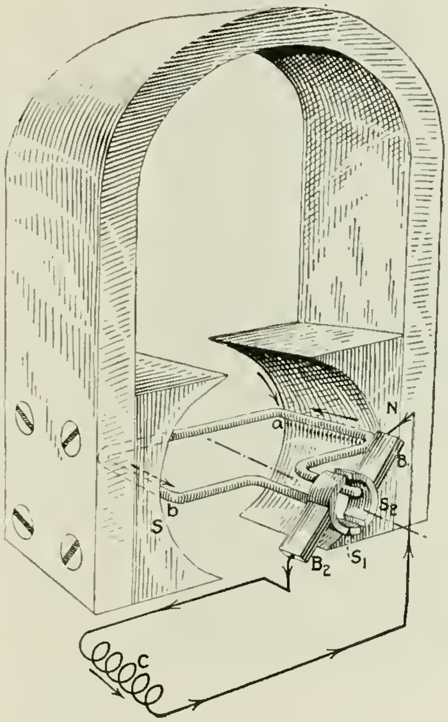


FIG. 2. ONE-COIL DIRECT-CURRENT GENERATOR

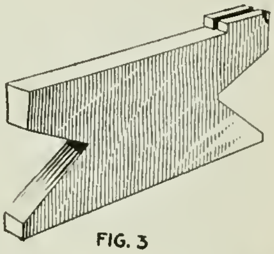


FIG. 3

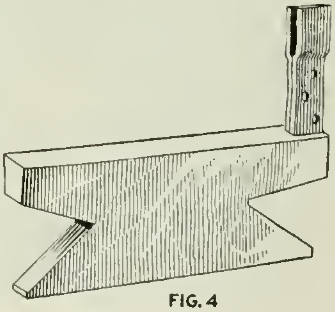


FIG. 4

FIGS. 3 AND 4. TYPES OF COMMUTATOR BARS

The commutator is made up of a number of copper segments similar to the one in Fig. 3, each segment being insulated from the other. These segments are slotted in one end, as shown, so that the armature-coil leads may be easily connected. Many of the large-sized commutators have an extension soldered to each segment or bar, as in Fig. 4, so that, instead of the coil leads being bent down to the commutator, they are brought out almost on a level with the periphery of the armature.

Fig. 5 shows a section through a common type of commutator. The black lines *A* across the surface are insulation, usually mica, between the segments. The heavy black lines *B* are also insulation, therefore it is evident that each segment is insulated from the iron or steel form. Each division on the commutator is called a bar or segment. The bars and insulation are assembled on the vee and sleeve *C*. Then the front vee, *D*, and its insulation are put in place and the nut *E*, which is threaded on the sleeve *C*, is screwed up as tight as it can be drawn. On account of the expansion and contraction of the commutator, caused by wide variations of temperature and strains due to centrifugal force, it is necessary that the clamping rings hold the bars and insulation very tight, or there will be a movement of the bars that will cause serious trouble.

The insulation used between the bars is usually mica or micanite, about $\frac{1}{32}$ in. in thickness, and in fact this is the only material that has been found that will stand up under all conditions. Micanite consists of thin flakes of mica built up into sheets and held together by a suitable binder. In some of the small-sized commutators, during the last two or three years, the bars are molded into the metal sleeve with an insulating compound. This construction for small-sized machines seems to give satisfactory results. In the early development of the art various material were tried for insulating commutators, such as red fiber, fish paper, asbestos, etc., and various combinations of these materials and also mica and other insulations built up in alternate layers, but all have been discarded.

One of the troubles with most of the substitutes for mica insulation in commutators is, they are easily eaten away in case of sparking at the brushes. Furthermore, all fibers or papers are subjected to more or less contraction and expansion due to moisture conditions. This eventually led to slight looseness between the bars and insulation, so that oil or copper and carbon dust could penetrate and cause pitting of the commutators. One of the chief requisites of a commutator insulation is that it shall not be affected by moisture and changes of temperature; also, it must possess a certain elasticity so that it will fill the space between the bars irrespective of the expansion and contraction of the commutator. So far, mica seems to possess these requirements to a greater extent than anything else. The story of commutator insulation is one of the most interesting chapters in the history of electrical development.

Many other kinds of commutator construction are used, especially in the older types of machines, besides that shown in Fig. 5, some of which are indicated in Figs. 6 and 7, from which it is seen that the general principle is the same. In the larger-sized machines the commutators are built upon a cast-iron spider, the same as the armature core. Fig. 8 shows a cross-section of a large commutator that is representative of large-sized construction.

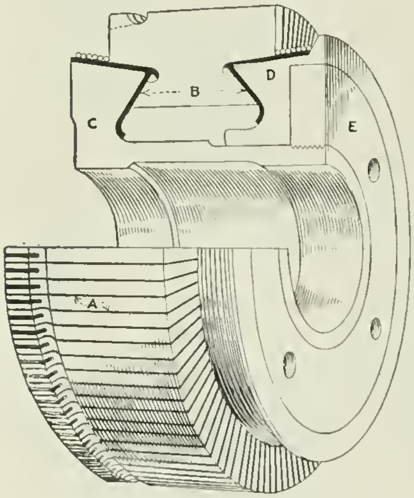


FIG. 5

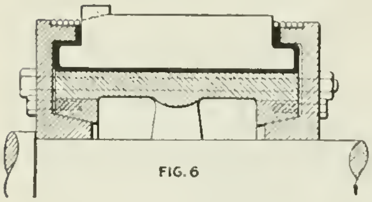


FIG. 6

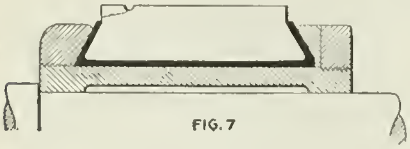


FIG. 7

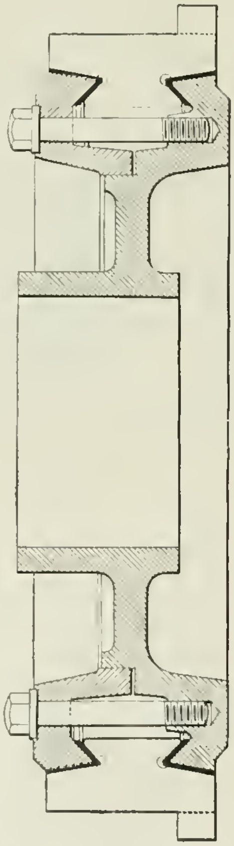


FIG. 8

FIGS. 5 TO 8. TYPES OF COMMUTATORS

In problem 1 given in the last lesson, the cross-section of the conductor was 18,750 cir.mils. The resistance per foot of copper is $R = \frac{10.7}{\text{cir.mils}} = \frac{10.7}{18{,}750} = 0.00057$ ohm. When 35 amperes is flowing through the conductor, the volts drop per foot is $E_d = RI = 0.00057 \times 35 = 0.01995$ volt.

Fig. 9 is a layout of problem 2 given in the last lesson. If the cross-sectional area of the line conductors is 6530 cir.mils, or No. 12 B. & S., then their resistance is that of 150 feet of No. 12 wire, from which $R_1 = 150 \times 0.0016 = 0.24$ ohm. The resistance is also $R_1 = \frac{10.7L}{\text{cir.mils}} = \frac{10.7 \times 150}{6530} = 0.24$ ohm.

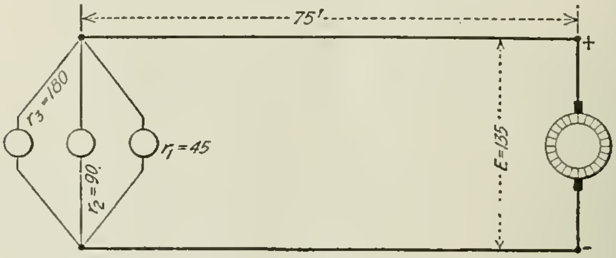


FIG. 9

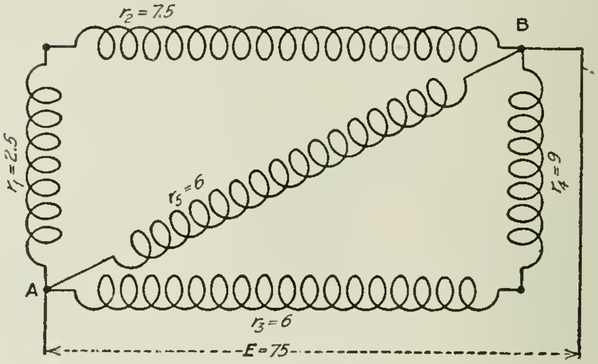


FIG. 10

FIGS. 9 AND 10. COMPLEX CIRCUITS

The joint resistance of the three lamps in parallel is

$$R_2 = \frac{1}{\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{r_3}} = \frac{1}{\frac{1}{45}+\frac{1}{90}+\frac{1}{180}} = \frac{1}{\frac{7}{180}} = \frac{180}{7} = 25.7\,ohms$$

Then the total resistance of the circuit is $R = R_1 + R_2 = 0.24 + 25.7 = 25.94$ ohms, and $I = \frac{E}{R} = \frac{135}{25.94} = 5.2$ amperes.

The value of the current in the circuits will be inversely proportional to their respective resistances; that is, since r_3 has the highest resistance of the three lamps, the value of the current in this circuit will be the lowest. Since r_2 is one-half the value of r_3, if one part of the current flows through r_3, two parts will flow through r_2, and as r_1 has only one-quarter the resistance of r_3, if one part of the current flows through r_3, four parts will flow through r_1. From this we can say that the current may be divided up into seven parts, one part flowing through r_3, two parts through r_2 and four parts through r_1. If seven parts equal 5.2 amperes, one part equals $\frac{5.2}{7} = 0.743$ ampere, two parts equal $0.743 \times 2 = 1.486$ amperes and four parts $= 0.743 \times 4 = 2.972$ amperes; that is, r_3 takes 0.743 ampere, r_2 1.486 amperes and r_1 2.972 amperes.

Another way of finding the current in the three circuits is to find the value of the volts E_a at the lamp terminals, and then by Ohm's law find the current in each circuit. The volts drop in the line is $E_d = R_1 I = 0.24$

$\times\ 5.2 = 1.248$ volts, and $E_a = E - E_d = 135 - 1.248 = 133.752$ volts. Then the current in r_3 is $i_3 = \frac{E_a}{r_3} = \frac{133.752}{180} = 0.743$ ampere; in r_2 is $i_2 = \frac{E_a}{r_2} = \frac{133.752}{90} = 1.486$ amperes; and in r_1 is $i_1 = \frac{E_a}{r_1} = \frac{133.752}{45} = 2.972$ amperes, which checks up with the values obtained by the foregoing methods.

1. In Fig. 10, find the joint resistance between points *A* and *B*. If points *A* and *B* are connected to a 75-volt circuit as shown, what will be the total current flowing in the circuit and the current in each branch?

2. At 115 volts a given circuit takes 15 hp. Find the current flowing in the circuit and the ohmic resistance.

Garabed: Boon or Buncombe?

Jules Verne in all his vivid imaginings never conjured up a more astounding and unbelievable story than that which is being told by Garabed T. K. Giragossian, a naturalized Armenian, who claims to have discovered a supply of free energy and to have invented and perfected a means whereby that energy can be converted into usable forms. He denies emphatically that it is perpetual motion or that it in any way controverts the law of conservation of energy, over which so many would-be inventors have tripped. He simply makes use of an inexhaustible quantity of energy that exists everywhere and that cannot be monopolized.

No one except the inventor has any information as to the exact nature of the free energy or the method by which it is used. He has firmly and consistently declined to divulge the secret until both the idea and the machinery for its development have been fully protected. This has been accomplished by the passage, on Jan. 16, of a joint resolution by Congress, authorizing the acceptance of the invention for the free use of the United States Government, protecting the inventor for a period of seventeen years, and providing for the appointment of five eminent scientists (to be approved by the Secretary of the Interior) to determine whether the discovery is a splendid benefaction or a stupendous bluff.

Mr. Giragossian, who is a citizen of Boston, has named his discovery the Garabed. With it he proposes to displace the steam engine as a prime mover. The steam boiler will be relegated to the scrap heap or the museum of antiquities. Smoke troubles will be at an end, for coal will be no longer needed for fuel. Petroleum will be used largely for making soap. The industries of the earth, the needs of the home, the illumination of cities, all the innumerable activities of humankind will eventually depend on the Garabed.

So far as it is possible to conjecture, the atmosphere is the inexhaustible reservoir of energy to which Mr. Giragossian refers, for, at a hearing before the House Committee on Patents, he was asked whether his process or contrivance is applicable to the submarine, and he declined to give an unequivocal answer. He does claim, however, that the motor by which he utilizes the free energy can be used for ship propulsion, haulage of railway trains, driving airplanes, production of electricity, pumping water, and doing the thousand-and-one things that have hitherto been done by steam engines and other types of motors; and he claims further that his motor will operate with the same certainty and regularity in all climates and at all altitudes, without human assistance.

The advantages of such a device—if it actually exists outside the imagination of Mr. Giragossian—are obvious. It is absolutely independent of auxiliary apparatus, for it is complete in itself, whereas the steam engine must have a boiler with its furnace, pump and other accessories. The Garabed is much smaller and lighter than the steam engine of equal output, is easily portable and will produce power anywhere at no cost other than the wear and tear on the machinery. With practically unlimited power at little or no expense, human labor will be vastly lightened and labor troubles will disappear. At the same time the productive capacity of industry will be enormously increased, and the present era of prosperity will be insignificant in comparison with that which will come when the Garabed is used universally.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GARABED T. K. GIRAGOSSIAN

The effect on social and economic conditions will be equally startling and revolutionary. Free energy in unlimited amounts will result in the production of an abundance of all those things necessary to the existence and comfort of the race. Thus, poverty will be wiped out and luxuries made the heritage of all.

Such prophecies as these have been made before and have been met by the sneers and laughter of all classes of people. Mr. Giragossian has not been exempt from ridicule; but his unwavering faith in himself and in the incalculable value of his discovery has made him indifferent to the derision of his fellowmen. For twenty years he has patiently pursued the task of developing his idea and rendering it available for general use. Three years ago he perfected the device, and since that time he has been trying to have it protected so that he shall not be robbed of the credit and the benefits of the invention.

The adoption of the joint resolution does not obligate the United States to buy the invention. If the committee of five eminent scientists decide that the Garabed is practicable, then the United States may, at its option, purchase from the inventor the exclusive right to utilize the discovery. The sum to be paid, in case the option to purchase is exercised, will be settled upon by a committee of even number, half of whom are to be selected by the Secretary of the Interior and the other half by Mr. Giragossian, and the verdict of this committee is to be subject to the approval of the Secretary of the Interior and the inventor. If the United States decides not to buy the invention, the rights of Mr. Giragossian remain, as guaranteed by the resolution.

It is significant that this man's enthusiasm, sincerity and intelligence so impressed the Committee on Patents and other members of the House that the resolution was adopted by a vote of 234 to 14. In the Senate it was approved without much debate, on the recommendation of the Patents committee. By this means the upper body relieved itself of being held up to ridicule in case the Garabed fails to demonstrate its inventor's claims.

TRUTH OF CLAIMS REMAINS TO BE PROVED

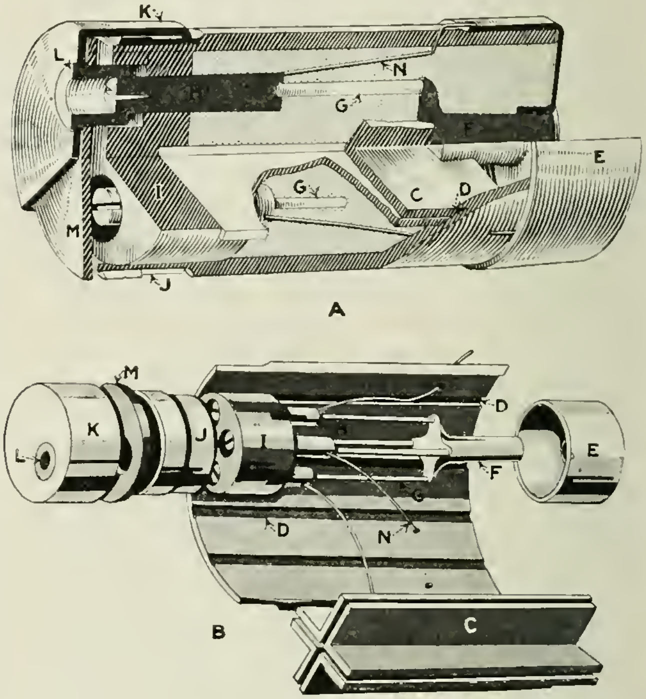
The ability of Mr. Giragossian to substantiate his assertions, by the exhibition of a motor that will run without the application of any of the commonly known forms of energy, remains to be proved. The inventor himself is confident and unperturbed, reiterating that he can and will do all that he has promised, and more. If he succeeds, as everyone would be glad to see him, the United States will have in its possession an agency by which the war can be brought to an end with stunning suddenness and certain victory; and in the peaceful years that will follow, the same agency will give to the nation an increase in material prosperity and happiness such as the world has never seen.

It is foolish to regard Mr. Giragossian as a harmless lunatic. That which he proposes is fantastic in the extreme and subversive of fixed ideas. But it must be remembered that people ridiculed the possibility of the airplane, the wireless telegraph and scores of other scientific discoveries that have now become familiar factors in everyday life. We are in an age of searching investigation and rapid development. The impossibilities of yesterday are the achievements of today; dreams of yesternight are realities tomorrow. It is unwise and unsafe to pass judgment on the discoverer of the Garabed. If he proves his assertions, the world will acclaim his genius and laud his perseverance. If he fails, his extravagant promises will be a boomerang that will knock him into the darkest corner of that limbo reserved for perpetual-motion cranks and other power-generating fakers.

Four-in-One Cartridge Fuse

No doubt many readers will recall the description of the Six-in-One plug fuse appearing in the July 11, 1917, issue of *Power*. Recently a four-in-one cartridge fuse, known as the Atlas fuse, has been placed on the market by the Atlas Selling Agency, New York City. A sectional view *A* and a view *B* of the fuse exploded are given in the figure.

From the outside this new type of fuse looks the same as the standard type of cartridge fuse and can be used anywhere that standard fuses are used. However, instead of a single chamber, as in the ordinary type of cartridge fuse, the inside of the shell is divided into four compartments by four pieces of fiber, bent and assembled as shown at *C* in both views. The fiber compartments fit into grooves *D* in the fiber-containing shell, making a very strong construction.



SECTIONAL VIEW AND PARTS OF FOUR-IN-ONE CARTRIDGE FUSE

One end of the fuse shell is equipped with a stationary brass cap *E*. From the center of this stationary cap is a copper extension *F* from which four fuse wires *G* run through the four separate compartments to four copper terminals *H* held in a short solid-fiber cylinder *I* at the opposite end of the fuse. On the end of the fuse shell containing the four copper terminals *H* and fiber cylinder *I* is placed a stationary brass ferrule *J*. Fitted over the stationary ferrule is a movable brass cap *K*, containing a copper receptacle *L* that fits over one of the copper fuse terminals *H*, as shown in the sectional view. This completes the circuit through the fuse from the movable cap *K* to the stationary cap *E*. The copper terminals *H* are slotted in the end that the receptacle fits over, to give them a spring and make a good contact in the receptacle.

If a fuse blows, all that is necessary is to remove the cartridge from the clips, pull cap *K* out about ¼ in. and give it a quarter turn, push back the cap and another fuse element is in circuit. Replace the cartridge in the clips and the circuit is again ready for service. To prevent making contact with any fuse element other than the one that is intended to be in circuit, a fiber washer M is placed in the top of the movable cap K. The blowing of a fuse element is indicated as in a standard fuse, by a fine steel wire N, that extends from the copper terminal H to the stationary cap E. Each fuse element is solidly packed in its chamber with an insulating powder. This new type of fuse is approved by the Underwriters' Laboratory and is made with ferrule contacts in all amperages up to and including 60. All measurements and dimensions are N. E. C. standards, thus assuring a perfect fit in every type of N. E. C. standard panels, switchboard and inclosed-fuse cutouts.

Velocity of Air in Ducts

After the velocity head of air in a chimney or duct is found by means of a manometer or U-tube, its velocity is calculated by the formula,

$$v = \sqrt{2gh}$$

where v = velocity in feet per second, h = velocity head in feet, and g = acceleration due to gravity in feet per second = 32.16 feet.

When the manometer contains water and the velocity of air is being determined, the head must be changed from inches of water to feet of air by multiplying by the ratio of the density of water to that of air. To do this the temperature of each must be known, as the weight of a cubic foot of air or water changes with variation in temperature. To illustrate, assume that the manometer reading h (the difference in level) is one inch of water and that the temperature of the water and of the air is 60 deg. F. From standard tables, the weight of one cubic foot of water at 60 deg. is found to be 62.37 lb. and of a cubic foot of air at the same temperature is 0.0764 lb., or the height of the column of air in feet to represent the same pressure as one inch of water would be $\frac{62.37}{0.0764} \times \frac{1}{12} = \frac{816.4}{12} = 68.03$ ft. In other words, water is 816.4 times as dense or heavy as air at the temperature taken, so that a column of air 816.4 in., or 68.03+ ft., would equal or balance a column of water one inch high or that difference in level in the U-tube manometer. Then applying the equation, the velocity of the air is found to be

$$v = \sqrt{2gh} = \sqrt{2 \times 32.16 \times 68.03} = 66.2\ \textit{ft. per sec.}$$

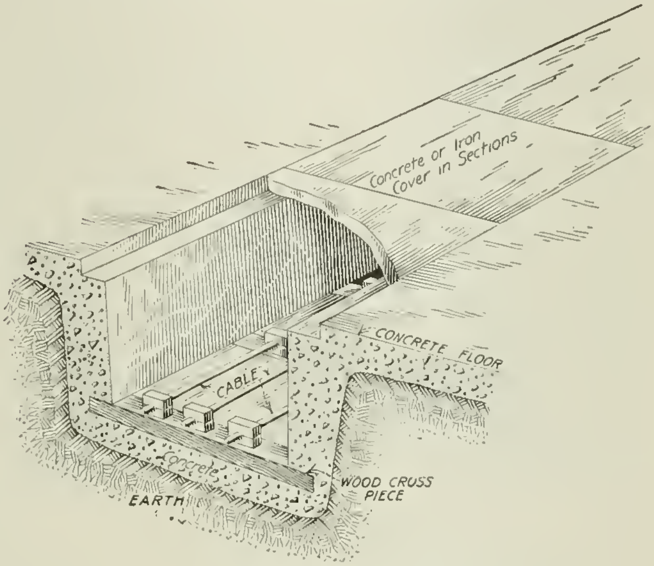
For any other temperatures, or if mercury is used in the manometer in the place of water, the proper weights per cubic foot will have to be used.

Installing Electric Cables Under Concrete Floor

By D. R. Shearer

Sometimes it becomes necessary to run heavy light and power cables under concrete for some distance, as for instance, from the generator to the switchboard in a power plant or from the transformers to the switchboard in a substation. Of course conduit is an excellent runway for such cables, but at times this is difficult to secure and some substitute becomes necessary.

An excellent method is to place a trough form in the earth floor before the concrete floor is laid. On the bottom of this form are placed cross-pieces of creosoted wood about three feet apart and slightly longer than the trough is wide. After the concrete sets the form is taken out, leaving the cross-pieces embedded in the bottom of the cement trough.



SECTIONAL VIEW OF CABLE DUCT

The cables are then cleated to the cross-pieces with porcelain cleats and heavy screws. Either iron or reinforced concrete may be used as a cover for the duct. This can be removed at any time for cleaning the cables or attaching other leads. The figure gives a sectional view of the duct construction.

To Determine Heating Requirements

By M. William Ehrlich

Under the present stress it is more important than ever to provide adequate heat for the comfort of workers, lest quality and output be impaired. Suppose a case of a corner office or workroom that could not be heated satisfactorily although it had been figured by the old rule allowing one square foot of direct steam radiation to take care of 80 cu.ft. of space and accordingly a radiator having 30 sq.ft. of heating surface was installed. Experience has shown this to be wrong. The mistake was made in using a thumb-rule to arrive at the radiator size. This has often proved to be a dangerous procedure unless seasoned with judgment based on ripe experience.

The cubical contents of a room have but little to do with its heating requirements. They enter into the question only as regards air leakage or ventilation, and in direct heating this factor depends mainly on the infiltration of air leaking through the door and window crevices. This has been found to average one air change per hour when doors and windows are closed. When some form of ventilation is desired, more air may be admitted through windows or otherwise, and the radiators must be proportionately larger to take care of this air change in the room. The cubical contents of the room are therefore taken to represent one change of air an hour which is usually but a small portion of the heating requirements, as will be shown. What does count, however, is the weather exposure and the materials used in the wall construction. The "exposure" is that part of the wall of a room or building which is subjected to the direct action of the outside weather, such as the walls, windows and doors facing on a street or other open space and also the roof. The chief heating work to be done depends on the losses through such exposed surfaces and is a component of the aggregate of such surfaces, their material and thickness and the difference in temperature between the indoor and the outside air. Thus, when it is —5 deg. outside and 65 deg. indoors, the difference is 70 deg., or with +10 deg. out of doors and 70 deg. indoors the difference in temperature is 60 deg. A temperature difference of 70 has become a standard for calculating radiator sizes in the eastern section of this country as well as elsewhere if climatic conditions are similar.

The demand on a heating system naturally varies with the fluctuations of the outdoor temperature, but the radiators must be selected to adequately serve the maximum difference in temperature. The total heat loss for any condition is the sum of the transmissions through all the surfaces and for air change, for any difference in temperature between inside and outside air.

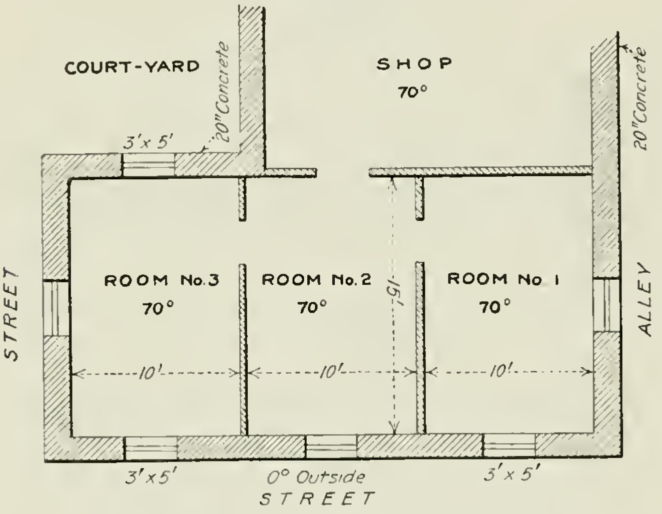


FIG. 1. CONTRAST IN HEATING REQUIREMENTS

As an illustration take a room arrangement as shown in Fig. 1, where each of three offices adjoining has a cubical contents of 1500 cu.ft., or an inside measurement of 10 x 15 ft. with a ceiling height of 10 ft. The windows are 3 x 5 ft. each and the outside temperature is taken at zero while 70 deg. is maintained indoors. Room No. 1 has two outside walls, a gross exposure of (15 and 10 times 10 ft. high) 250 sq.ft. Two windows (30 sq.ft. of glass) deducted from 250 leaves 220 sq.ft. net for exposed wall. No. 2 has one (10 × 10) 100 sq.ft. gross wall exposed to the weather, less 15 sq.ft. for the window, leaving 85 sq.ft. net wall exposure. No. 3 has three sides 10 + 15 + 10 = 35 times 10 ft. high, or 350 sq.ft. gross wall exposed, less three windows, or 45 sq.ft., leaving 305 sq.ft. net wall exposure. With such great differences in the surfaces through which heat is lost, each room will require a different amount of radiation, but on the basis of cubical contents each would get a radiator of the same size or, say, 80 cu.ft. to one square foot heating surface would be 1500 ÷ 80 = 18¾ sq.ft. This, obviously, cannot be right for three such conditions.

To properly determine what the radiation should be involves a series of computations. To eliminate this figuring the chart, Fig. 2 (p. 225), has been prepared for low-pressure steam and hot-water heating by direct radiation and a difference in temperature of 70 deg. The use of the chart for practical purposes is quite simple as it is only necessary to know the material and thickness of the exposed wall as shown on the scale at line *A*, and the square feet of this exposure as shown on scale *B* In case of air leakage or ventilation this same scale is used for reading cubic feet of air per hour. With these factors determined by examination and measurement or from plans, it is only necessary to lay a straight-edge across from point to point and read the answer from scale *C* for either steam or hot-water heating, adding together the amounts so found for the final answer. For example, take a 16-in. brick wall that has an exposure of 190 sq.ft. net. What is the amount of radiation necessary to compensate for the heat loss through this exposure? Laying a rule across from scale *A* at the point marked for a 16-in. brick wall to 190 on scale *B* gives, as shown, an intersection at scale *C* at 13 sq.ft. steam or about 21 sq.ft. hot-water radiation. The wall exposure is, however, only a part of the total heat loss a radiator would be called on to compensate. The total heat requirement is, of course, the sum of the losses through all exposures and air leakage. In the case of the three rooms shown in Fig. 1 and assuming the outside walls are of 20-in. concrete, the radiator sizes for steam would be found, by the use of the chart, as follows:

Room No. 1:	Determined from Plan, Fig. 1	Readings from Chart, Fig. 2, Sq. Ft. Radn.
Net exposed wall	220 sq ft.	23.0
Windows (single glass)	30 sq.ft.	9.7
1 Air change (contents)	1,500 cu.ft.	7.5
Total radiation		40.2
Room No. 2:		
Net wall	85 sq.ft.	9.0
Glass	15 sq.ft.	4.9
Air change	1,500 cu.ft.	7.5
Total radiation		21.4
Room No. 3:		
Net wall	305 sq.ft.	32.0
Glass	45 sq.ft.	14.8
Air change	1,500 cu.ft.	7.5
Total radiation		54.3

These values are all determined by placing a straight-edge from values on scales *A* and *B* and reading the answers directly from scale *C*. However, 1500, the cubical contents, is not on the chart, so 500 was selected of which 1500 is a multiple. For one air change and 500 cu.ft. the result on scale *C* for steam is 2.5 sq.ft. This multiplied by 3 gives 7.5 sq.ft. as the radiation required to compensate for air leakage. This same method may be relied on for any other values not found on scale *B*, which is limited to 1000. The different values found when added together give the size of radiator required for the given condition, then the nearest commercial size radiator or a pipe coil of the required capacity is made up.

By comparing the results found on a heat-loss basis with those of the thumb-rule ratio method, which gave only 18¾ sq.ft., it is seen why there would be difficulty in heating the corner rooms.

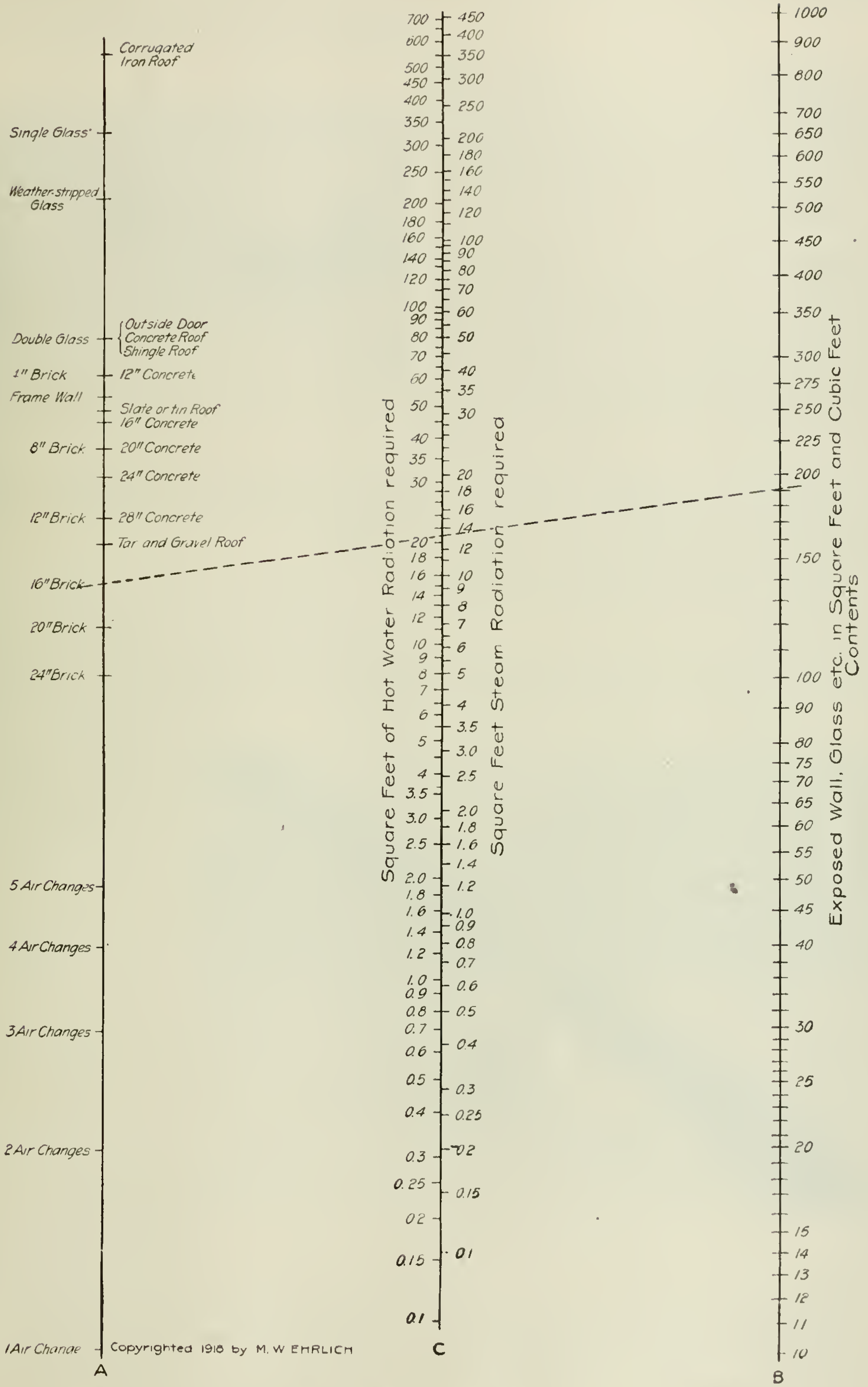


FIG. 2. GRAPHIC METHOD OF DETERMINING THE AMOUNT OF RADIATION REQUIRED

Self-Contained Portable Scoop Conveyors

The handling of coal from railroad cars to the storage pile is often expensive, and the more automatic and simple the apparatus can be designed the less the labor and operating cost involved. There are several types of portable conveyors manufactured, and among them is the portable scoop conveyor made by the Portable Machinery Co., Inc., Passaic, N. J., the design and application of which are shown in the accompanying illustrations.

This machine is of the belt type, and it may be driven either by a self-contained motor or by an internal-combustion engine. It is called a scoop conveyor because the conveying belt receives material through a scoop that can be pushed into the material to be handled. The machine, Fig. 1, is handled by one man in loading or unloading, stacking or reclaiming loose material, such as coal, coke and ashes, at a rate of about one ton per one and one-half minutes.

When used to handle from coal hopper cars, the scoop end of the conveyor is run in on the car and the coal can be elevated from the track level, a distance of from six to nine feet to a storage pile. One advantage of this machine is that by using two or more conveyors, as shown in Fig. 2, the coal can be elevated in successive stages until the storage pile has reached any desired height without the necessity of resorting to shoveling, thus saving in labor.

When used in reclaiming coal from a storage pile, the scoop end of the conveyor is pushed into the pile and the coal is discharged into the car for conveying it to the boiler room. If a storage pile is such a distance from the car track as to be out of the range of the machine, a second unit can be used, the first one discharging into the scoop of the second, which discharges in turn into the car. In this way the coal can be conveyed any distance, the only limit being the number of machines used.

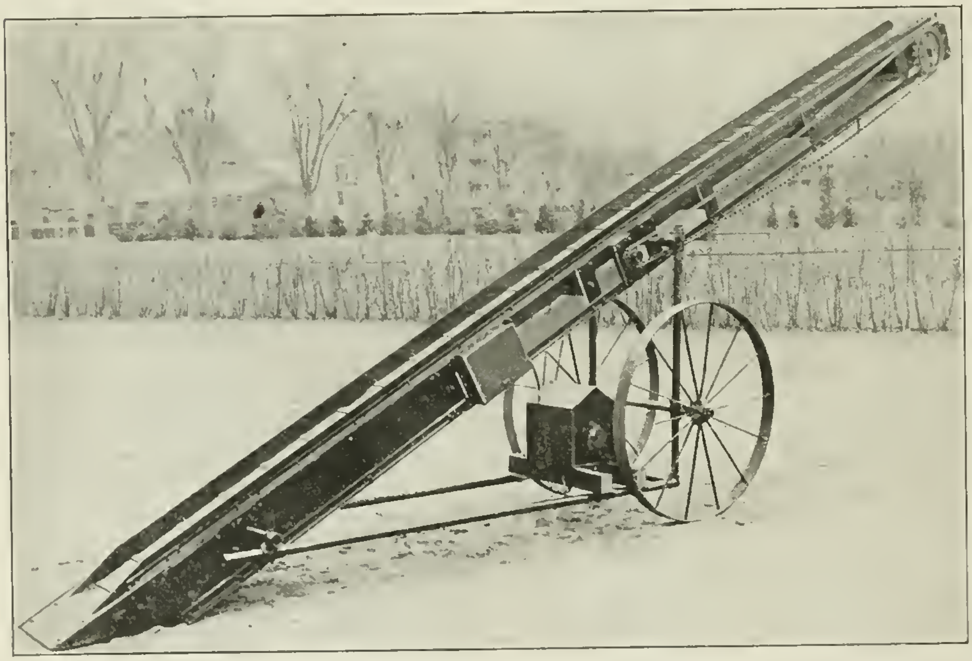


FIG. 1. PORTABLE SCOOP CONVEYOR WITH SELF-CONTAINED MOTOR

The conveyor is built of steel and is mounted on two wheels. The driving motor is mounted on a pipe frame, as shown in Fig. 1, and drives the belt by means of chains and sprockets. When the conveyor is to be moved, two lengths of pipe are inserted into the ends of the horizontal members of the pipe frame, which enables the machine to be easily wheeled from one place to another.

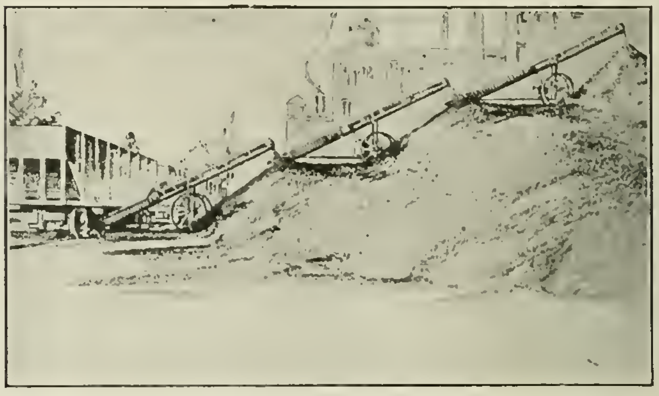


FIG. 2. UNLOADING CAR WITH THREE CONVEYORS

Handling Feed Water at River Station

It will be remembered that in the Feb. 13, 1917, issue of *Power* there was published a description of the River Station of the Buffalo General Electric Co., Buffalo, N. Y. One of the features of this station is the evaporator system for evaporating makeup water. The boilers are run at 300 to 400 per cent. rating, owing to the load demands increasing far more rapidly than plant expansion, the serious situation in load having been brought about by the withdrawal of water power by the Canadian government. The evaporator system has been in service now for nearly a year, and *Power* readers doubtless will be interested to know how the boiler-feed water is taken care of.

The evaporators (Reilly multicoil) are working up to the limit owing to the heavy overloads on the boilers, so that they are not able to supply all the makeup water; but they do supply on the average 98 per cent. of distilled water for makeup purposes. Once every month the water in each boiler is blown down so that the water level is lowered about three inches in the gage-glass. The boilers are opened once every six months, and so far the conditions observed have been excellent. There is no scale, and nothing but a slight amount of mud is found on the lower tubes. There is no pitting.

Editorials

The Solution of Greater New York's Coal Problem

"COAL-DOCK facilities are the key to the whole situation!" exclaimed Harry Peters, chairman of the Conservation Committee of the New York Fuel Administration, when interviewed on January thirtieth. And Mr. Peters is right. We concluded so ourselves, as pointed out in the article, "While the Idle Millions Shiver," in last week's issue. The thousands of tons of coal piling up on the rails at the coal docks or piers where great numbers of barges wait and wait, and the acute shortage in the greater city show instantly that here lie the causes of congestion and shortage.

There is another factor. According to New England Fuel Administrator Storrow the New England States consume forty-two million tons per year, two-thirds to three-fourths of which is ordinarily shipped by water, and most of it is delivered to New England during the six warm months of the year. The reserve supply in storage in these states is gone. Everybody's bin is empty. The industries and business houses in and about Boston must close, says Mr. Storrow, for a period two hundred per cent. longer during the crisis than the National Fuel Administration demands of the rest of the country. New England must make use of rail transportation to the limit of physical possibilities. This means throwing a severe overload on the coal piers located on the New Jersey shore and which also supply New York City, equally straining rail transportation from the mines to these piers and taxing barge transportation from the piers to southern New England.

New York City cannot escape being badly hit by the New England crisis and the great increase in ocean shipping from this port. New York City puts in only one-quarter to one-third of its coal during summer. The city has facilities for only four and one-half days' storage, chiefly because of real-estate values. Along in October the whole city suddenly demands coal, and in April the demand ceases just as abruptly. The unloading piers have been built and equipped to care chiefly for the usual demands of the Greater City. If the city is to be properly supplied, if New England is to be relieved and bunker coal furnished to the ships leaving New York harbor, the present piers are likely to be found to be wholly inadequate even if the whole eleven were worked day and night.

The report of the Conservation Committee upon its investigation of conditions at the eleven coal piers supplying New York City, published in our last week's issue, page 193, clearly reveals that the piers are not working at capacity, that they are inadequately equipped, undermanned and working but part time, considering twenty-four hour day operation imperative in this crisis. What is the good of rejoicing at the news in the papers each day that so and so many thousand tons of coal arrived at tidewater? It means nothing if the coal merely dribbles beyond that point.

But the conditions are more severe than is revealed by the report. The Conservation Committee says that for twenty-nine days last month the eleven piers together averaged 1335 cars unloaded per day, as against 1800 per day last year. So far as we can learn the railroads operating the piers say they can unload but 1300 per day. Their best performance was on January twenty-ninth, when they unloaded 1719. The Conservation Committee, the fuel administrators and the coal dealers know that unless the docks can average about 2000 cars per day, all hope of relieving the present situation is vain.

It is up to the coal-pier management to do this. If the local fuel administrators and the railroad representatives cannot get together and make these provisions at once, it certainly becomes the duty of Mayor Hylan and Governor Whitman to demand that Dr. Garfield and Director General McAdoo authorize someone to use a big stick here at tidewater.

The chief reason why the movement of anthracite is so slow at the piers seems to be lack of coal-pooling arrangements rather than physical impediments. According to the Conservation Committee it handed its report to A. H. Wiggin, Fuel Administrator for New York State, and to Dr. Garfield over a month ago, or on or about the date of its issue, which was December thirty-first. This report stated "that this committee recommends the pooling of *all coal* so that no additional time may be lost in switching." The italics are ours. Despite the urgent need of putting that recommendation into immediate effect over a month ago, only today (February fourth) have arrangements been put in force whereby barges may load with any coal available at the piers. And as this goes to press we are advised by the State Fuel Administration that this applies to three piers only; namely, those on the Delaware, Lackawanna & Western, Lehigh Valley and Erie railroads. It is hoped that they will go into effect for the other piers at an early date. The reader should understand that there is no pooling of anthracite as related to sizes.

There has been a considerable increase in demand for coal going over these piers, says the Conservation Committee. Twenty-five per cent. of the coal handled by them now goes to New England. Ships coaled in New York for transatlantic service must be provided with sufficient fuel to carry them across the ocean and back again, instead of one way only, as formerly done. It is likely, then, that at the capacity at which the piers are now worked the coal will continue to pile up in the yards, tying up more and more cars until a shortage of empty cars demoralizes mining. This is the very thing above all that should not happen through causes originating at this port. New York affords one of the best hauls in coal transportation. It is only a little over two hundred miles from the anthracite mines and about three hundred from the bituminous mines to tidewater, and a short tow, about twenty miles, from tidewater to the city. It is New York City's vital concern how the coal piers supplying the city are equipped and managed.

While the Mayor logically looks to Mr. Wiggin, State Fuel Administrator, and to Reeve Schley, Administrator for Manhattan, also to the other administrators for the city, to keep him informed, he must appreciate that these gentlemen interest themselves chiefly in individual consumers' complaints and adjustments. It is a veritable riot of activity in the offices of fuel administrators the country over, so voluminous and varied are these pleas and "howls." The Mayor has wired and phoned to Washington for priority in shipment. New York does not need priority. If he will, through a representative who has investigated, concentrate his demands on improving the loading piers, he will get greater results.

The question of labor is by no means a negligible one at these piers. First, the function performed by labor there during this crisis is indeed a vital one. The work is not attractive. The piers are wind-swept and much of the coal is badly frozen. The men are paid, so far as we can learn, but thirty-five cents an hour. The pier management should not lose sight of the fact that the new shipyards and many other plants near all these piers employ tens of thousands of men and will soon demand more. The laborer in the section in which these piers are situated, particularly the laborer in Government work, is getting considerably more than thirty-five cents an hour.

Clear the coal docks in New Jersey, add to their discharging capacity. Relief cannot come until this is done and the railroads are unhampered by red-tape rules.

The Ammonia Situation

NOW it is an ice famine that confronts Greater New York. Senator Wagner and Former Governor Odell estimate that the Greater City faces a shortage of 2,500-000 tons. The State Legislature at this writing contemplates harvesting ice now while it is at its best, piling it on the banks of the Ashokan Reservoir, the Croton Lakes and other places, until storage houses can be built to hold it.

The reason is that New York City relies upon artificial ice for the greatest part of its supply. Ammonia is, of course, required for ice making. But the report is current that little of this refrigerant is or will be available because those products from which it is made are sorely needed for munition purposes and for Southern cities which cannot get natural ice.

All this sounds reasonable, particularly as related to New York City. Most of the ice harvested may be transported to the city by barge, which does not require freight cars nor add to the congestion on the railroads.

One thing is sure: It is difficult to overestimate the importance of an adequate supply of ammonia for refrigerating and ice-making purposes. Refrigeration plays a most essential rôle in our national life, a rôle that has not only enlarged tremendously in recent years, but has so changed our whole system of transporting, storing and consumption of foodstuffs that to try to abruptly effect a marked change in any of these would be followed by a calamity as great as, if not greater than the fuel crisis.

Now above all times there should be a full supply of ammonia on hand. In five or six weeks the winter will break and the load on refrigerated warehouses and cooling systems will rise like a kite string. The refrigerating plants should start each with a full charge of ammonia. One cannot hoard ammonia by overcharging the system, because compressor operation will not permit of it without prohibitive mechanical trouble. Because excess ammonia must be stored in drums in the average plant and because it is easily possible to keep a record of sales, hoarding should be easily prevented.

It will not do for the Federal authorities to be too hasty in withholding ammonia, particularly from warehouse companies storing food. Considerable discretion is not only desirable but imperative. Food is now under Governmental control. On the whole owners and operators of these warehouses do not own the food. They must not be driven or goaded to an attitude of irresponsibility—to a state of mind that would bring about a condition whereby the food stored might spoil due to a shutdown for lack of ammonia or other causes. With the Federal authorities in control of food and the essentials necessary to its preservation, and when someone else owns the food, it is not a far cry to unloading on the Government, to "passing the buck next door." These warehouses may properly be regarded as public utilities. But the Federal authorities cannot be unmindful of the fact that they present a totally different problem, as related to service interruptions, from that presented by railroads or the electric-power utilities, for example. These can pick up the load where they dropped it. A refrigerating plant rapidly reaches a critical stage once the refrigerant ceases to circulate through the system. While the rolling stock of the railroad and all freight except perishable, and the transmission lines and lamps of the electric utilities suffer no deterioration while the "power is off," the foods in cold storage immediately start on a road whose end is ruin as soon as the compressors are stopped.

Not until every source of the raw materials from which ammonia is made is worked to its limit, not until everything has been done to develop new sources, should ammonia be withheld. Happily, the Government, is preparing to manufacture ammonia on a great scale.

The Great News

THE article by Dr. C. R. Mann, on page 217, has a significance beyond that suggested by its title. Although irrelevant to the field of *Power*, it is good reading for anyone who is observing the direction in which things are drifting in these times, when so much that was regarded as immutable has broken loose from its moorings and so much that was apparently crystallized is in a state of flux.

If we are now to "envisage an entire community as a single working plant for the purpose of organizing it for the production of human wealth"; if industry and commerce are to be "organized to make goods cheap and men dear"; if "public service rather than excess profit is to become the inspiration for enterprise"—then indeed will "the engineer and not the banker become the power behind the throne" and the word efficiency take on a new and broader significance.

Correspondence

Peening Pipe in Its Flanges

A steam line that once came under my observation gave trouble by leaking at the threads in the flanges. To my knowledge it was taken down three times and the ends of the pipes calked against the flanges. If, instead, with a ball-peen hammer, the pipe had been peened into the flange and back for a distance equal to the thickness of the flange, the job would have been more successful.

Many engineers make a practice of heating the flanges before screwing them on a pipe, believing that when they cool the joint will be tight. So far I have failed to get good results that way, but have always made it a practice to see that the pipe is well peened into the flange. The pipe should be screwed in to come flush with the face of the flange. If one has a lathe, the flange can be turned off a small amount at the inside edge. The pipe can then be screwed in so it projects through, and after it is peened into the flange and the recess, it can be faced off with a file, making a job that will stay tight. N. C. GLEASON.

Northport, Wash.

Hoisting Boilers to Second Floor

The boilers in the new plant of the Studebaker Corporation at South Bend, Ind., weigh 30 tons each and had to be placed on the second floor twenty feet above street level. I secured a double-drum hoisting engine and rigged up two sets of blocks with a ⅝-in. steel cable, fastened one end to an overhead beam in the building and the other to the boiler with cables and clamps. The leads ran from the upper blocks to snatch-blocks on the building column, thence down the column to the ground and through other snatch-blocks to the drums of the hoisting engine, all snatch-blocks being fastened to the building column with cable and clamps.

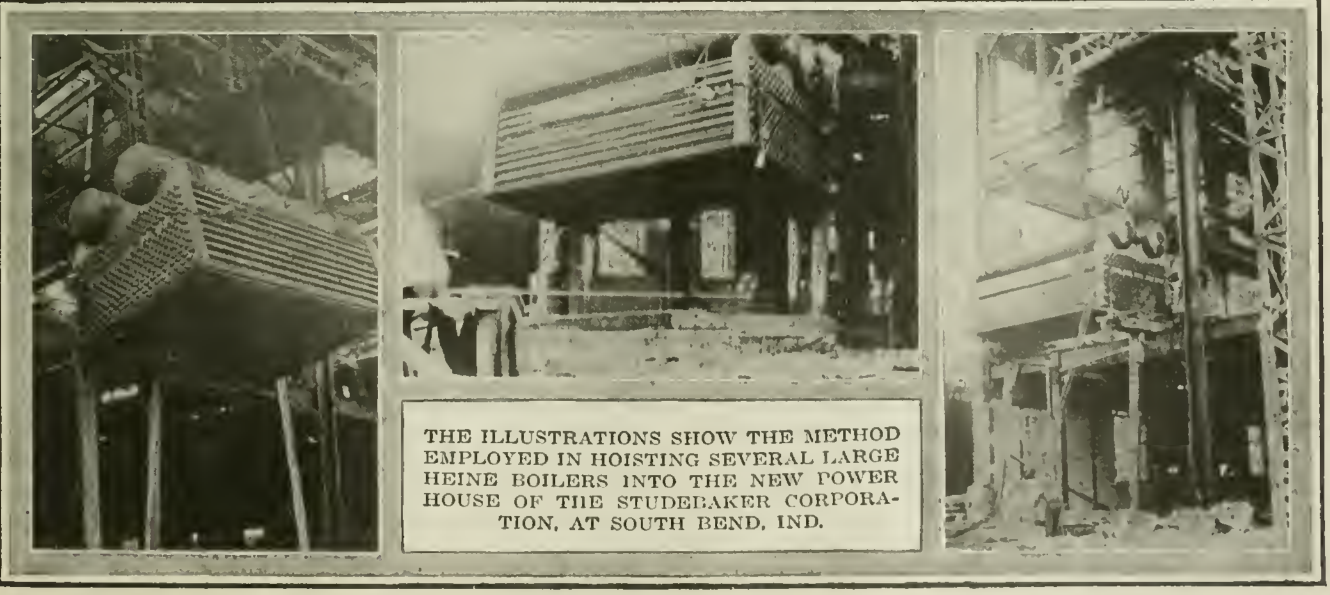
We hitched 1½-in. rope blocks to each end of the boiler to hold it away from the building and to let it come in gradually after hoisting it above the second floor. We also had a pair of skids from the ground to the second floor and two planks lashed to the tubes for the boiler to slide on, as it went up, to protect the tubes.

In hoisting, we raised each end six feet at a time until we had the boiler four feet above the second floor. We then slacked off on the rope blocks and placed two 14-in. x 14-in. x 20-ft. timbers under each water-leg, letting them extend five feet out from building. On these we put three rollers with a 3 x 12-in. plank on top of rollers and lowered the boiler to rest on these planks slightly and, with two rope blocks within the building, moved the boiler over into place. The time required after the rigging was set was just one hour to hoist and land each boiler, and there was no damage done to man or material on the entire job.

St. Louis, Mo. C. C. MULDNER.

Regulating Fuel-Oil Burners

I wish to add to the letter by Edward M. Walker, on page 807 in the issue of Dec. 11, regarding the proper method of regulating fuel-oil burners, that economical combustion is not assured unless strict attention is given to damper or air regulation, and in boilers of the B. & W. type using back-shot burners the proper place to observe the flame is through the small holes in the settings for soot cleaning, in the first pass opposite the second or third row of tubes where the end of the flame may be seen; then with the atomizer set so as to produce a clear flame, the breeching damper should be gradually closed until the end of the flame appears red



THE ILLUSTRATIONS SHOW THE METHOD EMPLOYED IN HOISTING SEVERAL LARGE HEINE BOILERS INTO THE NEW POWER HOUSE OF THE STUDEBAKER CORPORATION, AT SOUTH BEND, IND.

or slightly smoky. In this type of setting the flame is directed toward the front, and with a heavy fire curls back over the top of the main flame body, ending in the lower part of the tube bank; therefore no idea of the actual condition of the fire can be had by observations taken at the front—that is, through the fire-door—because the fire may be quite smoky either from insufficient atomization or a deficiency in the air supply, while the color of the main body of the flame is not noticeably changed, but a glance at the tip of the flame will plainly reveal the condition.

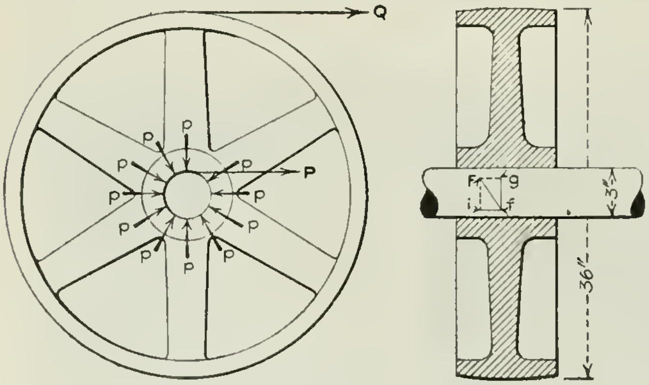
In some oil-burning plants the firemen are given instructions to so regulate the dampers that a faint haze will appear at the stack. The careless ones soon learn that by setting one fire so as to produce the haze the remaining boilers may be operated with the dampers wide open, thus saving them the trouble of regulating the dampers, and the chief or superintendent, seeing the haze coming from the stack, is satisfied. This little trick is often played on the CO_2 recorder when but one boiler is connected to it; that boiler is operated so as to give a good CO_2 reading, while the others are neglected. A. C. McHugh.

Del Monte, Calif.

Why Twist the Pulley?

On page 808 in the issue of June 12, 1917, Sidney A. Reeve asks, "Why is it that in forcing a pulley on a shaft, you can gain by twisting the pulley?"

I think that this may be explained in the following way: Imagine you have a pulley 3 ft. in diameter on a 3-in. shaft, as shown in the illustration, and the pulley is pinched on the shaft by forces p. When a force F is applied to the pulley in order to force it along the shaft, the pulley will move as soon as F is greater than Σpu, in which Σp = sum of pressures p and u = coefficient of friction. When $\Sigma p = P$, then F must be greater than Pu. Let Pu be $fi = 300$ lb., then it will not be easy to succeed without twisting the pulley. It is much easier to turn the pulley round the shaft. You need but apply to the circumference of the pulley a force $Q = 300 \times \frac{36}{3} = 25$ lb., as this force corresponds with a force $fg = 300$ on the circumference of the shaft.



PULLEY TO BE FORCED ON SHAFT

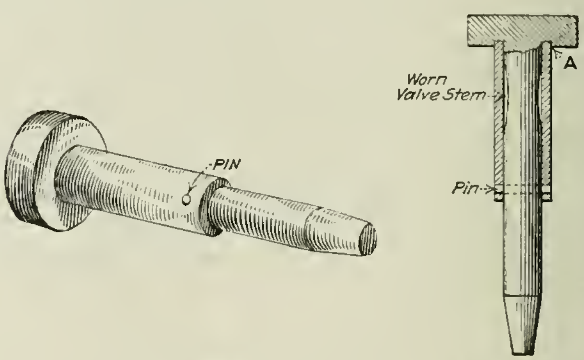
Suppose $Q = 24.9$ lb. or $fg = 24.9 \times \frac{36}{3} = 298.8$ lb. Then the pulley will not turn. At the same time we apply a force $fi = 32$ lb. in the axial direction. The resultant force will then be $fF = \sqrt{298.8^2 + 32^2}$, which is greater than 300 lb. In consequence the pulley will move in the direction of the resultant force fF; that is, it will turn round the shaft and move in an axial direction. If we apply a force $Q = 25$ lb., the force F, be it ever so small, will cause a movement in the axial direction.

This property might be taken advantage of with regard to measuring apparatus, where one wants to eliminate the influence of friction. If only we have at our disposal a turning force of sufficient strength, we can eliminate the friction in the axial direction.

Wageningen, Holland. Y. Brouwers.

Repairing Worn Valve Stems

When the valve stems of a Corliss engine become cut or worn from the friction of the packing, it is expensive, especially in large engines, to replace them with new ones. If the stem is not worn to a dangerously small diameter, the following methods of repairing will be found inexpensive and efficient. The job might be repeated whenever necessary, thus retaining the same stems indefinitely.



VALVE STEM FITTED WITH SLEEVE

The stem shown in the illustration is $2\frac{1}{4}$ in. diameter, with a tee-head $2\frac{1}{4}$ in. square. A piece of drawn steel tubing $2\frac{1}{2}$ in. outside diameter and a scant $2\frac{1}{4}$ in. inside diameter, making a snug driving fit on the stem, was forced on over the valve stem to the position shown at A. The hole in the bracket was bored out $\frac{1}{4}$ in. larger, as was also the gland. The stem was then put in place and packed with packing $\frac{1}{8}$ in. smaller than the old.

The job proved satisfactory and made the stem apparently as good as new.

If I were building an engine, I would have the stems provided with sleeves so that when worn they could be removed and replaced by new ones.

Passaic, N. J. Charles W. Oakley.

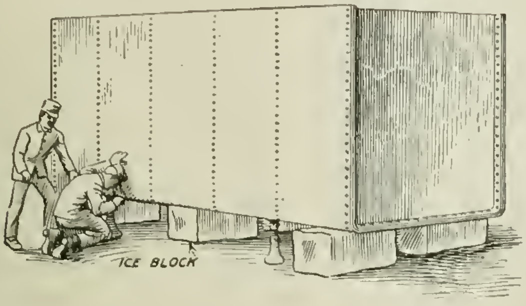
Removing a Key—Not

Of all the "fool stunts" I ever heard of, the following seems to be the limit. A self-styled expert machinery rigger, after sledging at a $\frac{7}{8}$-in. key that had been exposed to the weather for years and failing to move it, looped a few turns of No. 10 galvanized wire around it and hitched a "flivver" automobile to it expecting to draw it out by a steady pull. Did he succeed? He did not. B. C. White.

Spartanburg, S. C.

Lowering a Heavy Tank

At a certain plant a large tank was to be lowered from an elevated position to the floor. The job proceeded smoothly by successively blocking and lowering with jacks, until at last the tank was resting on the jacks with their bases on the floor. The problem then was to get it the rest of the way down. This was accomplished as follows: The tank was lifted slightly and blocks of ice placed under it. The jacks were then removed and warm water flushed around the ice and the tank gradually settled into place. J. M. **Purcell.**



LOWERING THE TANK TO REST ON BLOCKS OF ICE

Richmond, Va.

A Groaning Steam Pump

Following is my experience with a groaning pump. It was a Worthington duplex 16 by 12 by 12 plunger pattern, and furnished water at 90 lb. pressure to operate three hydraulic elevators in a loft and office building. The surge tank of the system was in an out-of-the-way place under the floor. The awful groan drove the whole lot of us almost to distraction, including about 50 or 60 dressmakers on the fifth floor, and they threatened to quit. Of course, that would never do.

We located the groaning in the water end, and began feeding it soap suds, cylinder oil and graphite, etc., without satisfactory results, so we decided to operate. It was found that the two bronze plungers and the cast bronze sleeves (a snug fit) were cutting badly and something had to be done. We painted the plungers with graphite and cylinder oil, then went on a still hunt for the cause of the cutting and found the water in the cistern full of grit, scum, lath, lime, sand and cement that would neither sink nor float on top, but would stay suspended in the water. There was no provision made for emptying the cistern, but we soon had an ejector at work and had the cistern empty and thoroughly cleaned; after filling it with fresh clear water, we had no more trouble. R. A. **Perry.**

Hayden, Ariz.

Why a Different Rate of Scale Formation?

I have picked up much useful information from *Power*, and by way of return I am sending the following on a subject I have never seen discussed, in the hope of stimulating investigation which may be well worth time and money to follow up.

As a boiler inspector I have often been struck by the different amounts of scale to be found in boilers using the same water and working under the same conditions, and on inquiry I find other inspectors have noticed the same thing, but without thinking further about it. Two cases in point are as follows: Of two locomotives made by the same firm, working at the same pressure, fed from the same water supply and working the same number of hours, one boiler shows practically no scale and the other is in a very bad condition with scale. In a battery of boilers all working under similar conditions as regards pressure, feed supply and time between each cleaning, one boiler has much less scale than any of the others, yet the man whose duty it is to look after the feed tells me that judging by the amount of water he puts into it, it must evaporate about twice the quantity of steam the others do.

I could cite many other similar cases, but these two are enough to show what is meant. My idea is that there is something in the composition of the plate which accounts for it. If this is correct, the task would be to find out what that something is and then to see that all future boilers were made with this material. Perhaps some readers may be able to confirm my statement.

Wigan, Lancashire, England. A. **Bennett.**

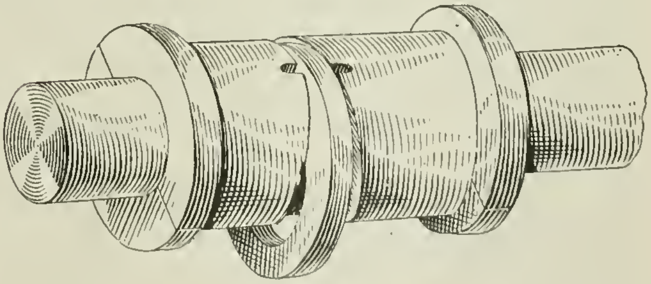
Keeping Lubricator Glass Clear

To keep cylinder oil from coming in contact with and adhering to the sight-feed glass of a lubricator, my practice is to insert a small strand of copper wire in the tube. This wire should extend to the top of the sight glass, but care should be taken not to have it so long as to come in contact with the top plug when it is screwed in. M. H. **Osgood.**

Woburn, Mass.

Improvement in Ring Oilers

The slot in the top half of ring-oiled bearings is sometimes made too wide for the ring and the oil is not carried to the oil grooves and consequently is not properly distributed. On the high-pressure end of turbines the heat from the casing and the steam makes the use of a heavy oil almost imperative, as the lighter oils are "boiled out" of the reservoirs. A good grade of steam-cylinder oil follows up the oiling ring in a thicker film, but this necessitates a wider ring slot at the bottom, as shown in the illustration. I make it a rule to increase the width of the slot at the bottom to twice that of the top and find it a great improvement.



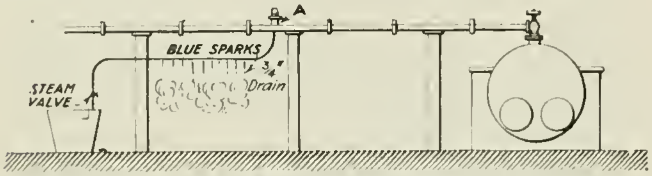
OIL-RING SLOT MADE WIDER AT BOTTOM

In using heavy oil, start the turbine slowly and give the oil time to get thoroughly warm and flowing freely.

Herkimer, N. Y. **Harold G. Burrill.**

An Electrical Phenomenon

At the close of my apprenticeship days, many years ago, I had a peculiar experience never since observed, although it is said not to be unusual. It manifested itself in a curious manner and in such a way as might easily give a man of nervous temperament a shock not soon to be forgotten. I was at that period engaged upon the upkeep of the works plant which included, among other things, a 9 x 30-ft. Lancashire boiler carrying 150 lb. pressure and situated some distance from the works at the end of a field, where a new power house was to be erected. Steam was sent across the field through an 8-in. pipe supported about seven feet above ground to supply the existing works engines, and at a point *A* about midway in the line there was a branch taken vertically and then horizontally at right angles to the main pipe line across to another part of the works, where other engines were situated.



PIPE LINE WITH BLEEDER PIPE THAT BURST

At the base of the tee there was a $\frac{3}{4}$-in. pipe attached to act as a drain and also to feed a tank for boiling suds. It was the custom to shut the steam off this pipe line at night and turn it on again early in the morning. On this particular morning in January, during a spell of extremely "black frosty" weather, on starting up it was found that the $\frac{3}{4}$-in. drain pipe had frozen solid during the night, and it had to be allowed time to thaw out, which occurred about 6:30 a.m., but the frost had split it all along one length of pipe so that after it had thawed out, steam issued from the split into the cold air of the early morning with a high velocity and a tremendously shrill noise. This in itself was not so alarming, but the phenomena accompanying it presented a startling appearance, for, at a distance of about three inches from the split seam, and at that point where the steam began to show itself expanding into a visible vapor, there was a steady stream of heavy blue sparks having a comb-like appearance, apparently jumping across the air space from the pipe to the vapor, the effect being accentuated by a crackling noise not unlike continuous musketry firing at a distance.

When called to my attention, I naturally experienced an uncanny feeling, intensified by the frightened tones of my informant, but soon decided what the cause was. The blue sparks were discharges of static electricity produced by the friction of dry steam slightly superheated passing through cold dry air at a high velocity. Upon closer examination the discharge was found to be taking place actually where the expansion of steam was visible. Detailed information will be found in textbooks treating of electricity and magnetism regarding such phenomenon.

Such electrical effects are also met with by engineers in other forms. A fireman vowed that he got a shock upon touching the mechanical stokers, and it was found to be caused by the dry driving belt running at a high velocity, for upon holding the hand near the inner side of the belt a thick bluish spark leaped across the air space from the belt to the hand, giving the experimenter a sharp but not dangerous shock.

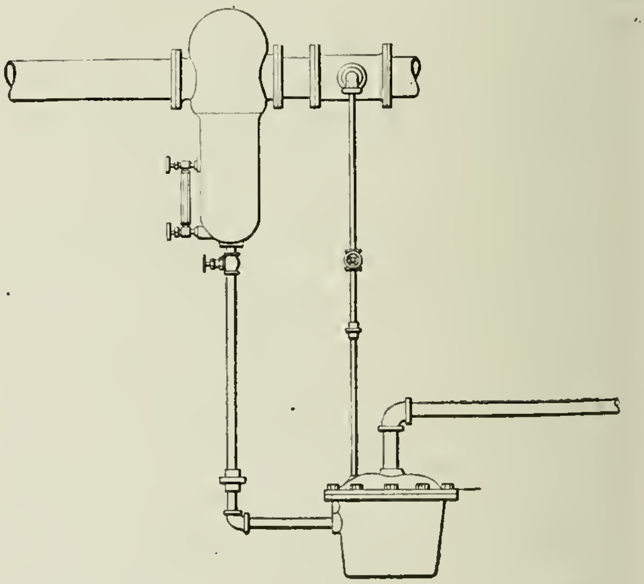
Electrical effects of this nature are met with in paper making. Paper is passed from the wet stage onto steam-heated revolving cylinders, then put through heavy calendering rolls so as to glaze the surface somewhat. This last process creates a static discharge, with its crackling noise, tending to distort the paper as it is being wound on to rolls. To prevent this distortion, a crude but satisfactory method is adopted; that is, two or three pails of water are placed upon a plank, spanning the machine, vertically over the point of exit of the paper from the rolls, and into each pail is inserted some loose strands of cotton rope or other material hanging well down below the bottom of the pails. The capillary action of these wick siphons is sufficient to distribute drops of water at regular periods into the air space between the paper and rolls, which is enough to dissipate the electrical discharge.

Doubtless other engineers know of many such instances, but perhaps under different conditions.

London, N. W., England. **Henry S. Whiteley.**

Trapping Water from Air Line

In a plant furnishing compressed air for various processes of manufacturing, a great deal of complaint was occasioned by the moisture in the air, especially during damp weather. A separator "helped some," but there was difficulty in trapping the water from the separator and it was necessary to leave a small drip or bleeder open all the time, as the trap did not work right; consequently, there was considerable loss of air at times and at other times the water would accumulate faster than the bleeder could take care of it. The difficulty with the trap was caused by its becoming air-bound, so the engineer drilled, tapped and connected it as shown in the illustration, with the air main allowing the air to flow back to the main, and no further difficulty was experienced. **C. W. Oakley.**



TRAP CONNECTED TO SEPARATOR ON AIR LINE

Passaic, N. J.

Inquiries of General Interest

Strength of Manila Rope—What is the breaking strength of ½-in., ¾-in., 1-in. and 1¼-in. diameter Manila rope? I. P.

New well-laid Manila hemp rope, ½-in. diameter, should have an ultimate strength of at least 1900 lb.; ¾-in., 4100 lb.; 1-in., 7100 lb.; and 1¼-in., 10,900 lb. But for ordinary uses the working stress of ½-in. diameter rope should not exceed 50 lb.; of ¾-in., 112 lb.; of 1-in., 200 lb.; and of 1¼-in., 312 lb. Greater working stresses cause the rope to rapidly deteriorate in texture and strength.

Grate Openings for Smaller Size of Coal—For using a smaller size of coal with forced draft we are using the herringbone grate bars with ⅜-in. openings formerly used for burning buckwheat size of coal, and considerable trouble is experienced from coal falling through the grates after each cleaning. What size of grate openings should be used? E. T.

The smallest slot form of openings practicable for ordinary forced draft are ⅛ to 3/16 in. wide. By first spreading the grates with the coarsest fuel that is retained in cleaning, a minimum amount of fresh fuel will drop through.

Steam Consumption and Weight of Feed Water—In stating steam consumption in pounds, is this calculated from the number of pounds of feed water evaporated? B. C. M.

Unless otherwise qualified, steam consumption stated in pounds refers to the weight of dry saturated steam supplied at some particular pressure. Computation of the weight consumed can be made from known weight of feed water that has been evaporated and supplied as steam with deduction of the percentage of moisture in the steam delivered or of the percentage of moisture above the stipulated percentage. The weight is only to be considered identical with the weight of the boiler-feed water when the steam is delivered as dry saturated steam or if it is superheated or it has the specified percentage of moisture.

Cost of Coal per 1000 Cu.Ft. of Steam Generated—Where the actual evaporation of a boiler is 8 lb. of water per pound of coal into steam at 100 lb. gage pressure and the cost of the coal is $8 per ton of 2000 lb., what is the cost of coal per 1000 cu.ft. of steam generated? H. L. Y.

The cost of coal would be $8 ÷ (2000 × 8) = $0.0005, or 1/20 of 1c. per pound of steam generated. Assuming that the feed water is converted into dry saturated steam at a pressure of 100 lb. gage or 115 lb. per sq.in. absolute, then, according to the Marks and Davis Steam Tables, the density of the steam or weight per cubic foot would be 0.2577 lb. Therefore 1000 cu.ft. would weigh 1000 × 0.2577 = 257.7 lb., and the cost of coal required would be 257.7 × $0.0005 = $0.12885, or practically 13c. per 1000 cu.ft. of steam generated.

Space Occupied by Coal—How many cubic feet should be allowed per ton of coal? W. E. T.

The weight per cubic foot and consequently the number of cubic feet per ton varies with size, and uniformity of size to which the coal is broken, and also depends upon whether the coal is "shaken down" in bulk as by transportation and on the specific gravity of the coal, which varies for different mines and for coal taken from different parts of the same mine. Hence there is considerable variation in the cubic feet per ton, and further confusion arises from misunderstanding of whether "long" tons of 2240 lb. or "short" tons of 2000 lb. are under consideration. The average weight of American anthracite, taken in boxes holding 2 cu.ft., has been quoted as 53.4 lb. per cu.ft. and of Maryland and Pennsylvania bituminous coal as averaging 52.8 lb. per cu.ft., from which a short ton of anthracite would occupy 2000 ÷ 53.4 = 37.45 cu.ft. and a long ton 2240 ÷ 53.4 = 41.94 cu.ft.; and a short ton of bituminous coal would occupy 2000 ÷ 52.8 = 37.87 cu.ft. and a long ton 2240 ÷ 52.8 = 42.42 cu.ft. On account of the wide variation of conditions, no estimates of weight of coal from measurements of bulk should be regarded as more nearly approximate than within about 10 per cent. To be on the safe side, provision for space for storage of coal should allow not less than about 40 cu.ft. per ton of 2000 lb. and 45 cu.ft. per ton of 2240 pounds.

Relative Efficiency of Copper and Iron Heating Surfaces—What is the relative efficiency of coils made of iron or of copper tubes for heating water by a gas flame? F. M. E.

Copper coils are more durable than coils made of iron or steel pipe, and while the material is bright and clean the rate of transmission of heat to the water is several times as rapid as with new iron or steel pipes of the same size and arrangement. But coils of copper heated by gas quickly become coated with a deposit from the products of combustion that renders the copper surfaces no more efficient than similar iron-pipe heating surfaces that have been in use for the same length of time. Tests of two fire-tube boilers made alike, excepting that one had iron fire tubes and the other copper fire tubes, showed that their evaporative activity was practically the same.

Explanation of Formula for Use with Throttling Calorimeter—What is the explanation of the formula for determining the fraction of dryness of steam with the throttling calorimeter? A. L.

So far as practical results are concerned, the steam in the throttling calorimeter contains the same number of heat units per pound as the steam in the pipe from which the sample is taken; and since the original steam contains more heat per pound than necessary for dry saturated steam at the low pressure in the calorimeter the latter is superheated; that is, contains more heat per pound and is of a higher temperature than if it were dry saturated steam at the low pressure.

The specific heat or heat required to raise one pound of superheated steam through one degree when near the pressure of the atmosphere is commonly taken as 0.48 B.t.u. per pound, hence if t_2 is the temperature indicated by the thermometer and t_1 is the temperature of dry saturated steam given by the steam tables for the pressure existing in the calorimeter, then the steam is superheated $(t_2 - t_1)$ degrees and the B.t.u. absorbed as superheat by each pound of steam would be $0.48\ (t_2 - t_1)$. Hence if $H =$ the total heat of a pound of dry saturated steam at the pressure that exists in the calorimeter, then the number of B.t.u. contained by each pound of the steam in the calorimeter would be $H + 0.48\ (t_2 - t_1)$, and this same quantity of heat is assumed to be present in each pound of the initial steam. The whole of each pound of the original water must have been heated to the boiling point while only a fraction of a pound may have received the latent heat of evaporation. Hence, if for a pound of the initial steam $h =$ the heat of the liquid, $L =$ the latent heat of evaporation, and $q =$ the fraction of the whole pound that is dry saturated steam, then for a pound of the initial steam the B.t.u. present would be $h + qL$, and as the heat per pound of the initial steam is assumed to be the same as the heat per pound of the steam in the calorimeter, then

$$h + qL = H + 0.48\ (t_2 - t_1), \text{ or } q = \frac{H + 0.48\ (t_2 - t_1) - h}{L}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Storage and Weathering of Coal*

By W. D. STUCKENBERG and J. F. KOHOUT
Commercial Testing and Engineering Co., Chicago

During the present international complications the storage of coal is becoming increasingly necessary. The prime purpose, of course, is to have a supply of fuel on hand so that plants will not be shut down and homes will not be without heat. Another reason is the occasional, at the present almost universal, lack of railroad equipment to move the coal from its source to the ultimate destination. Labor troubles also interfere with the production or handling of coal, either at the mine, in transit, or in the cities.

ONE OF the theories now being advanced for the relief of railroad congestion and mine running time is to require large consumers, who are under annual contracts, to accept their coal in equal monthly shipments. This practice, if instituted, will necessitate storing coal when the deliveries are in excess of daily demands. The storage thus accumulated will have to be used at times when shipments are less than daily consumption.

Broadly speaking, the larger sizes of coal from about No. 3 nut on up through the various sizes of nut, egg and lump store without giving any trouble. This is due to the fact that these sizes are drier and offer a smaller surface, in proportion to their mass, to the action of oxygen than do the finer sizes.

Anthracite and semibituminous coals store well in any size, but this is probably due to their chemical composition. Oxidation occurs here also, but is much slower in action, and, therefore, smaller in amount for any given length of time. Sub-bituminous coal from the West, frequently called black lignite, is hardly suitable for storage. Its tendency to slake condemns it.

Finer Sizes High in Moisture and Iron Pyrites

The finer sizes of coal, which are used principally for power purposes, are generally high in moisture and iron pyrites. These are deleterious ingredients because of the ease of oxidation of the pyrite in the presence of water vapor. The finer sizes, that is, coal passing through 2-in. screen and smaller, expose a great number of small surfaces to the air. These several factors all tend to initiate oxidation and to speed it along once it has started.

Here also the difference between Eastern and Western coals should be explained. The former are much purer in that they are low in moisture and pyrite. The Western coals are much higher in both of these constituents and are therefore to be considered as being much more liable to spontaneous ignition. As an illustration of this peculiarity, a quantity of screenings from southeastern Kentucky was in storage for seven years, but when it was moved there was no visible evidence of excessive oxidation or deterioration. On the other hand, a storage pile of western Kentucky screenings may fire easily within 60 days.

Storage piles vary in size from a few tons to many hundred thousand tons. This fact necessitates a careful consideration of the three methods of storage—under water, in closed bins and in open piles. Under water any kind and size of coal may be kept for any length of time without danger from fire. This method is used by large consumers who also hold coal in open piles for immediate use. Storage in closed bins is generally limited to small quantities of fuel.

The great bulk of storage coal at present is kept in open piles. It is intended to be held readily available for use, and is seldom on the ground for more than a few months. As a matter of fact, it should not be kept long, but the length of time should depend on the kind of coal, since this is the most dangerous form of storage. However, when proper precautions are taken at the time the coal is placed on the ground and maintained while the pile lasts, losses may be eliminated or reduced to a minimum.

The losses which occur may be considered to be due to oxidation. It should be borne in mind that the rate of oxidation increases with the temperature, also that coal is a poor conductor of heat, so that much of the heat occurring or generated in the interior of the pile stays there. These two facts indicate that when oxidation starts, even though at a low temperature, it generates a small amount of heat. This heat is insulated from the outside air and, being retained, tends to increase the rate of oxidation. This one action helps the other, and the oxidation proceeds at a constantly accelerated rate, the more easily oxidizable compounds or constituents being attacked first.

Iron pyrite is oxidized in the presence of water to ferrous sulphate and sulphuric acid according to the equation expressed in plain English,

Iron pyrite + oxygen + water = Iron sulphate + sulphuric acid + heat.

This reaction takes place with a considerable evolution of heat. It is true that the oxidation really goes farther with the evolution of still more heat, but this additional heat, and also the heat due to the action of sulphuric acid on lime or alkalies present in the coal, or the heat generated by the dilution of the acid with water, are not considered. It must be remembered that the water actually enters into chemical combination with the pyrite and oxygen, unless the water is present in sufficient amount to exclude the air. This is the condition that prevails in under-water storage and is one of the reasons why that method is best.

When coal is stored in the dry state, the equation for the oxidation of the pyrite previously given is incomplete, since the moisture component is absent. When it is stored under water, the equation is again incomplete, because the air is thus excluded and the oxygen component is absent.

In other words, the oxidation of coal in the dry state proceeds very slowly, since the only moisture available is that in the coal and in the air. In dry coal the moisture is very low, so in dry storage one of the necessary constituents of the reaction is lacking to a relatively large extent.

In several instances which have come under observation a low-volatile coal, called "Arkansas semi-anthracite," has given considerable trouble from spontaneous combustion. This coal has a fairly large content of sulphur and low moisture. Its principal use has been as a substitute for semibituminous or Pocahontas coal for domestic use; and when it is unloaded from wagons into basements, it is generally sprinkled with a garden hose to lay the dust. This supplies the moisture which is necessary for the oxidation. Several fires have occurred in Chicago from this cause, and the fact that the coal is used so much in dwellings makes extreme care in its storage and handling absolutely necessary. It has not been on the Chicago market long enough to demonstrate if it would heat up in the dry state, but theoretically it should give no trouble in such a condition.

How the Temperature of the Pile Is Raised

The heat due to the oxidation of pyrite, helped by that coming from external sources, if any, raises the temperature of the pile to the point where the carbon and hydrogen of the coal begin to be attacked. This action is aided by the fact that coal, particularly when freshly mined, has a strong affinity for oxygen. The oxygen is absorbed much as water is taken up by a sponge. This supplies the oxygen needed for the oxidation of the carbon and hydrogen. The action is not likely to occur until a temperature of about 250 deg. F. is reached. The temperature of the coal is raised by these processes until it reaches a point (about 450 deg. F.) where the action is autogenous and is no longer dependent upon external sources of heat to maintain

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*Excerpt from paper read before the Kentucky Ice Manufacturers' Association.

the temperature. When the temperature mounts up to about 750 deg. F., the coal takes fire.

Paradoxical as it may seem, the fact must be kept in mind that small amounts of moisture assist in the oxidation of the coal. This was tested out by Professor Parr at the University of Illinois. His bulletin No. 46, "The Spontaneous Combustion of Coal," giving the results of his experiments, shows without exception, in all the series of tests, that the wetting of the coal increased the activity, as shown by the ultimate temperature. Thus, when a storage pile is burning, it must be flooded with water to extinguish. Merely wetting the surface or outer layers of coal with a hose or spray will hasten the loss.

Heat from External Sources

In connection with piles of coal in storage, the effect of external sources of heat is of extreme importance. Without the aid of heat from some external source, the initial stages of oxidation either would not occur or their rate would be extremely slow. These sources may be steam pipes in the ground or near the pile, as in conduits, etc., which are in contact with the coal, or the heat from boilers. This last is particularly true in the case of bunkers on vessels. In one case that came under observation, a pile of coal which ordinarily stores without trouble, ignited. The cause was finally discovered in the presence of a manhole covered with a thin layer of earth, and so overlooked, through which steam passed. This manhole was immediately under the pile of coal and was the means of supplying enough heat to start the oxidation of this coal.

When coal is unloaded by dumping on the ground from a car or a high trestle and then is piled up to almost the level of the car floor, as is frequently done in the coalyards, the heat of impact and of pressure constitutes a positive danger to the coal.

The question is often asked as to the best season of the year to store coal. As far as possible coal should be placed on the ground in the winter months. It is then cold and fairly dry. The heat of impact and pressure, due to unloading and piling, while present, will not raise the temperature of the coal to any noticeable degree, and certainly not to the temperature of ordinary summer weather. Of course the coal must be free as possible from snow and must be unloaded on an area from which the snow has been carefully removed. One plan worked out for a consumer was to put down about two or three months' supply in September, October and November, then when the first of January came around to pick up this storage and let the daily shipments be put down for the fresh storage to be used in the spring, when labor troubles would disturb production.

Absorption of Sun's Heat

Absorption of heat from the sun will also raise the temperature of the coal to a surprising degree. This was noticed particularly at a plant in Chicago that was receiving coal direct from a mine in Indiana. The coal carried a rather large amount of moisture and pyrite, but was taken out of the ground only about ten days before delivery. When received, it was so warm that the hand could not be kept in contact with it for more than a few seconds. The reason for this was discovered in the fact that it was shipped in steel cars which stood on sidings exposed to the direct rays of the sun for about two days. The steel absorbed the heat readily and so raised the temperature of the coal. If this coal, instead of being passed directly to the furnace, had been placed in storage in the condition in which it was received, undoubtedly it would have fired spontaneously in a short time.

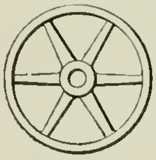
Oxidation or weathering of coal decreases the heat value. The loss is brought about by the oxidation of carbon and hydrogen to carbonic acid and water, which escape as gases. There is also an increase in weight of the coal due to the absorption of oxygen. This oxygen replaces combustible matter and acts like so much ash. In fact, the United States Bureau of Mines has shown in Bulletin No. 29, "The Effect of Oxygen in Coal," that oxygen and ash are of very nearly equal anticalorific value. Oxygen also interferes with the coking quality of coal, and a coal that has weathered to any great extent has either entirely lost its coking quality or at any rate will make coke of inferior quality. In addition, coal will disintegrate under the influence of oxygen, and the larger pieces will break up. In fact, the recommendation has been made that coal a size larger than that ordinarily burned at the partricular plant should be stored, so that when the storage coal is burned it will not be too fine for use.

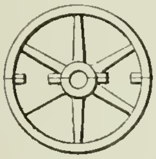
This discussion of the effects of oxidation leads to a consideration of some of the precautions to be taken to prevent or minimize them. One scheme used in this connection had the opposite result. This consisted of two perforated pipes placed down in the pile. The idea evidently was to ventilate the interior and to provide for the escape of heat, should it be generated. However, one of the pipes, which happened to be about two feet higher than the other, acted as a stack, while the lower pipe served as an intake for fresh air. The odor of coal gas and of the products of combustion was clearly perceptible at the top of the higher pipe. Thus what was intended to check combustion was really furthering the oxidation of the coal. To minimize oxidation the following precautions should be taken:

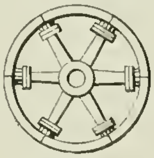
1. Avoid external sources of heat that may in any way contribute toward increasing the temperature of the mass of the coal.
2. Eliminate coal dust and fine coal as far as possible.
3. Store dry coal and keep it dry.
4. Put the coal on the ground in a dry, clean place on as clear and cool a day as possible.
5. Do not pile the coal too high. Shallow piles afford the best chance for the escape of heat from the interior.
6. Store as large a size of coal as possible.
7. Store under water if possible and be sure the coal is completely submerged.
8. Watch the interior temperature of the pile with a thermometer, and as soon as any abnormal rise in temperature occurs, mark that spot as the next one to be drawn on for fuel, or if the conditions seem serious, overhaul the pile at that point and flood it.

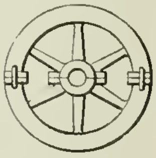
Safe Speed for Cast-Iron Flywheels

The following table of safety speeds for cast-iron flywheels has been prepared by William H. Boehm and published in the *Operative Miller*. The margin of safety at the speed given is considered to be approximately three:


No Joint
100 Per Cent.


Flange Joint
25 Per Cent.


Pad Joint
50 Per Cent.


Link Joint
60 Per Cent

TYPES OF WHEELS AND THEIR MAXIMUM EFFICIENCY

Diameter in Ft.	R.P.M.	R.P.M.	R.P.M.	R.P.M
1	1,910	955	1,350	1,480
2	955	407	675	740
3	637	318	450	493
4	478	239	338	370
5	382	191	270	296
6	318	159	225	247
7	273	136	193	212
8	239	119	169	185
9	212	106	150	164
10	191	96	135	148
11	174	87	123	135
12	159	80	113	124
13	147	73	104	114
14	136	68	96	105
15	128	64	90	99
16	120	60	84	92
17	112	56	79	87
18	106	53	75	82
19	100	50	71	78
20	95	48	68	74
21	91	46	65	70
22	87	44	62	67
23	84	42	59	64
24	80	40	56	62
25	76	38	54	59
26	74	37	52	57
27	71	35	50	55
28	68	34	48	53
29	66	33	47	51
30	64	32	45	49

If the revolutions given in the table be increased 20 per cent., the margin of safety on speed will be reduced to two and one-half; if the revolutions be increased 50 per cent., the margin of safety will be reduced to two.

Hydro-Electric Development*

THE introduction of electricity as a means for transmitting power over considerable distances and its subsequent rapid development completely changed the status of hydraulic power. Previously, such power could be used only near falling water. Now it is commercially available in convenient form within a radius, in some instances, up to 200 miles, a fact that has made it possible to utilize water powers even when located in remote and inaccessible places. Indeed, today practically all hydraulic-power developments of any magnitude are hydro-electric.

In the light of the foregoing it might seem reasonable to suppose that a large proportion of the modern demand for electric current would be supplied from the energy in falling water. Such, however, is not the case. Accurate statistics are difficult to obtain, but some approximate totals may prove illuminating. It has been estimated by a careful engineer that in 1911 there were over 26,000,000 steam-engine horsepower capacity in use (including railroad locomotives) in the United States. The aggregate water horsepower developed and undeveloped has been computed as around 60,000,000. Of this latter the United States Census of 1912 gives 4,870,000 as developed, and in a report of January, 1916, the Secretary of Agriculture estimates this total to have been increased to 6,500,000. Making liberal allowances for correction in these several figures, it seems probable that there are in service from four to five times as many steam as water horsepower and that there are still undeveloped water horsepower equal to at least twice that of all the steam capacity in service.

Steam- and Hydro-Electric Power Compared

There are two fundamental causes which have militated against the substitution of hydro-electric for steam-electric power. One is economic and permanent; the other is statutory and therefore subject to modification. Both reasons apply to some powers, but neither, fortunately, to all. The economic and permanent reason is high cost of development due to natural conditions. Electric power generated by falling water is inferior to that generated by steam in every particular except cost, and therefore water-driven service must be cheaper than steam-driven in order to justify its existence. The price for service depends primarily on cost, and cost divides itself naturally into two main items, namely, operation (including maintenance) and fixed charges. As a hydro-electric plant consumes no fuel, its operating cost is less than that of an equivalent steam-driven plant. On the other hand a steam plant costs usually only from one-fifth to one-half as much per unit of capacity as a hydro-electric plant, so that the latter must carry very much heavier fixed charges.

This disability of water service is usually even greater than the ratio of the costs of two equivalent complete developments. When steam is to be the motive power, only such capacity is installed as initial demands require, and the cost per unit is fairly proportional to that of the ultimate development. In a water development, a large part of the cost is for riparian rights, for the dam, flume, forebay, etc., and for the transmission right-of-way, towers, etc., which must be at the start largely provided and constructed for the complete installation. The obvious result is a greater fixed charge per unit of capacity and a higher cost per horsepower delivered for sale.

In forecasting the commercial prospects of a power enterprise, the possible market must be studied and, of course, a sale price for power decided upon. As this price is controlled by the cost of similar service from other sources, usually from steam, and as it must be attractive from the start, the additional burden of fixed charges on the initial part of a hydro-electric installation frequently forces the sale of its power below cost. The projectors of the enterprise then must rely for success on a sufficient subsequent increase in their markets. The possibility of an incorrect forecast of the extent of such increase and of the time when it may come imposes a serious business hazard against water and in favor of steam.

It has been frequently pointed out that as the nation's coal supply is depleted, the cost of coal must rise, thus increasing the cost of steam-electric power as a competitor and raising the market value of hydro-electric power accordingly. The rising price of coal is a matter of record, but it is not so generally known that the improved efficiency of boilers, engines, generators and auxiliaries has more than kept pace, so that the net cost of producing electric power from coal has steadily declined.

Factors That Influence the Cost of Power

There is nothing to indicate that the limit of improvement in the design of steam prime movers has been reached or is even in sight. It is, therefore, a reasonable assumption that further advances in the art will continue to occur and to cut down both the fixed charges and the operating cost of steam power as a competitor of water. As bearing on the water-power situation, obviously many sites which fifteen years ago might have been developed to sell energy in successful competition with steam at its then cost could not now be so developed, and in consequence their development is no longer commercially possible.

The cost of producing power from either water or steam is a function of load. Fixed charges remain practically unchanged in both instances, whether the output in energy be large or small; but with a steam plant, increased output means increased fuel consumption, while a water plant operates either with or without load with but little variation in expense. To illustrate by a concrete example representing not unusual conditions, suppose we assume a steam plant using 2½ lb. of coal per kilowatt-hour at a price of $3 per short ton and having a plant or output factor of 35 per cent.—that is to say, an output equal to 35 per cent. of its theoretical output if every unit were loaded to capacity 24 hours each day of the year. Under these assumptions the cost of fuel per unit of installed capacity per year would be $11.50, and if the other operating and maintenance charges be assumed to fairly offset those of a water installation of equivalent size, $11.50 represents the additional fixed charges which the hydro-electric plant could carry and produce power at an equal cost. If the fixed charges (interest, taxes, insurance and amortization) total 11½ per cent., therefore, the hydro-electric investment per kilowatt capacity could exceed that of steam by $100. This is not an abnormal excess. Many hydro-electric developments exceed the cost of equivalent steam-driven systems by much greater amounts, in which cases they become commercial prospects only if either coal be more expensive per unit of output, or the plant factor be higher, or some other operating or maintenance condition be more favorable.

Inferiority of Hydro-Electric Power

As has been previously stated, hydro-electric power is inferior to steam-electric power. The reasons are elementary. Stream flow is subject to seasonal variation, and therefore to complete or partial interruption by drought in summer and by ice in winter. Floods are a menace. Long transmission lines may break from wind or sleet or the service be disarranged by lightning. The losses on such lines vary with load and are frequently responsible for annoying pressure variations. On account of these and other reasons, hydro-electric power cannot prevail against steam competition at the same or a slightly lower price. It must be materially lower.

We do not mean to imply that water power may not be a commercially practicable competitor of steam. Many successful hydro-electric installations give substantial proof to the contrary. We do wish most emphatically to combat, however, the widely held but mistaken view that any water-driven plant will produce power at lower cost than steam can, and that the margin is so large investors generally

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*Excerpts from a statement prepared and presented on the special invitation of the Water Power Committee of the United States Chamber of Commerce, by the Executive Committee of Engineering Council of the United Engineering Society.

are eagerly seeking a chance to put money into hydro-electric projects. The most careful investigation, frequently demanding substantial expenditure and the keenest scrutiny by experts, is needed to discriminate between worthy and commercially impractical projects, and the difference is often so small that the imposition of even what seem to be minor burdens is sufficient to turn the scale in favor of steam and entirely prevent what might otherwise be a desirable hydro-electric development.

The second condition which vitally affects development is statutory. After ten years or more of discussion it has come to be generally agreed that our Federal laws discourage the development of a large proportion of the nation's water powers, and remedial legislation has been considered at every session of Congress for many years. The legal obstacles are quite distinct and separate from the economic facts which have been previously described and are in addition thereto.

Of the estimated 55,000,000 undeveloped water horsepower in the entire country, approximately 40,000,000 is within the boundaries of the thirteen so-called Western water-power states. In these same states the Federal Government still retains as proprietor 760,000,000 acres, or over two-thirds of the aggregate acreage of all these states taken together. In order to develop power in that section it is therefore nearly always necessary to use some part of this public domain, if not for the dam site itself, at least for flowage, for transmission right-of-way or for some other purpose. Existing law forbids such use except under permit issued by the Secretary of the Interior and revocable without cause, at any time, by himself or his successor in office.

It was once believed that revocation would only follow gross abuse well established by evidence; but the drastic action of a one-time Secretary of the Interior some years since to the contrary disabused investors of this confidence and demonstrated by a sad object lesson the insecure tenure afforded by existing law. As funds for hydro-electric development must come from private sources, the unstable tenure imposed by this condition has constituted so great a hazard of loss that the private investor has been loath to assume it. The unfortunate—almost disastrous—result has been practical stagnation in water-power development for many years.

Many available power sites not in the Western States, or not on the public domain, are on navigable streams. For each such project a special act of Congress is necessary. The difficulty of obtaining suitable rights by this means has been found so very great as largely to discourage, even if not entirely to prevent, the developments affected.

It should be pointed out that a hydro-electric enterprise being once successfully established, it is alike to the interest of the owners of the Government and of the public that it should continue indefinitely without interruption. There is no economic reason to be served by a cessation, and the only reasons for providing a legal means of recapturing the installation and the water rights are to preserve an additional measure of Government control against possible abuse by the permittee, and to provide for a contingency which might make it desirable that the Government would want to use the power for some other purpose.

In nearly all cases steam plants are necessary to supplement hydro-electric power at periods of low water and in case of interruption, as well as, in some instances, to provide increased capacity. In fact, modern practice is rapidly approaching that of providing steam capacity equal to 100 per cent. of hydro-electric for the purposes stated. In any event the growth of the enterprise over a term of years will be continuous and progressive. There will never come a time when it may be said to have been completed and subject to no further expansion. This continuing growth makes burdensome and usually abortive any attempt to amortize the investment, while the investment in other water powers or in steam plants or both, interconnected with, and generally dependent for their economic operation on, the original development renders the right to recapture that development very onerous and one which constitutes a serious impediment to the free and full development of an enterprise which is otherwise most desirable from all viewpoints.

With respect to power sites on the public domain and on navigable streams, the Government is in the position of seeking to have its resources developed without assuming any business hazard and without contributing either capital or credit. It would be unfortunate, in the light of past experience, if any new laws which may be enacted should put the Government in the position of bargaining with capital and of offering just sufficient incentive not to induce capital to undertake the developments desired, thereby, while apparently providing a remedy, in reality insuring a continuance of the present undesirable condition.

It is our belief that the benefits afforded the communities served by cheap power, and to the nation by the conservation of coal resulting from the substitution of a self-renewing for a nonrenewable natural resource are far more valuable than is the exact solution of the question of restricting the returns to capital to their irreducible minimum. The present emergency due to the progress of the war has forcibly illustrated the importance of having developed the greatest possible number of water powers as a source of industrial power supply. As it consumes no fuel, the substitution of water for steam power would release to other uses all the extensive railroad and water facilities now engaged in transporting coal. It would similarly release a corresponding volume of labor now occupied in mining this coal and in operating such transportation agencies as well as the boiler-room forces of the steam-power plants themselves.


The Thinker.

—By Gibbs in Baltimore *Sun*


The Only Other Fuel Shortage That Could Please Him More.—By Webster

—By Webster in N. Y. *Globe*


Looked Worse Than It Tasted.

—By Gibbs in Baltimore *Sun*

What We Do and Don't Know About Heating[*]

BY PROF. JOHN R. ALLEN

THERE are many things we know about heating and I will try to enumerate the principal ones; there are many things we don't know about heating, but *can* know if we would take the time and the money necessary to investigate. There are also many things that we will never know, because the problem involves too many variables which can never be solved.

Let us start first by considering the laws of heat. Most of the useful experiments that can be immediately applied to heating were first made by Peclet in 1840 to 1850. Peclet's work was translated into English by Box about 1880 and is given in Box's "Treatise on Heat." Almost every author since Box's time has quoted Box and given Box's constants for radiation, conduction and convection. Some authors have given him credit, but most authors seem to have forgotten the source of their information.

In recent years very little fundamental work has been done by physicists upon heat and its application. The modern physicist is wedded to electricity, and he can tell you the electrical resistance of iridium and titanium and all the metals that are never used for electrical conduction, but he cannot tell you the heat resistance of a brick or a piece of stone, or a piece of concrete. There is a real reason for this. Heat is extremely difficult to experiment with accurately and electricity is the easiest of all the fields of research. If electricity is in its infancy, as is often said, heating is in embryo and unborn. We know a thousand things about electricity to one that we know about heat.

Has anyone ever looked up the various authors to find the constants for radiation, conduction and convection? If so, he would have found results varying as much as 100 per cent. There is an opportunity for some physicist to make himself undyingly famous by establishing beyond controversy some of these much-used constants. It is this lack of fundamental knowledge that has hampered and is still hampering the heating engineer in dealing with the heat problems connected with his business. This lack of fundamental knowledge has affected all our experimental work. We make small experiments through a very narrow range of observation on very special devices, and these experiments would be absolutely unnecessary had we the fundamental principles underlying these devices.

Of the fundamental laws we probably know a little about conduction, still less about convection and very little about radiation. We find the statement made in physics that a dull-black surface radiates the most heat. In my own experiments upon cast-iron radiators I found that there was practically no difference in heat transmission between dull-black and pure-white polished surfaces. In fact the pure-white polished surface gave off about 3 per cent. more heat than the dull-black. These are facts that my physicist friends have never been able to explain.

HEAT LOSS FROM BUILDINGS

Consider heat losses from buildings. For years we guessed at them by some rule-of-thumb. These rules were usually proposed by someone supposed to know more about heat than anyone else and were usually very dangerous to apply throughout a wide range of conditions.

We have followed the German, the theory of which is generally considered to be at least approximately correct, but these formulas require certain practical constants for heat transmission. The heat laboratory at Charlottenburg has determined many of these constants for German forms of building construction, but very little work has been done in this country. Some years ago I started to check up the German constant for glass, which of course is the most fundamental constant that we have. I found that for dry glass with no rain or wind the constant $K = 0.64$; for rain and no wind, $K = 1.248$; for wind and no rain, $K = 1.05$; for rain and wind, $K = 1.485$. The generally accepted constant by authors as determined by the German government is 1.3 and for fifteen years we have accepted this constant. It is entirely possible to have the glass surface wet even in zero weather and the constant is manifestly too small. Personally I am now using $K = 1.25$ as the glass constant. This only goes to show that some of our fundamental facts are wrong and need a careful checking up.

When it comes to the constant K for cement, hollow tile, metal lath and similar construction, practically all the constants we have are based upon computation—they are only approximate. They may be right; they are probably wrong or largely in error, and we have no experimental work to guide us. We need in this country a vast amount of experimental research so as to place these fundamental constants of the heating business on a well-established foundation.

INFILTRATION AND RADIATION

One of the important factors in determining the heat loss from a building is the amount of air that leaks in around the cracks and crevices. One of the first assumptions with respect to infiltration was made by Carpenter, in which he assumed that the air in a room was changed once per hour due to infusion of air from outside or infiltration. In the average room this is approximately true. On the other hand, there is absolutely no reason why the cubic contents should have anything to do with infiltration, as infiltration occurs largely around the windows and window frames, and it should be based on wall and window conditions and not upon cubic contents. Recent experiments in New York show that, particularly in metal sash, infiltration should be based upon the perimeter of the sash.

Of course, there is one factor in this that we will never know, as no one can foresee how tight or how loose the contractor is going to construct the building. The equation of the contractor has never been determined, and considering the number of variables entering into the problem, it never will be determined. Such phases of our computations will always have to be covered by adding a certain percentage which might well be called the "factor of ignorance."

We have much more explicit information in regard to radiation than in regard to heat loss from buildings. We know that a two-column 38-in. radiator will give a value of K of about 1.65 B.t.u. with 1 lb. steam pressure and a room temperature of 70 deg. We know that this constant K increases as the difference between the temperature outside the radiator and the temperature inside the radiator increases. The approximate formula is:

$$K = 1.445 + 0.001437 \ (T_1 - T_2)$$

where T_1 = the temperature of the steam and T_2 = the temperature of the room.

We know something about the painting of radiators. If a radiator is painted with any kind of flake metal pigment, such as aluminum, gold or bronze, its efficiency is reduced approximately 25 per cent. If it is painted right over the aluminum with an enamel, the heat transmission is the same as the bare iron. I have made these experiments with 14 coats of paint on the radiator and the effect of the last coat was practically the same as that of the first coat.

This shows that the heat transmission of the radiator depends upon the ability of the surface to dispose of the heat and not upon the conductivity of the material of which the radiator is composed. That is, under the conditions existing in a radiator, the heat is transmitted much more rapidly through the metal of the radiator than the surface of the radiator can dissipate the heat. It is possible that we may find some coating which can be placed upon a radiator that will increase its conductivity beyond that of the bare iron. I do not know that any attempts have ever been made to do this, but it is one possible means of increasing radiator efficiency.

A radiator gives off heat in two ways—by radiation and by convection. For many years I have tried to find out what proportion of the heat is given off by radiation and what proportion by convection. Approximately it is "50-50," but I have never been able to make a satisfactory determination. This is impossible as undoubtedly some of the radiant heat from the radiator passes directly out through the wall and window surface without having any effect, and we may find it desirable to so arrange our radiators that all heat given off by them is given off by convection. We should have more fundamental knowledge on this subject.

Take the indirect radiation, and by indirect radiation I mean that not only through which air circulates by natural circulation, but through which air circulates by means of a

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[*] A paper presented at the annual meeting of the American Society of Heating and Ventilating Engineers, New York City, Jan. 23, 1918.

fan or of fan coils. We know that in this type of radiator all the heat from the radiator is given off by convection and in convection the form of the surface plays a very important part in its effectiveness. We also know, and recent experiments prove, that effectiveness of its surface is practically independent of the material of which the surface is composed. Copper, cast iron and wrought iron give practically the same effect.

The condensation from surfaces of this kind depends upon the air resistance of the radiator, provided the radiator is properly designed. That all depends upon the temperature of the surface and the temperature of the air. Since the condensation depends upon the air resistance of the radiator, in radiators of this class low resistance is not wanted because in order to get the condensation, it will be necessary to put in a number of radiators. Some engineers have specified widely spaced fan coils of low resistance and then put in a bank of coils in order to obtain condensation. This is simply wasting surface, as the same heating effect could be produced with closely-spaced coils and a much smaller number of them.

Determining Pipe Sizes

In this country we probably give less consideration to pipe sizes than in any other engineering country. The sins committed by the average contractor in the matter of pipe sizes are legion. When we get down to the economical use of pipe there is just one way to determine the sizes and that is to determine the resistance of each piece of pipe. We design good fan piping systems for air by resistance and yet we design our steam-piping sizes on a heating job by guesswork and experience—these terms are sometimes synonymous.

Some years ago, when I had some time on my hands and a heating plant was to be designed, I designed a real piping job and figured the pipe resistance to each radiator, and it is the most satisfactory job of heating that I ever installed. The average engineer, however, is too lazy to go to the trouble of doing this, and I am just as guilty as the rest.

To take pipe sizes out of a table and have them determined by the square feet of radiation is no basis of reason on a large job. It is quite possible that close to the boiler you can put 150 sq.ft. of radiation on a 1¼-in. riser, while at a remote point a 1¼-in. riser might carry only 60 sq.ft. A tremendous amount of pipe is wasted in the heating business by using excessive sizes. To design a system of this kind requires great accuracy but gives economical results.

The modern piping system in a steam-heating installation always reminds me of a small pumping station I once inspected. The board of directors had purchased a pump with a 2-in. discharge, and they instructed the engineer to run the 2-in. pipe from the pump a distance of three-quarters of a mile. When I came to examine the pipe I found that the pump was working against a static head of 70 lb. and friction head of 100 lb., and that in place of a 2-in. pipe they should have had a 6-in. pipe when the calculations were based on friction.

In the heating business, however, we more often make the mistake of using pipe too large rather than pipe too small, particularly in the smaller installations. In hot-water piping with forced circulation it is absolutely necessary to work from friction, if uniform circulation and no short-circuiting is expected.

Pipe Coverings

We have some very good information upon the subject of pipe coverings above ground. We are just acquiring a little information in regard to pipe coverings below ground. I have been making some experiments on pipes buried in the ground without any covering. The surprising thing in these experiments is the great distance that heat is transmitted through the ground. It is possible to detect a steam pipe under ground twenty feet away.

We also find that the condensation below ground is less than the condensation in the air. Our latest experiments show that there is less condensation with the steam passing through the pipe at a good velocity than with the steam in a quiescent state in the pipe. Of course, the deeper the pipe is buried in the ground the less is the heat transmission, and if we were to bury a pipe to a sufficient depth it would be unnecessary to have any covering at all—the ground would serve as its own heat insulator, so that the deeper we run heating ducts and heating pipes the less we need insulation. This fact is often lost sight of. Exact data in regard to these facts are not available, but as a number of experiments are being carried on we undoubtedly will soon be able to make some exact statements.

Every heating engineer seems to have an ambition to invent some new heating device that everyone will have to use and that incidentally will give him an opportunity to make some money. There have been placed upon the market and advertised, thousands and thousands of heating devices. Some of them are very good, some do no harm when placed upon the heating plant, and some are positively detrimental. Some are very good when properly applied and are useless under other conditions.

Some years ago I installed a heating plant in a residence, and the plant is almost identical with a certain patented system of heating now on the market. The only difference between my system and the patented one is that I left off all the patented articles and my system, I think, works a little better than similar near-by systems that used the patented articles.

We must always remember as engineers that the best design is always the simplest. There is a tendency among all engineers in the heating business to complicate their systems—to use too many unnecessary devices. This is largely due to the fact that these devices have been urged upon them by salesmen who must secure business. Many of these devices are very meritorious, but the attempt is to give them universal application when they should only be applied in specific cases.

The purpose of these remarks has been to emphasize:

1. The necessity of bringing to the attention of physicists and scientific men the fact that we need more knowledge of the science of heat and heat transmission. As we get more and more exact knowledge, this knowledge should be used by the engineer so as to leave less to experience and guesswork and more to actual figures. It will never be possible, however, in heating work to entirely eliminate the factor of judgment. So many variables enter into the problem, such as the conditions of building construction and the materials used, that we will always have to make our figures only the basis for our judgment.

2. To call the attention of engineers to the tendency to overload the plants with unnecessary devices and to urge the greatest simplicity in construction and the economical use of materials. The present high prices of piping and materials should lead us to consider every possible means of conserving these materials.

Cost Plus a Fair (?) Profit

Fuel-oil prices are discussed in a special bulletin issued Jan. 27 by the Federal Trade Commission, showing wide variation between the cost of oil plus refining and the sale price, particularly in the East and Middle West.

The figures are based on August reports of the refiners. The commission notes that published quotations show that prices now are from 70 to 104 per cent. higher than they were in June. Following are the August figures in cents for "representative cost," refining charge and sale price at district centers:

	Cost Crude	Refining	Cost Refined	Selling Price	Percentage Profit
New Jersey and Eastern Territory (Pittsburgh)..	$3.34	$0.94	$4.28	$8.00	87
Indiana and North Mississippi Valley (Chicago)	2.04	.47	2.51	5.75	129
Oklahoma (Tulsa)........	1.85	.58	2.43	3.60	48
Gulf Coast (Ft. Worth)..	2.14	.33	2.47	4.00	62
California Coast (San Francisco)........	1.96	29	2.25	3.45	53

The selling prices given were those at the district centers named in the first column.

Appointment of Ordnance Draftsmen

The Bureau of Ordnance, Navy Department, is in need of competent draftsmen. Men who are graduates in mechanical engineering from a technical school or college of recognized standing and have had some drafting-room experience, or men who are competent designers of heavy machinery, engines or shop tools, and have had a number of years' drafting-room experience, are eligible for these positions. The pay ranges from $4 to $6.88 a day, depending upon the qualifications of the draftsman.

There are now a number of vacancies in the rating of draftsman at the Washington Navy Yard. Additional information may be had by addressing the Commandant and Superintendent, Naval Gun Factory, Navy Yard, Washington, D. C.

Labor in Its Relation to National Efficiency

Until within a month the most discouraging fact to those looking on in Washington was the lack of any indication of broad consideration of the labor problem. The President's speech before the American Federation of Labor put up no constructive policy. It was a patriotic appeal. The Department of Labor was dealing with industrial disputes as they arose, but there was no expression of fundamentals. The direct parties to the controversy—employers and employees—were pulling apart instead of being drawn together. Apparently, as far as official Washington was concerned, we were to be allowed to come to an *impasse* without any effort on the part of the Government to compromise the difficulties.

Within two weeks there has been a most remarkable and a most welcome change. Today machinery is in motion which will bring the contending interests together on a broad basis. Light has broken. Hope has succeeded the discouragement of last month.

The first official recognition of the need for a broad consideration of the problem was the appointment of an Advisory Council to the Secretary of Labor. This appointment—far more important, broadly speaking, than many of the problems that have occupied front-page space—was hardly noticed in the public prints. Yet that council is expected to determine the policy that shall keep labor and capital working together during the war. More than this, if their work is far-seeing—as the constitution of the council gives warrant for expecting—it should have a tremendous, if not the determining, influence on the socio-economic conditions under which we shall live after the war. To industry, therefore—yes, and to labor, to the country at large—the establishment of the council is easily the most important event since the beginning of the war.

Lest this estimate of the importance of the council be considered extravagant, it will be well to set down here the work outlined for it. It will consider the establishment, in the Department of Labor, of agencies to perform the following functions:

1. A means of furnishing an adequate and stable supply of labor to war industries. This would embrace: (a) a satisfactory system of labor exchanges; (b) a satisfactory method and administration of training of workers; (c) an agency for determining priorities of labor demand; (d) agencies for dilution of skilled labor as and when needed.

2. Machinery that will provide for the immediate and equitable adjustment of disputes in accordance with the principles to be agreed upon between labor and capital and without stoppage of work. Such machinery would deal with demands concerning wages, hours, shop conditions, etc.

3. Machinery for safeguarding conditions of labor in the production of war essentials—this to include industrial hygiene, safety, woman and child labor, etc.

4. Machinery for safeguarding conditions of living, including housing, transportation, etc.

5. Fact-gathering body to assemble and present data collected through various existing Governmental agencies or by independent research to furnish the information necessary for effective executive action.

6. Publicity and educational division, which has the function of developing sound public sentiment, securing an exchange of information between departments of labor administration and promotion in industrial plants of local machinery helpful in carrying out the national labor program.

The first four divisions cover matters familiar to all manufacturers, contractors and engineers. Subdivisions (b), (c) and (d) of function (1) represent activities made necessary by the war. The true significance of the establishment of the body is appreciated when attention is directed to the sixth division, and when we recall the activities of the labor division of the British Ministry of Munitions and the influence that its work, of the same broad scope, has had on industrial England. What can one not read into "the function of developing sound public sentiment" and "promotion in industrial plants of local machinery helpful in carrying out the national labor program"? such program obviously being comprehended in the determination of the first four divisions of the program. One may expect that the "developing of a sound public sentiment" will necessitate the statement of the fundamentals for industrial and labor prosperity—a difficult task, but one the performance of which would be of the greatest value.

If further evidence is needed as to the possible influence of the council, it is furnished by its action last week in recommending to the Secretary of Labor (1) the organization of a board which will formulate an arrangement for ending strikes and (2) the centralization in his department of the industrial service divisions of the various branches of the war machine. Both plans have been approved by the secretary. The first of them is absolutely essential if coöperation is to replace strife.

The personnel of the council, as has been said, gives warrant for expecting broad-gaged results. It is headed by John Lind, former governor of Minnesota and envoy to Mexico, representing the public; Waddill Catchings, president of the Sloss-Sheffield Steel and Iron Co. and of the Platt Iron Works; and A. A. Landon, general manager of the American Radiator Co., representing the employers. Labor's members are John B. Lennon, treasurer of the American Federation of Labor, and John J. Casey, former member of Congress. Dr. L. C. Marshall, of the University of Chicago, is the economist member, and Agnes Nestor, of Chicago, represents women.

The council's duty is not merely to formulate a program, but to recommend the machinery for putting it into effect. That it believes in action is shown by its two public acts within ten days after its organization. Industrial leaders will be impressed by that evidence of virility and will follow closely the further activities of the body.—*E. J. Mehren, in Engineering News-Record.*

Work of the Labor Divisions of War Administration Co-ordinated

Upon the recommendation of the Advisory Council created to report on the handling of industrial relations growing out of the war, the Secretary of Labor has arranged for the coördination of the industrial service (labor) activities being developed in the various purchasing and supervisory offices of the war administration. Simultaneously, a number of new bureaus have been established and will assume the coördinating functions.

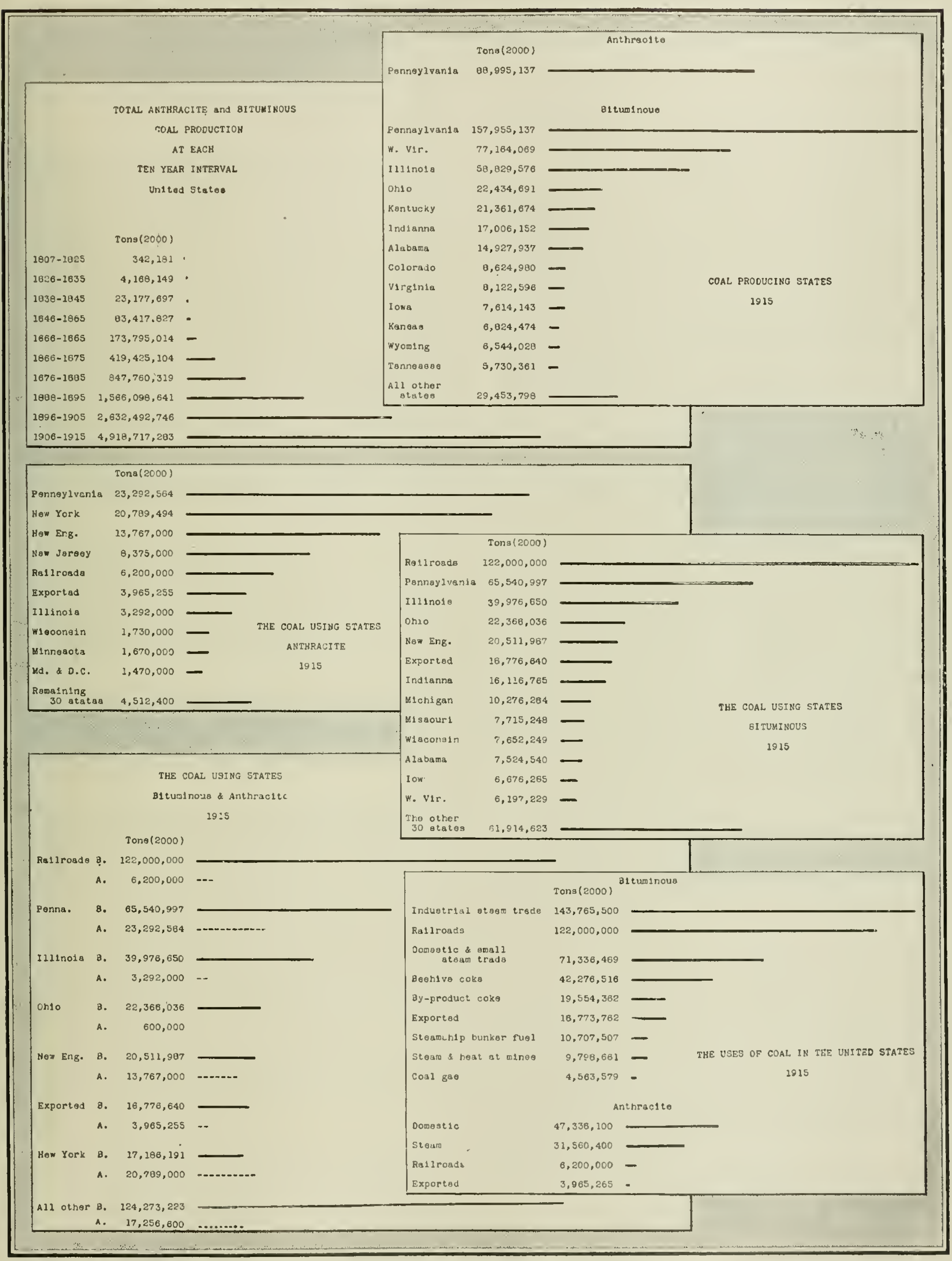
A well-developed industrial service division is in operation in the Ordnance Department, and similar organizations are being worked up in the other purchasing and supervisory branches of the War Department as well as in the Navy Department and the Shipping Board. These bodies are all developing plans for accomplishing similar results in their own given departments. In some cases they might, if not coördinated, work to cross purposes, and in any of their activities exchange of views on methods is desirable. The necessary machinery for getting together is now provided by the action of the Secretary of Labor.

The following new bureaus are established to effect the desired coördination: (1) Adjustment Bureau, to deal with disputes; (2) Condition of Labor Bureau, to administer conditions of labor within business plants, such as safety, sanitation, etc.; (3) information and Education Bureau, to promote sound sentiment and to provide appropriate local machinery and policies in individual plants; (4) Women in Industry Bureau, to correlate the activities of various agencies dealing with this matter; (5) Training and Dilution Bureau; (6) Bureau of Housing and Transportation of Workers; (7) Bureau of Personnel (which may possibly be fused with the Information and Education Bureau).

The present United States Employment Service will act as the coördinating bureau on the procurement of labor.

In a theater, hall or other densely filled room, the body heat given off by the occupants must be considered. This averages 425 B.t.u. per hour per person. After the building is once warm, thoroughly heated and the performance has started, it is more a problem of cooling than of heating, and it is the ventilation which is of prime importance.—*B. F. Sturtevant Engineering Series.*

Production and Uses of Coal in the United States



The above tables, with graphical representations of coal production in the United States and of consumption for the year 1915, were presented by Prof. L. P. Breckenridge at the recent meeting of the American Society of Heating and Ventilating Engineers.

The total production shown for the ten-year period 1906-15 would give an average annual production of 491,871,728 short tons. For 1916 the total production in the United States was 590,098,175 short tons, and for 1917 it was increased to 633,401 789 short tons.

Points in Steam-Boiler Management*

BY C. E. STROMEYER†

Some points relating to the safe and economical operation of steam boilers, obtained from the experience of an association which has been engaged for over fifty years in the prevention of boiler explosions by scientific inspection.

An EFFECT of the war conditions is the scarcity of labor and its replacement by substitutes. As a rule boiler attendants of former days, if engaged from outside, will have had varied boiler experiences, or if they were advanced from the position of laborers, they will have been selected on account of their reliable disposition and will have received some training. It is a mistake to imagine that boiler attendants should think that they are competent to judge of the safety of boilers. Their first and foremost qualification should be reliability. In fact, the little knowledge which can be imparted to them may be or, rather, often has been a dangerous thing. A fireman who has been taught to believe that it is dangerous, especially to himself, to overload the safety valve or to allow the water level to sink out of sight is safer than a man who has heard that a boiler is worked at a factor of safety of four or five and overloads the safety valve or who knows that the gage-glass bottom is 3 in. or 5 in. above the furnace crown and, once too often, allows the water level to fall out of sight.

There are, of course, many good men among the substitutes and many willing men who wish to do their best. They show their willingness by working hard, but a busy stoker is rarely a good one. A stoker's limited duty is to shovel coal on the fire, watch the pressure gage and water level, and manipulate the feed valve. A man who is new to his job is probably at first not impressed with the importance of these matters. Not until he discovers that the works actually engage an inspector to carefully examine the inside of the boiler, to adjust the safety and low-water alarm valves, and to verify the pressure and water gages, does he become impressed with the importance of these matters and of his own duties.

SUBSTITUTES FREQUENTLY REDUCE EFFICIENCY

Another effect of having to employ substitutes in place of well-tried stokers is that the efficiency as well as the output of boilers is very frequently reduced. This is particularly annoying at the present time, when coal is both scarce and dear and increasing demands are made on boilers. Take the case of a boiler that used to be fired with good coal by an expert fireman. Possibly the duty of such a boiler might have been increased 10 per cent. without a reduction of efficiency. If, however, the demand for steam has increased 10 per cent., if the quality of the coal has been reduced, and if an inexperienced stoker has been engaged, the probability is that he will not be able to maintain steam, he will rake and slice his fires and reduce the efficiency by perhaps 10 per cent., and the boiler, which is probably unable to increase its consumption by 20 per cent., wastes coal and reduces its steam production.

It seems desirable to discuss the suggestion that managers should set aside a day or two to the study of the firing problem, and devote themselves to the teaching, or rather guiding, of the newly appointed fireman. If, as may easily be the case, especially with the present high coal prices, such a procedure should result in a saving, the time and trouble will have been well spent.

Seeing that the best teachers are said to be those who are learning while teaching, the owner or his manager who watches the stoking operation need not imagine that his is a case of the blind leading the blind. The leading principles are exceedingly simple and are based on what is transparently obvious, that the maximum quantity of steam is produced from a ton of coal if the heat losses are reduced to a minimum.

The man who may be watching the fireman will soon discover that the more quickly the firing is done the more easily can steam be maintained, but only if the firing is properly done. Suppose that the coal is thrown on the grate anyhow; then, as there is less resistance to the passage of air at the thin parts than at the thick ones, the latter hardly burn away at all, while the former burn themselves first into pockets and then into holes, and long before the next firing is done there will be a rush of cold air through these holes. This unfavorable condition has, of course, to be remedied by raking, but that operation introduces cold air and results in a diminished steam production and a reduced efficiency.

It would, however, be wrong to forbid the raking of the fires or the opening of the doors. Some coals must be broken up, and some coals, because they produce smoke, must be supplied with air through the doors. This latter air supply has to be regulated by studying the smoke discharged from the chimney. If it is black or dark, then the air supply through the fire-door is insufficient; if there is no smoke, then there is an excess of air either through the door or through holes in the bed of fuel or through the bed of fuel if this is too thin.

HOW TO FIRE DIFFERENT QUALITIES OF COAL

As some of the preceding remarks apply only to smoke-producing coal, a few words on the firing of different qualities will be needed. Roughly speaking, coals can be divided into caking and noncaking coals. The latter break up while burning, and if disturbed by raking, they fall through the grates and the result is much waste. Coal of this class should therefore be thrown evenly on the grate and should not be disturbed. Considerable manual skill and a good eye are required to do this work properly, and inexperienced firemen will have to use the rake.

Caking coal, on the other hand, must be broken up after it has become heated and stuck together. Caking coal produces smoke, and that has to be avoided. The general practice with this coal is therefore to throw it on the front end of the grate, nearly choking the fire-door hole, which is kept open during the time that the mass of coal is warming up and producing smoke and combustible gases. Then this mass of coal is broken up with a rake and shoved back, the fire-door being entirely or partly closed some time after. Another method, called side firing, is equally effective in preventing smoke. The firing interval of, say, fifteen minutes is divided into two short ones of about seven minutes, and during the one opening of the door the fuel is thrown only on the one side of the grate, and during the next on the other side. The smoke which is produced on the newly charged side is consumed as it passes to the other side. If this firing were done with the help of long troughs filled with coal, in the same way that horizontal gas retorts are charged, the periods during which the fire-doors are open could be very much curtailed and the efficiency of the furnaces improved.

INSPECTION AND CLEANING OF FLUES NECESSARY

Bad results are, however, not always due to the fireman; in many cases the inspection and cleaning of flues is not properly carried out. In a certain factory the power requirements had increased somewhat, and on account of bad coal and poor firemen the steam production sank lower and lower and the coal consumption rose higher and higher. On the advice of an outsider, which advice seemed reasonable under the existing conditions, a sixth boiler was added to the five overworked ones. Then the trouble grew

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*Excerpts from "Memorandum by Chief Engineer" of the Manchester Steam Users' Association.

†Chief engineer, Manchester Steam Users' Association.

worse; even more coal was burnt, and less steam was produced. Several people were asked to give advice, and we too were appealed to. On examining the various dimensions it was found that the flue area was only suitable for three boilers, and as alterations could easily be made, we recommended the building of a larger flue. It was also discovered that there was a solid layer of flue dust, which must have been damp occasionally, of two feet in thickness. The factory can now be worked with the greatest ease with five boilers, and the saving of coal is probably well over $5000 per annum.

A source of recurring trouble is the disturbance of the brickwork of the flues and outer walls. It is an almost daily occurrence that our inspectors draw attention to these and similar defects in the flues and thus help to maintain the efficiency. That these disturbances should occur is but natural, for the difference in length of a boiler when cold and when hot is about half an inch, and as it is a heavy weight, it is sure to pull the brickwork about. These expansions and contractions also affect the outer walls, which crack and admit air, and this unnecessary air wastes much heat. As these cracks may occur the day after an inspection, it is desirable to look for them and have them plastered up. Searching along the walls with lamp or candle flames is not an efficient method. A simpler plan is to have the boiler walls, especially the front and the blowoff pit, whitewashed as frequently as may be found necessary. If any cracks occur, the inrushing air, laden with coal dust, will blacken the cracks, and these can then be plastered up and whitewashed.

In continuation of my analysis of the Board of Trade reports on boiler explosions, those accidents which were due to wasting of shell plates have now been taken in hand. The analysis embraces 75 reports. The general conclusion to be drawn from these practical cases, and it is an important one, is that when wrought iron plates are very materially reduced in thickness by corrosion, their tenacity is also reduced to about one-third of its original value.

In plotting these 75 explosions against the years in which they occurred, it appears as if the prospect of the early passing of the Factory and Workshops Act, with its compulsory inspection clauses, had frightened many careless owners into having their neglected boilers examined. At any rate, whereas before 1900 there were on an average three explosions per annum due to shell wasting, from that date the average number was reduced to one.

Men Wanted for Shipyard Work

The Department of Labor is seeking to enroll 250,000 men for work in shipyards. A nation-wide campaign began Jan. 28 with an appeal to all men possessing any skill in any of the trades necessary to the building of ships to enroll as a reserve supply of labor sufficient to meet present and future needs of the shipyards. Some of the men enrolled will be called upon at once, others as they are needed. Men who enroll themselves will not sacrifice independence of action, and are advised to remain at their present jobs until notified that places in shipyards are open to them. The "four-minute men" will conduct a speaking campaign in every state.

Following is the quota for each state: Maine, 2972; New Hampshire, 1698; Vermont, 1390; Massachusetts, 14,321; Rhode Island, 2355; Connecticut, 4786; New York, 39,526; New Jersey, 11,348; Pennsylvania, 32,771; Ohio, 19,802; Indiana, 10,847; Illinois, 23,662; Michigan, 11,734; Wisconsin, 9611; Minnesota, 8762; Iowa, 8531; Missouri, 11,812; North Dakota, 2548; South Dakota, 2393; Nebraska, 4400; Kansas, 6330; Delaware, 811; Maryland, 5250; Virginia, 8453; West Virginia, 5327; North Carolina, 9264; South Carolina, 6253; Georgia, 11,001; Florida, 3435; Kentucky, 8260; Tennessee, 7952; Alabama, 8994; Mississippi, 7488; Arkansas, 6022; Louisiana, 7064; Oklahoma, 8492; Texas, 17,023; Montana, 1583; Idaho, 1621; Wyoming, 618; Colorado, 3320; New Mexico, 1428; Arizona, 888; Utah, 1660; Nevada, 386; Washington, 5906; Oregon, 3204; California, 11,310.

The American Engineer*

The American engineer is that citizen of the United States who is qualified by training and practice to join with his coworkers to direct organizations and harness natural resources which will crush the greatest menace to Christianity and make the world safe for democracy.

He is the man who will after this war solve the great international problems of making all countries safe and sanitary for their peoples.

He is the man who has for his foundation a broad engineering education that has prepared him to use the natural elements which he has discovered and developed through experiment until today the Atlantic and the Pacific are speedways; the air is a highway free from dust and the shortest distance between two points for travel, and a line for conversation by telegraph and telephone; the swamps are the best fields for grain; and the hills and mountains are producing untold wealth.

He is the man who recommends the expenditures of millions by his government or by the business men of the country. All industry, either in war or peace, depends upon the engineer for production and operation. Our profession is extremely fortunate to have the opportunity to step in and be the deciding factor in the war which will mean most to civilization for all ages.

The American engineer is the man of the hour.

Would Utilize Peat

Governor McCall of Massachusetts has sent a message to the legislature, saying in part: "I recommend that you make an investigation of uses of peat, the near-by deposits, the methods of its utilization in producing heat and power, and in other ways with a view to enacting such legislation relating to it as your investigation may show to be for the public interest. Peat has long been used as fuel in different countries, and I am informed that at present it is utilized in Germany in the production of heat and power, in munitions of war and even in clothing, through use of its fiber. I am advised that large deposits exist in New England, and that even under existing methods of preparation much of it may be made available for power and heat before the coming of another winter.

"Its large content of ammonia would tend to relieve scarcity of that article, much needed now in the making of munitions and invaluable at all times for use in agriculture. We are largely dependent on coal for heating our homes and keeping our industries in motion. If we have on hand in great quantities a substance which may make us less dependent upon coal, it is our obvious duty to take steps for its development. I believe the subject well worth immediate investigation by you either through a regular or special committee or in some other way, and that a moderate appropriation be granted to make the investigation effective."—*Boston News Bureau.*

Ecuador and Peru Favor American Electrical Goods

America's opportunity of increasing its sales of electrical goods in Ecuador and Peru during the absence of German competition is pointed out in a report made public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce. Before the war this trade was divided between Germany and the United States, the advantage being with the American manufacturer. The Government's report is concerned with the market as it exists today and the opportunities it offers for the future.

Copies of "Electrical Goods in Ecuador and Peru," Special Agents Series No. 154, can be purchased at the nominal price of 10c. from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the district or coöperative offices of the Bureau of Foreign and Domestic Commerce.

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*From address given before the Savannah Chapter of the American Association of Engineers, Saturday, Jan. 26, by A. H. Krom, general secretary, American Association of Engineers.

Firing Bituminous Coal in Heating Boilers

Technical Paper 180, "Firing Bituminous Coals in Large House-Heating Boilers," by S. B. Flagg, Bureau of Mines, tells how to burn bituminous coals economically in these large house-heating boilers.

In burning bituminous coals in large house-heating boilers the fuel bed should not be seriously disturbed until the coal has become well coked; that is, until the gassy part of the coal has been largely driven off.

Both caking and noncaking types of coal may be used satisfactorily in boilers of this type if properly handled.

The presence of a moderate proportion of screenings mixed with the lump coal causes the fresh charge of coal to heat more gradually and the emission of smoke is kept down more easily. Therefore such a proportion of screenings is an advantage.

Increasing the proportion of screenings in the coal necessitates the use of a stronger draft to carry the same load. Smaller firing charges must also be used and more frequent attention given. The tendency of caking coals to cake is increased and this also means that the fire must have more frequent attention.

One large charge of coal fired by the spreading method will result in a longer emission of dense smoke than the total emission of such smoke from two charges of half the size fired some time apart and by the alternate method.

With some coals moderate charges fired by the alternate method necessitate less frequent attention to the heater than larger charges fired by the spreading method. Caking coals having a considerable proportion of fine coal or screenings are usually among these. Conversely, a fire will usually require more frequent attention when a lumpy caking coal free from screenings or a noncaking coal is fired in moderate charges by the alternate method.

The number of tests made was not large enough to justify conclusions regarding the relative efficiency with which a coal may be burned by the two methods of firing, but the author believes that in actual service over considerable periods better results will be obtained by the alternate method.

Frequency of cleaning the fires will be determined by the character of the coal and the rate at which it is burned, but with most coals the fires should be cleaned only once or twice in 24 hours in ordinary weather.

If the alternate method of firing is employed, the cleaning should be done just before firing the fresh charge, and only one-half of the grate cleaned at a time. Then little or no smoke will result from the cleaning, because the side of the fire on which there is uncoked coal is not disturbed.

All three of the coals fired by the alternate method in the tests described were burned at rates corresponding to the heating conditions during the most of the winter, with scarcely any manipulation of the fuel bed except the cleaning of the fires and an occasional leveling just before firing.

The average fireman is apt to poke and slice the fire much more than is necessary. If a caking coal is used and the caked fuel must be broken up before it is well coked, slice the fire by running a straight bar under the fuel bed and raising it slightly so as to crack the caked mass. Do not stir the bed upside down by raising the bar through the fuel bed, nor break the bed with a bar from the top.

If the fuel bed is covered with a charge of fresh fuel in a layer more than 5 in. thick, the new charge, unless it is very free from slack, is likely to have a smothering effect. Then the output of the boiler will be correspondingly decreased and, especially if the spreading method of firing is employed, the mass of fresh coal will usually have to be broken once or twice before the fire will pick up. Consequently, the maximum firing charge should be not much thicker than five inches and for caking coal containing considerable slack it should not be more than four inches thick. Of course, when a fire is to be kept banked, heavier charges may be used.

Do not fire large lumps of coal. Break all lumps into pieces no larger than fist size.

Large house-heating boilers do not require an intense draft to meet any reasonable demands for heat if the fuel bed is kept in proper condition, but the draft must be properly controlled.

The damper regulator should work freely with changes in steam pressure and should close the swinging damper in the ashpit door before it starts to open the check damper in the smoke pipe.

The doors on the front of the boiler should fit snugly in their seats; special care should be taken to prevent any material wedging between the doors and the front and thus admitting air when or where it ought to be prevented from entering.

Do not allow clinkers to accumulate in the fire or too great a quantity of ashes on the grates. Be careful, however, in shaking the grates not to shake through unburned fuel.

In ordinary or severe weather keep an active fuel bed averaging ten to twelve inches deep. In milder weather the depth of active fuel may be decreased by keeping a layer of ashes on the grate under the live coals.

Copies of this technical paper may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

Fuel Administration Wants Uniform Regulation

The United States Fuel Administration has advised all state fuel administrators east of the Mississippi River and also those of Minnesota and Louisiana in part as follows:

As a result of various restrictive regulations established locally by state fuel administrators in certain states, we are receiving many complaints of discrimination between different states and inequalities in the requirements of neighboring communities. Fuel Administrator Garfield has concluded that regulations in every state should in general be uniform with those promulgated by Washington. This does not absolutely prohibit additional local regulations where they are necessitated by extraordinary local emergency.

We particularly desire to secure uniform regulations for the whole country at the earliest possible date, not later than Feb. 6.

In general, we feel that the United States Fuel Administrator's order of Jan. 17 is sufficiently drastic and that further extensions should not be attempted unless absolutely required by local emergency and substantially supported by local sanction.

If you have already established additional regulations, we ask that you announce a date in the near future, after which regulations in your state will be uniform with those of Washington.

Dam's Effect on Subsurface Waters

Where a power company by erecting and maintaining a dam across a stream raises the level of the water so that flow of percolating waters from adjacent lands owned by others is obstructed, and where the impounded water of the stream percolates through the adjoining land, causing subsurface waters under such land to rise and remain so near the surface as to injure the land and the crops and improvements thereon, damages may be recovered by the landowner against the power company on the theory of unreasonable interference with his enjoyment of his property. (Florida Supreme Court, Cason vs. Florida Power Co., 76 Southern Reporter, 535.)

It is difficult to put ordinary wood screws into hard timber; the thread in the wood keeps stripping, and the head of the screw may break. It can be easily done, however, in the following way: Grind or file another screw flat on one side to the form of a half-round or shell bit to be used as a tap. A small hole is first bored into the hard timber and the tap screwed into it. It will cut a good thread, and the screw can then be easily turned into the hole if it is well coated with tallow.

New Publications

Central Stations. By Terrell Croft. Published by McGraw-Hill Book Co., New York, 1917. Cloth; 5¼ x 8 in.; 332 pages; 306 illustrations. Price, $2.

Although this book has been written, as its name would indicate, to deal with central-station practice, nevertheless the major portion of the work can be read with profit to himself by almost anyone interested in the generation, transmission and distribution of electric power. The work is divided into eighteen sections. The opening section defines the terms most commonly used to designate the different components of an electrical-energy-distribution system; then the other chapters following in order take up: Distribution loss and distribution-loss factors; maximum demand, maximum-demand meters and demand factors; diversity and diversity factors; load factor, plant factor and connected-load factor; load graphs and their significance; general principles of circuit design; calculation and design of direct-current circuits; calculation and design of alternating-current circuits; transmission and distribution of electrical energy; lightning-protection apparatus; automatic voltage regulators; switchboards and switchgear; characteristics of electric-generating stations; adaptability of steam, internal-combustion engine, and hydraulic prime movers; steam-electrical-energy generating stations; internal-combustion-engine stations, and hydro-electric stations.

The treatment of alternating-current problems usually involve more or less complicated trigonometric expressions; however, the author, in the many problems on alternating-current circuits treated in this book, keeps within the bounds of simple arithmetic, therefore he can be comprehended by the reader of only limited mathematical attainments.

As the dimensions in the book would indicate, its treatment of central-stations practice must needs be limited, and in this case is confined to the practical side of the subject; therefore, the work will meet the needs of the practical electrician and station operator rather than those of the designing engineer, and it should fill a large field of usefulness with the former class of readers.

Personals

Capt. C. W. Dyson, U. S. N., of the Bureau of Steam Engineering of the Navy Department, has been promoted to the rank of rear admiral.

Rear Admiral R. S. Griffin, U. S. N., chief of the Bureau of Steam Engineering, has been reappointed as engineer-in-chief of the navy for another term of four years.

F. E. Pratt, formerly representative of the Worthington Steam Pump Co. in Brazil, is now New York sales manager of the Steam Motors Co., Inc., with offices at 30 Church St.

E. P. Worden, formerly chief engineer of Henry R. Worthington Pump Corp., has resigned to accept the position of mechanical engineer for the Submarine Boat Corp., New York.

J. H. Pardee, president of The J. G. White Management Corporation, New York, and J. P. Ripley, engineer, have returned to New York from a general inspection of the Manila Electric Railroad and Light Co. and other interests in the Philippine Islands operated by The J. G. White Management Corporation.

Engineering Affairs

The American Society of Mechanical Engineers announces the following sections meeting: Buffalo, N. Y., Feb. 26; Meriden, Conn., Feb. 14; New York City, Feb. 21; Philadelphia, Feb. 26.

New York Chapter A. A. E.—At the next meeting of the New York Chapter of the American Association of Engineers, which will be held at the Hotel McAlpin on Wednesday, Feb. 13 at 8 P.M., H. H. Bubar, of the National Aniline and Chemical Co., will speak on "The Engineer; His Present and Future."

The Trustees of the United Engineering Society, held their annual meeting Jan. 24, and elected the following officers for the ensuing year: President, Charles F. Rand, member A. I. M. E.; first vice president, Calvert Townley, member A. I. E. E.; second vice president, Robert M. Dixon, member A. S. M. E.; treasurer, Dr. Joseph Struthers, member A. I. M. E.; secretary, Alfred D. Flinn, member A. S. C. E.; chairman finance committee, J. Vipond Davies, member A. S. C. E.

The American Institute of Electrical Engineers will hold its sixth annual midwinter convention on Feb. 15 and 16, in the Engineering Societies Building, New York City. The convention will include four technical sessions, which will take place on Friday morning, afternoon and evening, and Saturday morning. A strictly informal dinner will be held at the Cafe Boulevard, 41st St. and Broadway, on Friday evening, Feb. 15, at 6:30 o'clock. The session on Friday morning will be devoted to "Circuit-Breaker Ratings." One paper will be presented, "Rating and Selection of Oil Circuit-Breakers," by E. M. Hewlett, J. M. Mahoney and G. A. Burnham. The session on "Meters and Measurements" will be held on Friday afternoon. Four papers are scheduled for this meeting: "A New Standard of Current and Potential," by C. T. Allcutt; "The Thermoelectric Standard Cell," by C. A. Hoxie; "The Character of the Thermal-Storage Demand Meter," by P. M. Lincoln; "Measurement of Power Losses in Dielectrics of Three-Conductor High-Tension Cables," by F. M. Farmer. Dr. A. C. Crehore will lecture at the Friday evening session on "Some Applications of Electromagnetic Theory to Matter." This lecture will be followed by a discussion. The session on "Alternating-Current Commutator Motors" will be held Saturday morning. Three papers will be presented: "Commutation in Alternating-Current Machinery," by Marius A. C. Latour; "The Secomor—a Kinematic Device Which Imitates the Performance of a Series-Wound Commutating Motor," by V. Karapetoff; and "The Polyphase Shunt Motor," by W. C. K. Altes.

Miscellaneous News

A Boiler Exploded at the plant of the Leesburg Silica Sand Co., near Mercer, Penn., Jan. 25, killing two and injuring two men. The cause of the explosion is unknown.

A Boiler Explosion in a shoe store at Peterboro, Ont., on Jan. 26 caused a fire that wiped out one-half of the business section of the town, entailing a loss of half a million dollars damage.

National Labor Policy Board Authorized—Acting on the recommendation of the Advisory Council (on labor problems), the Secretary of Labor will appoint a Policy Board, which will formulate a program for the settlement of difficulties between employers and employees arising during the war. It will be composed of twelve persons. The American Federation of Labor has been asked to nominate five persons to represent the workers and the National Industrial Conference Board five to represent the employers. Each group will nominate a representative of the public, thus completing the board.

New Power House Extension—The steel framing of the extension of the new power house of the Binghamton (N. Y.) Light, Heat and Power Co., is completed and the roof and side walls are well under way, being, on Jan. 19, about 50 per cent. finished. Work has been started on the installation of the additional boilers. The concrete work is in such condition that with a few warm days this end can be finished. During the enforced industrial shutdown it was possible to close this plant completely and to do a considerable amount of construction work to good advantage, with some saving in cost over what it would have been if the work had been done while the plant was running.

A Boiler Exploded on the Weirich farm, west of Washington, Penn., on Jan. 17 and damaged considerable property. Fortunately no one was injured. The cause of the explosion was a most unusual one. A contracting company was putting in a switch from the B. & O. railroad to the coal works, when one of the piles that was being driven for a trestle struck and broke a 5-in. oil line. The oil gushed out, ran down the hill to the boiler and caught fire, and in less than five minutes the boiler let go and was wrecked completely. Two tool sheds standing nearby were also burned. The property loss amounted to about $5000, as well as a financial loss occasioned by the holding up of the work awaiting new equipment.

Flywheel of Stoker Engine Burst — A series of circumstances led up to the injury of one man and the curtailment of the electric service in Cumberland (Md.) and the Georges Creek region early Monday morning, Jan. 21. It appears that some repair parts had been ordered and shipped by express from Boston on Jan. 8 for the governor of the stoker engine in the plant of the Edison Electric Illuminating Co. of Cumberland, but were not delivered as promptly as expected. In the meantime the engine was being operated and, although given unusual attention, it raced and burst the flywheel. Fragments of the wheel struck and broke the arm and hand of one of the employees. The service on several lines of electric railway was reduced one-half and all users of electric current were urged to minimize their demands so that all might have part service.

Drug Stores Recruiting Agents for Merchant Marine—Five hundred and twenty-six druggists scattered all over the New England States, from Fort Kent, Me., to Greenwich, Conn., and from Swanton, Vt., to Nantucket, have volunteered as recruiting agents for the new merchant marine, and will begin their official labors Feb. 4, according to a statement issued by Henry Howard, Director of Recruiting for the United States Shipping Board, Custom House, Boston, Mass. Each of the druggists will conduct an enrolling station at his store, at which young Americans from 17 to 27, inexperienced in seagoing, may put their names to applications for training as sailors firemen, oilers, water-tenders, cooks or stewards, on ships of a training squadron maintained by the Shipping Board, with headquarters at Boston, for preparing crews to serve on the new cargo fleets of the merchant marine. The coöperation of the druggists with the Shipping Board was brought about through the initiative of Louis K. Liggett, of Boston.

Government Control of Fuel Oil—On Feb. 4 President Wilson issued his proclamation putting under license manufacturers and distributors of fuel oil with an output of more than 100,000 barrels a year. The proclamation went into effect Feb. 11.

Preference in shipments is to be given first for war purposes at home and abroad, public utilities and private consumers in the order of necessity.

The classes referred to and the order of their preference are: (1) railroads and bunker fuel; (2) export deliveries or shipments for the United States army or navy; (3) export shipments for the navies and other war purposes of the Allies; (4) hospitals where oil is now being used as fuel; (5) public utilities and domestic consumers now using fuel oil (including gas oil); (6) shipyards engaged in Government work; (7) navy yards; (8) arsenals; (9) plants engaged in manufacture, production and storage of food products; (10) army and navy cantonments where oil is now being used as fuel; (11) industrial consumers engaged in the manufacture of munitions and other articles under Government orders; (12) all other classes.

Mark L. Requa, recently appointed Oil Director by Dr. Harry A. Garfield, Fuel Administrator, will have power to move oil to those industries needing it most, classes of priorities being issued by President Wilson in rules and regulations governing those distributors licensed. The proclamation is essentially a war distribution measure and exerts no control or restriction over the oil wells. Government officials say there is no shortage of fuel oil or gasoline production.

Traffic congestion preventing sufficient shipments to the Allies and allowing the movement of fuel oil to industries that are secondary in importance to war needs, caused the Government to issue the order.

Business Items

The January Issue of the "Walworth Log" is largely devoted to the newly opened Seattle branch of the Walworth Manufacturing Co. We recognize the work of L. F. Hamilton.

Walter A. Zelnicker Supply Co., of St. Louis, has established permanent offices at Minneapolis, Minn., at 627 Plymouth Building, to serve the North Central and Canadian trade. Richard K. Papin, formerly St. Louis and Southwestern representative of the Davenport Locomotive Works and for ten years manager of the Zelnicker Co.'s equipment department, is in charge. He is especially qualified to handle inquiries on rails, locomotives, cars, machinery, piling, tanks, etc., in his district.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$6.50—6.75
Buckwheat ..	4.30—5.00	2.75	5.50—6.00	6.00—6.25
Rice	3.75—3.95	2.20	4.50—5.00	4.50—5.00
Barley	3.25—3.50	1.95	4.00—4.25	3.25—3.75
Boiler	3.50—3.75	2.20	....	....

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)................	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higber than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918		One Year Ago
Buckwheat ..	$3.15-3.75	$2.50	$3.75	$3.40	$4.15
Rice	2.65-3.65	2.10	3.65	3.00	3.35
Boiler	2.45-2.85	1.95	3.55	3.15	....
Barley	2.15-2.40	1.85	2.40	2.05	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Split
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.35-2.75
2-in. lump..	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Steam egg ...	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Mine-run ...	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Alexander—City plans to issue $10,000 bonds for the erection of an addition to its electric-lighting plant. J. A. Coley, Ch. Engr.

Ala., Mobile—The Mobile & Ohio Ry. plans to install electrical equipment in its grain elevator which is nearing completion. P. A. Wood, Ch. Engr.

Ark., Osceola—Town plans to install a 200 kva. generating unit in its electric-lighting plant. E. Teaford, Mgr.

Calif., Palo Alto—City voted $66,000 bonds to install a Diesel engine in its electric-lighting plant. J. F. Byxbee, Jr., City Engr. Noted Jan. 8.

Fla., Pensacola—The Pensacola Electric Co. plans to build a 13,200 volt transmission line from here to Pensacola Naval Station. T. J. Hanlon, Jr., Mgr.

Ga., Portland—The American Potash Co. is in the market for 200 kw. electrical equipment to operate fuller mills for manufacturing potash from sericite.

Kan., Leon—City having preliminary plans prepared by W. B. Rollins & Co., Engr., 209 Ry. Exch. Bldg., Kansas City, Mo., for the erection of an electric-lighting plant.

Ky., Walton—The Walton Electric Light Co. is in the market for an electric generator.

Mich., Marquette—City is having preliminary plans prepared for the erection of a power plant to include a 140 ft. pentstock. Estimated cost, $150,000. M. H. Wright, City Engr.

Miss., Canton—City plans to install new equipment in its electric-lighting plant including a surface condenser for a 200 hp. engine and spray equipment for cooling. J. T. Sharp, Jr., Mgr.

Miss., Houston—City plans to install new equipment in its electric-lighting plant including an 80 hp. crude oil engine directly connected to a 60 kw., 3 phase, 2300 volt, revolving field motor and switchboard, etc. A. G. Atkinson, Supt.

Mo., Wellsville—The Blattant Poultry and Manufacturing Co. plans to rebuild its electric-lighting plant which was recently destroyed by fire.

Neb., Falls City—City voted $75,000 bonds for the erection of an electric-lighting plant. K. J C. Mullen, City Clerk. Noted Dec. 25.

Neb., Juniata—City plans an election soon to vote on a $7000 bond issue for the erection of a transmission line from here to Hastings.

N. J., Jersey City—The Board of Freeholders, Hudson County, is having plans prepared by P. A. Vivarttas, Arch., 110 4th St., West New York, for the erection of a 1 story, brick, power house and electric lighting plant. Noted Dec. 18.

N. Y., Albion—The State is in the market for two 150 hp. horizontal tubular boilers. Estimated cost, $10,000. L. F. Pilcher, Capitol, Albany, Arch.

Okla., Canadian—City plans to vote on bond issue for the erection of an electric-lighting plant.

Penn., Harrisburg—The Harrisburg Light and Power Co. plans to improve and enlarge its plant; also install 4 new stokers.

Penn., New Castle—The Mahoning & Shenango Ry. and Light Co. has been granted permission by the Public Service Commission to issue $2,000,000 bonds; the proceeds will be used to build additions and improvements to its system. E. H. Bell, Youngstown, Ohio, Mgr.

Va., Richmond—The Virginia Ry. and Power Co. plans to erect a 21 x 116 ft. concrete addition to its power house on 12th St. C. B. Buchanan, Gen. Mgr.

Wash., Seattle—The Board of Public Works will receive bids until March 1 for the erection of an addition to its hydro-electric power plant. Estimated cost, $5,000,000. J. D. Ross, Supt. of Light and Power.

Wash., Tacoma—City having plans prepared for the erection of an additional power plant with 17,000 hp. capacity. Estimated cost, $1,000,000. L. Evans, Gen. Supt.

Wis., Madison—The Di-Electric Manufacturing Co., incorporated with $40,000 capital stock, plans to build a plant. E. W. Smythe, Jr., Vroman Blk., and E. K. Frautschi, incorporators.

B. C., Nelson—The Swanetta Power Co., incorporated with $500,000 capital stock, plans to build a large hydro-electric plant on the Bend d'Oreille River, south of Nelson.

Ont., Elmira—A. S. Gingrich is in the market for a 30 to 35 hp. oil engine.

Ont., Hamilton—The Wentworth Orchard Co., Sun Life Bldg., is in the market for a 5 hp. electric motor for hydro power.

Ont., Merritton—The Riordon Pulp and Paper Co., Ltd., 355 Beaver Hall Sq., Montreal, will soon award the contract for the erection of a power plant.

Ont., Renfrew—The British Explosives, Ltd., is in the market for several $^{1}/_{15}$ hp. and ½ hp. electric motors. W. C. Cram, Mgr.

Ont., Toronto—E. Pullen, 20 Main St., is in the market for a 10 hp. D. C., 550 volt, high speed motor.

POWER

Vol. 47 NEW YORK, FEBRUARY 19, 1918 No. 8

The Secret

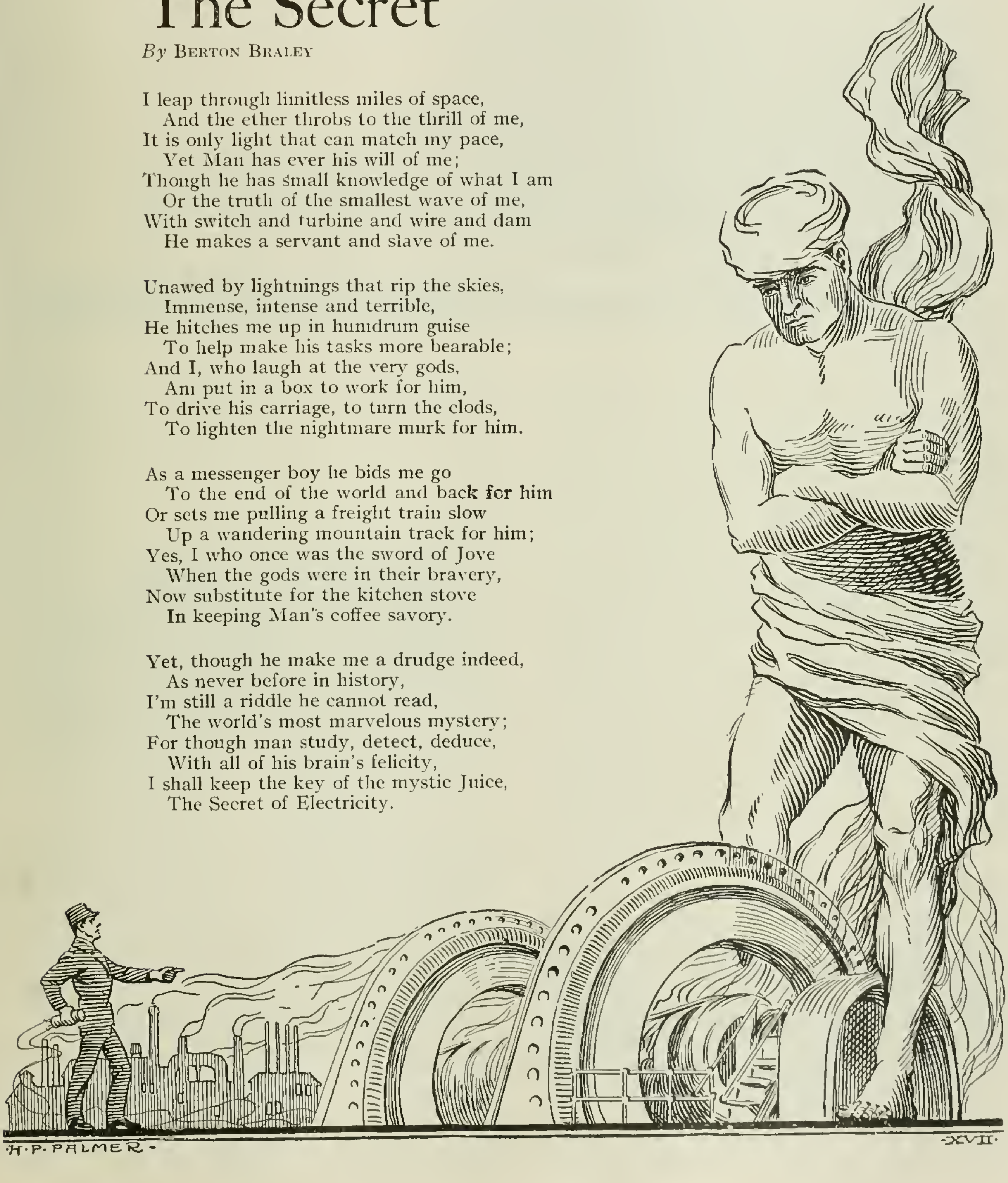
By Berton Braley

I leap through limitless miles of space,
  And the ether throbs to the thrill of me,
It is only light that can match my pace,
  Yet Man has ever his will of me;
Though he has small knowledge of what I am
  Or the truth of the smallest wave of me,
With switch and turbine and wire and dam
  He makes a servant and slave of me.

Unawed by lightnings that rip the skies,
  Immense, intense and terrible,
He hitches me up in humdrum guise
  To help make his tasks more bearable;
And I, who laugh at the very gods,
  Am put in a box to work for him,
To drive his carriage, to turn the clods,
  To lighten the nightmare murk for him.

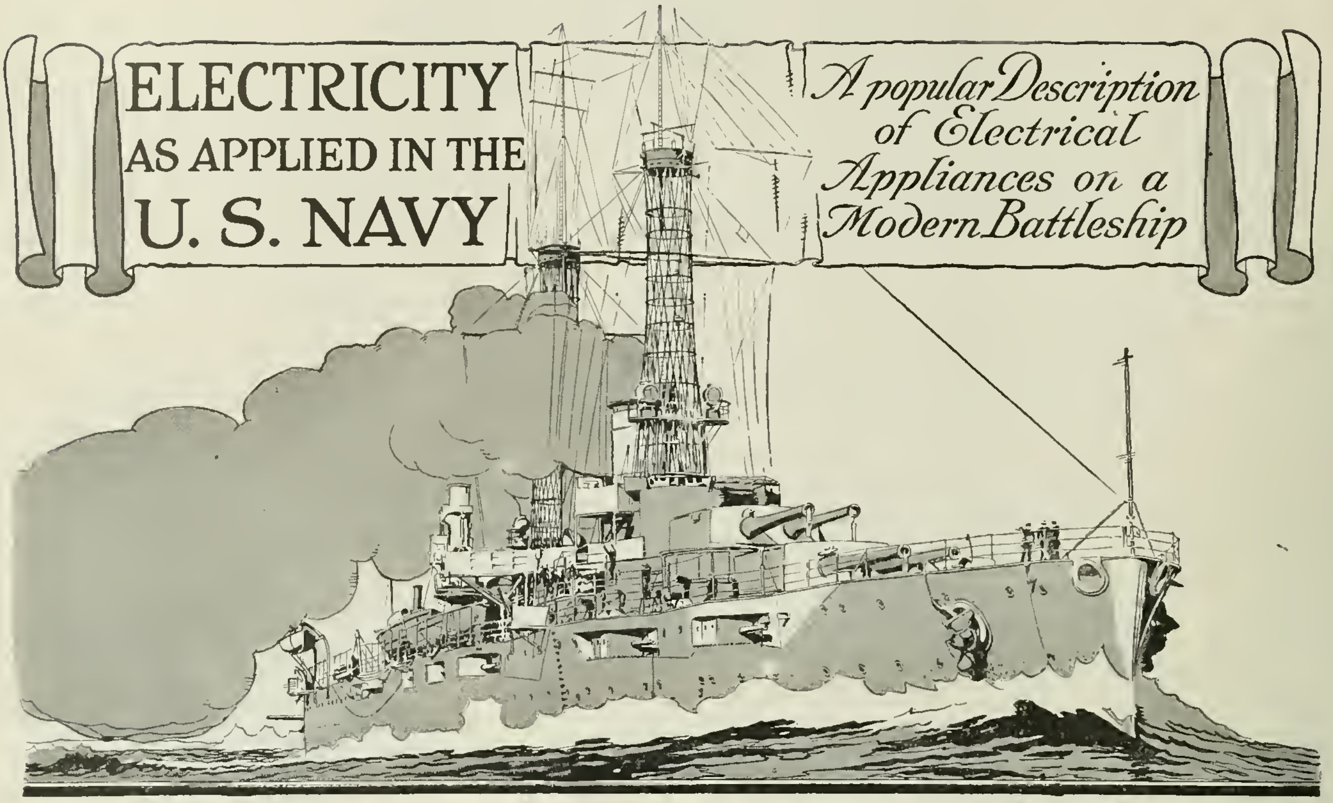
As a messenger boy he bids me go
  To the end of the world and back for him
Or sets me pulling a freight train slow
  Up a wandering mountain track for him;
Yes, I who once was the sword of Jove
  When the gods were in their bravery,
Now substitute for the kitchen stove
  In keeping Man's coffee savory.

Yet, though he make me a drudge indeed,
  As never before in history,
I'm still a riddle he cannot read,
  The world's most marvelous mystery;
For though man study, detect, deduce,
  With all of his brain's felicity,
I shall keep the key of the mystic Juice,
  The Secret of Electricity.



ELECTRICITY AS APPLIED IN THE U. S. NAVY

A popular Description of Electrical Appliances on a Modern Battleship



UNTIL recent years the application of electricity to the operation of the various devices on board ship has been slow. This has been true of marine work in general. The most conspicuous exception to this rule has been in the American Navy, which is not only a larger user of electrically driven machinery than the merchant marine, but also leads the navies of the world in the application of electricity to the almost countless devices used on board a modern battleship.

The employment of electricity on shipboard was at first limited to illuminating purposes and searchlights. On the cruiser "Brooklyn," which was launched in 1895, electric motors were used to drive the ammunition hoists and for turning two of the turrets, but it was not until the launching of the battleships "Kearsarge" and "Kentucky" in 1898 that an extensive use of electrically driven auxiliaries began. Since then the use of electricity has been extended until today some of our largest and most powerful superdreadnaughts and battle cruisers are electrically driven. As an illustration of this, the superdreadnaught U.S.S. "Tennessee," which has a displacement of 32,600 tons and is designed for a speed of 21 knots per hour, will be driven by four alternating-current motors, one on each propeller. Each motor will have a normal capacity of 6700 hp. and a 25 per cent. overload rating, or 8375 hp. for four hours. Power will be supplied by two 13,500-hp., standard steam turbo-alternators similar to those used in large power houses throughout the country (Fig. 1). In addition to the main generators there will be six 300-kw. direct-current geared-turbine-driven auxiliary units, similar to that shown in Fig. 2, to furnish current for exciting the alternators and for light, power, signals and several hundred motors used about the ship. This equipment was described in *Power*, Aug. 7, 1917 issue.

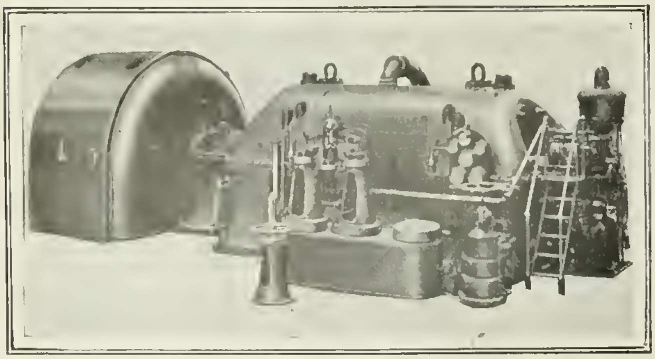


FIG. 1. STANDARD STEAM TURBO-ALTERNATOR

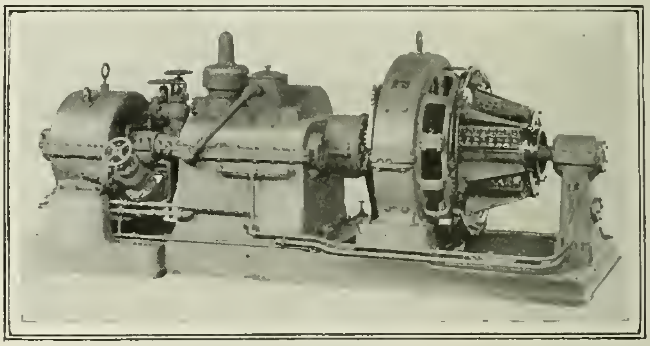


FIG. 2. GEARED-TURBINE, DIRECT-CURRENT GENERATOR

The first ship of any importance, excepting submarine boats of the navy, to be electrically driven was the U. S. collier "Jupiter," which was built at the Mare Island Navy Yard and put in commission Sept. 15, 1913. This vessel is of about 20,000 tons displacement and is designed to carry 12,000 tons of coal or oil. The main units of this boat consist of one alternating-current turbo-generator set of 7000 hp. and two 3500-hp. wound-rotor induction motors, wound for 3400 volts. The stator and rotor of one of the motors are shown in Figs. 3 and 4 respectively.

The electrical installation on board a modern battleship may be divided into three general systems—power, lighting and signaling. Outside of the main drive, when the vessel is electrically driven, the power plant usually consists of a number of 300- to 375-kw. turbine-driven 125- or 250-volt direct-current generators, although in some of the oldest ships 80-volt equipments are used. As pointed out in a previous paragraph, the superdreadnaught "Tennessee" will have six 300-kw. direct-current units in the auxiliary power plant. The generators of the earlier equipment were direct-connected to the turbine, ran at a speed of 1500 r.p.m. and were of the compound-wound type with commutating poles. In the more modern equipments geared turbines are used and the generator operates at from 700 to 1000 r.p.m. On account of the comparatively heavy current and small diameter of the commutator, the 125-volt units generally have two commutators, one at each end of the armature.

It is general practice to provide not less than four of these sets and locate them in two separate dynamo rooms, so that in case of the disablement of one dynamo room the entire electrical equipment will not be put out of business.

The method of operating the generators varies somewhat with different nations. In America it is general practice to operate them in parallel, while in Europe in many cases the generators are arranged so that the distributing circuits can be transferred from one generator to another, but the generators cannot be operated in parallel.

Figs. 5 and 6 show the back and front view of a switchboard used for the control of the direct-current power plant on a modern battleship. On the center panels are mounted the switches, circuit-breakers, instruments, etc., for the control of two generator sets, either or both of which may be connected to the busbars. The end panels are for the control of the distributing circuits. Circuit-breakers are used to protect the large-capacity circuits, while fuses are used on the smaller circuits. Where the power plant is divided and located in different rooms, tie lines are provided between the different switchboards so that the machines in one generator room may supply power to busbars of the switchboard located in the other room. In addition to the main switchboard other distributing panels are located in the various parts of the ship for the control of motors and distribute the current to the various equipments.

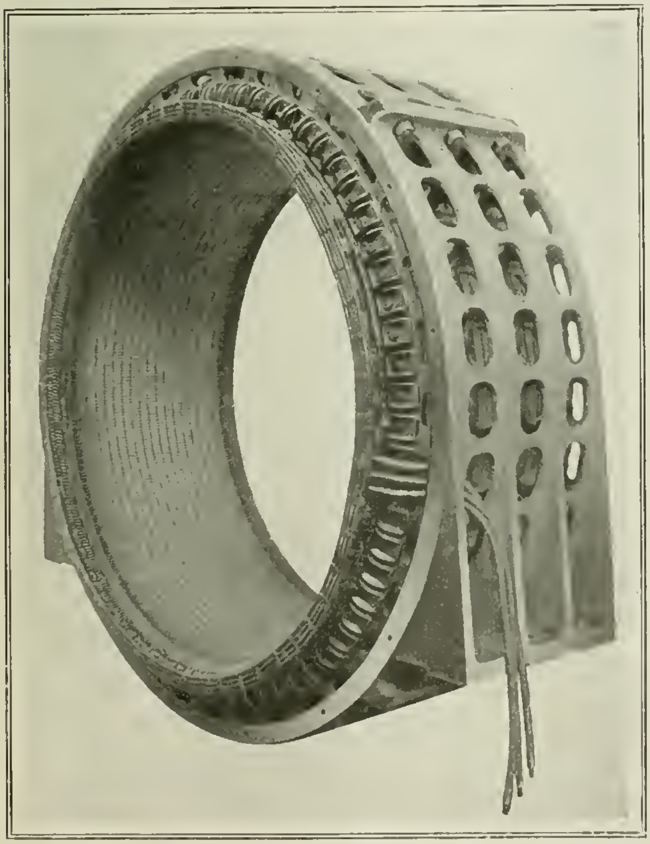


FIG. 3. STATOR OF ONE OF THE JUPITER'S MOTORS

FIG. 4. ROTOR OF THE STATOR, FIG. 3

In America the earlier practice was to construct the switchboard panels of slate mounted on angle-iron supports, and sometimes cushioned with rubber to prevent breakage. The more modern practice is to construct the panels of nonfragile insulating material, such as asbestos lumber. In Europe the panels are frequently made of steel with the instruments insulated therefrom.

The largest and one of the most important applications of electricity on board ship is the steering gear. The operation of the steering gear by some power means dates back to the "Great Eastern," on which was placed a steam-operated steering equipment. The success of this installation soon led to the general adoption of steam-operated steering gears on most all classes of vessels. Although electrical steering gears have been given attention for some twenty or twenty-five years past, it is only within recent years that they have been adopted in general. At first they were applied in conjunction with steam engines, the electrical drive acting as an auxiliary.

One of the first systems to be successfully employed, utilized a motor-generator set to supply power to a shunt motor for operating the rudder. Control with this system was effected on the Wheatstone-bridge principle and is known as the "Pfatischer" system, one arm of the rheostat being located at and operated from the steering stand and the other located at and operated by the rudder.

This system followed along the idea of the old follow-up system, used with the steam engine; that is, the helmsman sets the steering wheel at the angle it was desired to have the rudder moved to, and when the latter arrived at this position it automatically cut out the source of driving power.

Quite a number of the United States battleships and cruisers are equipped with a rheostatic system of control on the steering gear. The motor is fed directly from the ship's mains, thus obviating the use of a motor-generator set. With the rheostatic control the motor is controlled by the use of a contactor panel, Fig. 7, equipped with contactors for reversing the motor, cutting out the armature resistance, for operating at slow speeds and for dynamic braking. The controller, along with the starting resistance, is usually placed near the motor and operated from a steering stand, Fig. 8, located at steering stations in different parts of the ship. The helmsman can always tell the position of the rudder by a helm-angle indicator located near the steering stand. To prevent the rudder from jamming on the hard-over position, limit switches are provided similar to the one shown in Fig. 9.

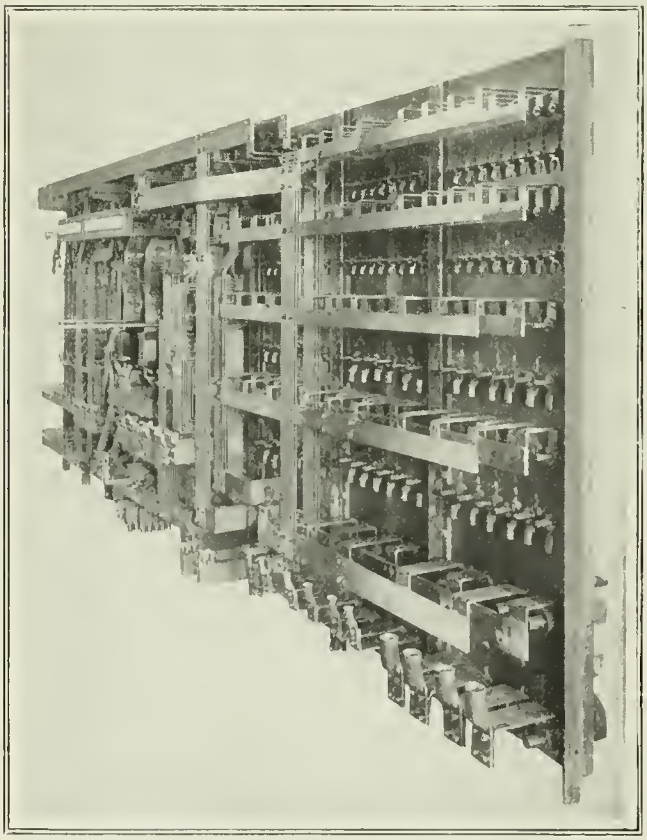


FIG. 5. BACK VIEW DIRECT-CURRENT SWITCHBOARD

The system which is now receiving favorable consideration at the hands of the Navy Department involves the use of a hydraulic mechanism to operate the rudder. A variable-stroke hydraulic pump delivers oil to large rams connected to the rudder crosshead, and this variable-stroke pump is driven by a constant-speed motor, which is started up and allowed to run continuously. A small pilot motor operates the valve of the hydraulic variable-stroke pump, and the control of this pilot motor, from various stations in the ship, is the same as the rheostatic system described in the foregoing.

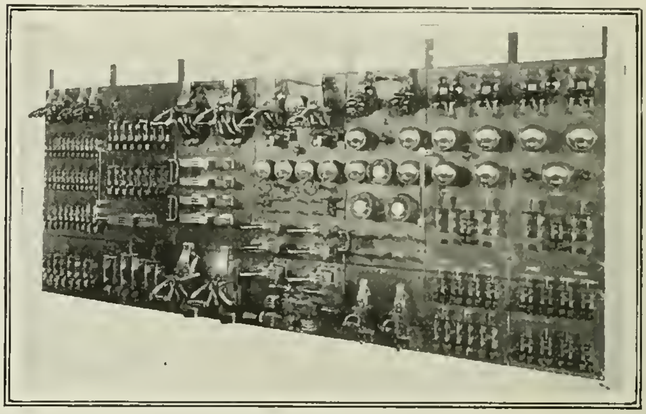


FIG. 6. FRONT VIEW DIRECT-CURRENT SWITCHBOARD

While this hydraulic-electric steering-gear system may be said to be still somewhat in the experimental stage, it is being installed at the present time quite generally on large naval vessels. Its principal point of advantage is that it substitutes the hydraulic variable-stroke pump and hydraulic ram for the very inefficient screw-gear arrangement previously used on all the old vessels, and therefore permits the installation of a motor of relatively small horsepower for driving the rudder.

The requirement on nearly all naval vessels is that the motor must operate the rudder from hard-over to hard-over in twenty seconds. On the most recent and largest vessels, it has been modified in some cases to thirty seconds. With the rheostatic control on the larger battleships, compound-wound interpole motors of 300-hp. capacity are required to operate the steering gear, while with the hydraulic-electric the horsepower is reduced to about one-half, or 150. Fig. 10 shows a pair of 175-hp. steering-gear motors operating in parallel on a single rudder shaft. The motors are equipped with disk brakes on the armature shaft, which, assisted by dynamic braking, brings the rudder to rest.

Another service that requires large motors on board ship is the anchor windlass. On some of the recent equipment installed on American battleships, two motors are used, each having a one-hour rating of from 125 to 150 hp. The motors are compound-wound and equipped with commutating poles and a disk brake, and are coupled directly to the two worm gears through which the windlass is operated. The control of the motors is such that each can be operated independently as well as the two simultaneously in series or parallel. The equipment is capable of raising two 20,000-lb. anchors simultaneously and 360 ft. of chain on each, each chain weighing about 36,000 lb., at the rate of 36 ft. per minute.

The cranes for handling the lifeboats are operated by compound-wound motors, usually of 50-hp. capacity, one of which is shown in Fig. 11. In this equipment the requirements are that it raise a 40,000-lb. load at

20 ft. per min. and the empty hooks at 60 ft. per min. The motor is equipped with an electric brake so that it will hold the load if the power fails. A motor is also used for rotating the crane so as to place the boats in position on deck. The capacity of this motor is frequently 50 hp. A rheostatic controller for a boat-crane motor is shown in Fig. 12.

Winch motors for both coal and cargo are 35 to 45 hp. in size, compound-wound and equipped with interpoles. The winches for coal handling are generally capable of handling a 5000-lb. load at 200 ft. per min. and a 20,000-lb. load at 50 ft. per minute.

Forced ventilation is an important feature in the operation of a modern battleship. On large ships the ventilation system may consist of over one hundred electrically driven fans, handling 500,000 cu.ft. of air per minute. The size of the motors varies from 1 to 15 hp. In addition to the ventilation motors, there may be as many as 200 small desk or bracket fans in use. In the latest practice on battleships steam turbines are being used extensively for driving the ventilating fans.

Electrically driven pumps are used for various purposes, such as fire, fresh-water supply, bilge, drainage tanks, sanitary purposes, refrigeration, etc. These motors vary in size from 1 to 75 hp. To handle the bilge water 15 to 20 pumps are supplied. These pumps require vertical and horizontal motors varying in size from 25 to 75 horsepower.

Motors are used for turning the turrets, elevating the large guns and hoisting ammunition. These services require motors ranging in size from 3 to 35 hp. Variable-speed as well as constant-speed motors are used on the ammunition hoists.

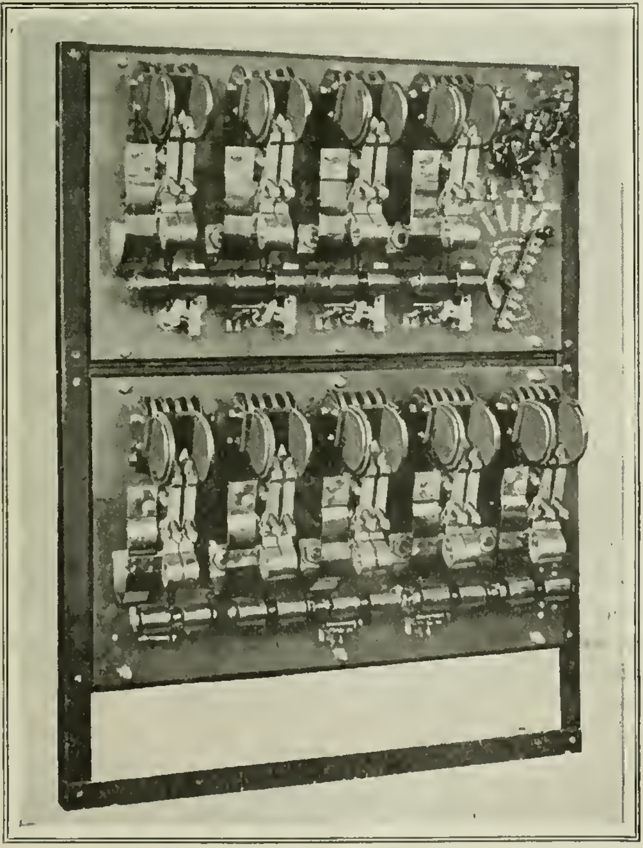
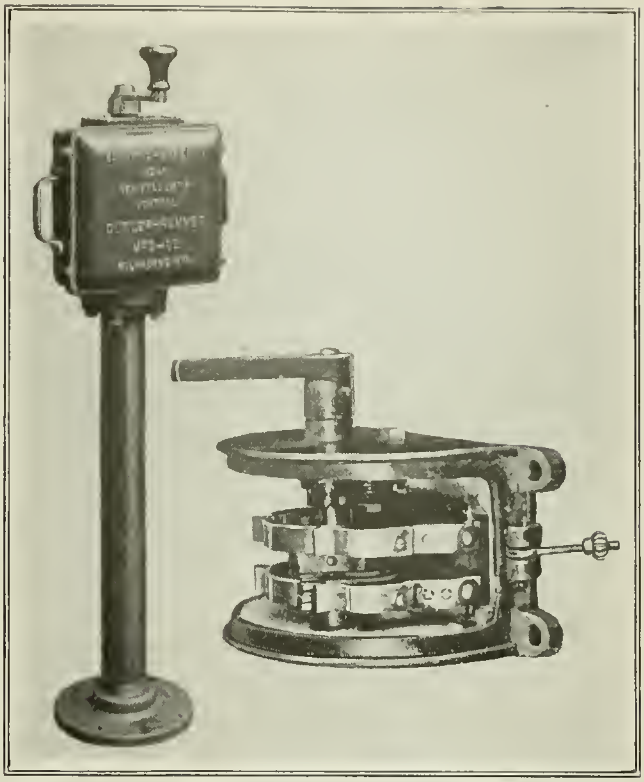


FIG. 7. CONTACTOR PANEL FOR 300-HP. ELECTRIC STEERING-GEAR MOTOR



FIGS. 8 AND 9. STEERING STAND AND LIMIT SWITCH

Fig. 8—On left, electric steering stand for non-follow-up system. Fig. 9—On right, rudder limit switch

Electricity is used for almost every imaginable purpose on board the modern battleship. The completeness of the equipment is evident from such items as moving-picture machines, motor-driven cake mixers, ice-cream freezers, etc., which would indicate that about all the luxuries that may be had on land are also provided on board ship.

The illuminating equipment of a battleship consists of from 3000 to 4000 lights. Incandescent lamps are used almost exclusively for this purpose. The fixtures are of special design to make them water-tight and also on account of the vibration of the ship.

The cables must also be of special design on account of the moisture. They are insulated with a high-grade rubber and a suitable braid, and then protected with a lead sheath, covered with metal armor. This cable is quite flexible and can be easily made to conform to almost any contour. The electrical installation on a battleship requires from 75 to 100 miles of cable.

The signaling systems are also a very extensive part of the electrical equipment, consisting of some 40 different systems, including ammunition-hoist indicators, gun firing, turret telephone, fire-control telegraph, engine-room telegraph, fire alarms, torpedo firing, wireless telegraph, etc. A number of these equipments are installed in duplicate and are supplied with power from two sources. The systems operate on voltages ranging from the potential of the power circuit down to 15 volts used for call bells. Both alternating and direct current are used. Alternating current and low-voltage direct current are obtained from motor-generator sets.

One of the most interesting pieces of electrical apparatus on a battleship is the gyroscopic compass. This has completely displaced the magnetic compass on the larger vessels and submarines of practically every navy in the world. The sensitive element is a rapidly revolving wheel which, owing to the peculiar effect of gyroscopic force, keeps its axis parallel to the axis of the earth and hence points to the north pole.

A magnetic compass must be corrected for the iron masses surrounding it and also for the difference between the location of the magnetic north pole and the geographic north pole. As the gyro compass is independent of magnetism, these corrections do not have to be made and calculations based on compass bearings are greatly simplified. The only corrections are for the speed of the ship and for latitude. These corrections are made semi-automatically and involve no calculations.

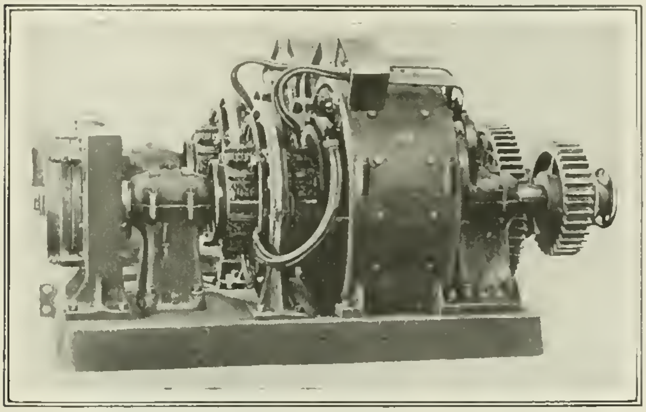


FIG. 10. PAIR OF 175-HP. STEERING-GEAR MOTORS

The complete battleship equipment consists of two master compasses, one of which is shown at *M*, Fig. 13, a number of repeater compasses *R*, a motor-generator set *G*, and a control panel *C* for running either master compass and for interconnecting the repeater compasses in any desired combination.

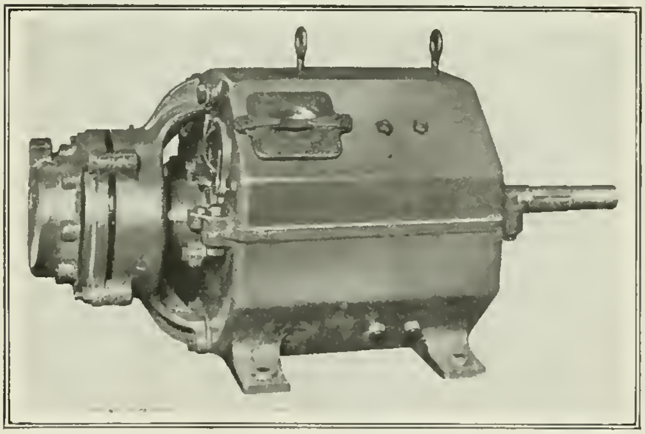


FIG. 11. BOAT-CRANE MOTOR

The repeater compasses contain small motors which are driven by a transmitter in the master compass. The master compass is mounted below deck out of all danger, while the repeater compasses are used in navigating the ship. These repeaters are mounted in different ways—on a stand similar to the ordinary magnetic compass; on the wall; on a pelorus *P*, Fig. 13, for taking azimuth sights directly; and they even may be portable so that the navigating officer may walk around and still have the compass with him.

To the layman the master compass appears to be a tremendously complicated and delicate mechanism. A detailed view of it is given in Fig. 14. Its "sensitive element" is a steel wheel *W*, with its axis horizontal, driven at 8600 r.p.m. by a self-contained three-phase alternating-current motor. This wheel runs in a vacuum to eliminate the air friction, which is very great at the high speed at which it runs. The wheel and case *W* are suspended on a steel cable, which is held at its upper end in a ball bearing. This bearing is covered by a cap which can be seen at *C* in the figure. Connected to this case through the "floating ballistic" is the compass card *D*, Fig. 15, from which the heading is read. The card is kept continually oscillating about half a degree by a small motor, to keep out any slight friction lag in the reading. The force of the gyro does not turn the card directly, but closes contacts at *T* and *T*, which causes a little motor to drive it one way or the other. The transmitting mechanism which controls the repeaters is also operated by this motor. At *W* are shown the small wheels for correcting the

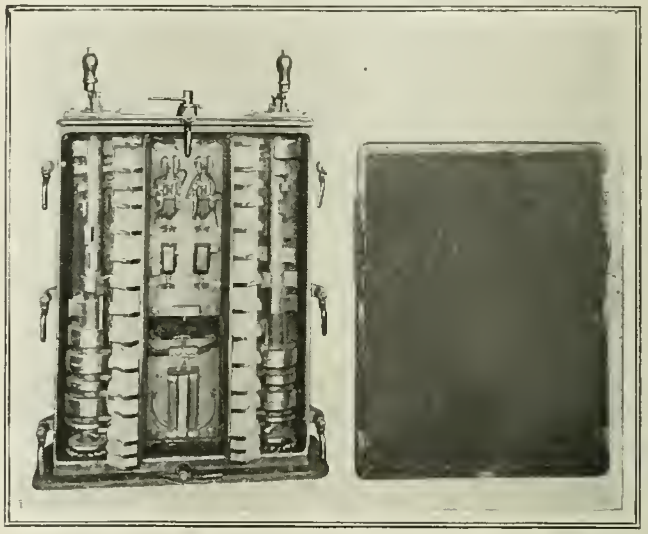


FIG. 12. BOAT-CRANE MOTOR CONTROLLER

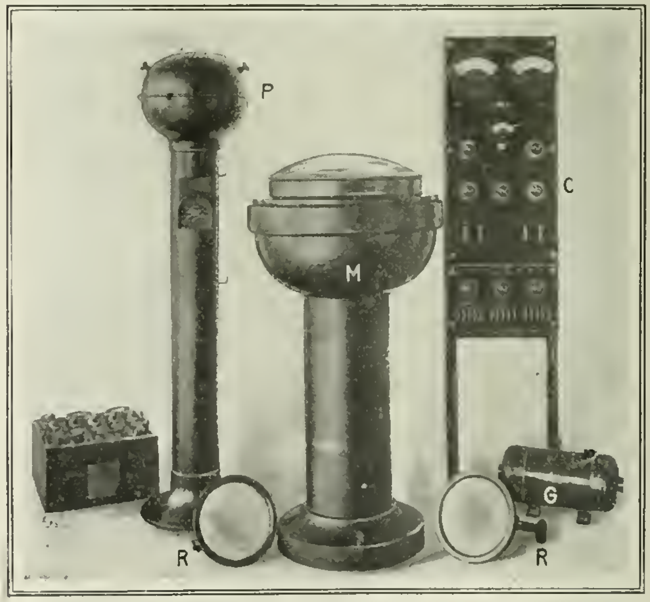


FIG. 13. GYROSCOPIC-COMPASS EQUIPMENT

compass for speed and position. These two knobs operate interconnected cams and link which automatically solve an involved trigonometric equation and make the necessary corrections.

Another interesting and important device used on warships is the high-intensity searchlight, Fig. 16. The beam from this light is the most brilliant known, being equal to the sun's intensity at 8 a.m. or 4 p.m. New York latitude. The size used on ships is 36 in. diameter and will throw a beam 40 miles.

The positive and negative electrodes are respectively 16 and 11 millimeters in diameter in this lamp. Its candlepower is 320,000 per sq.in., and in the 36-in. type it has a beam intensity of 256,000,000 cp. The temperature of the arc is about 5000 deg. C., or 9000 deg. F. The arc running at a temperature of 7000 deg. F. higher than the melting point of the carbon holders is only about one inch away from them. The positive carbon is rotated as it is fed forward, while the negative feeds forward and upward at an angle to meet the positive. The voltage of the arc is approximately 75. When focused sharply, the beam will ignite paper at a distance of approximately 250 ft. A larger size, 60 in. in diameter, used in coast-defense work, is the most powerful light in the world, having a beam of 1,280,000,000 cp. This lamp stands ten feet high and weighs three tons; newspapers may be read in its light thirty miles away. It has been reported that signals flashed by this searchlight were seen 150 miles away. The brilliant light is obtained by the use of special carbons having a deep but small crater in the positive carbon, in which the vapor burns. This gives a beam 3.5 times greater than an arc using ordinary carbons.

FIG. 14. SIDE VIEW OF MASTER GYRO COMPASS

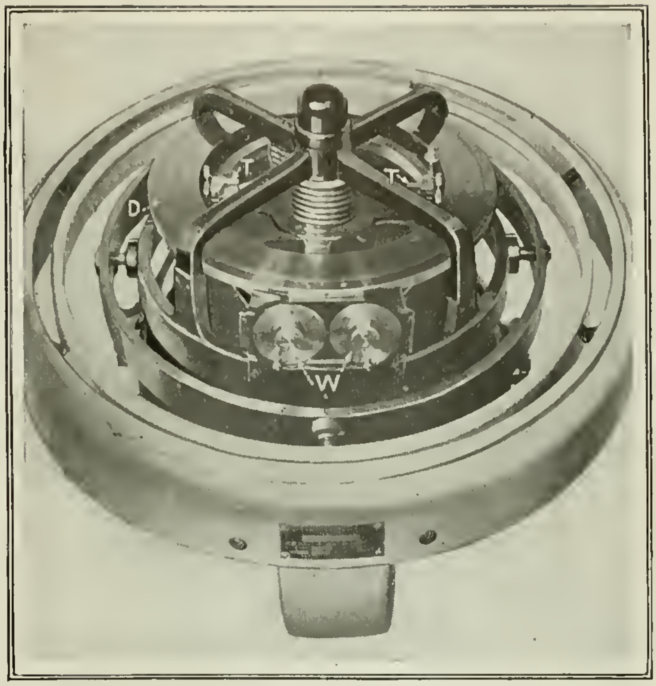


FIG. 15. TOP VIEW OF MASTER GYRO COMPASS

The lamp may be controlled directly by using the handwheel *W*, or it may be trained and elevated by using the remote-control lever *L*, which may be located in any part of the ship. This is a very important feature, as it is much easier to see what the light is disclosing from a point 200 ft. away from the light than from a position near the light itself. It is possible to elevate the lamp to a vertical position, making it available for anti-aircraft work. The shutter, which completely cuts off the beam, may be seen at *S*. The

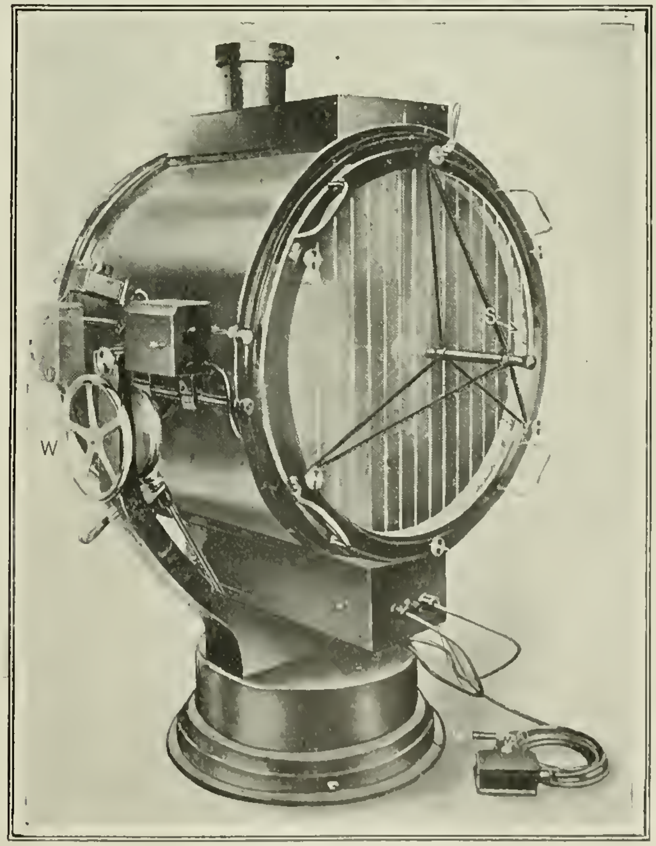


FIG. 16. THIRTY-SIX INCH SEARCHLIGHT

movement of a lever closes it tightly. This feature is very important, as a dying arc makes an excellent target. For this reason the shutter is closed previous to putting out the light, leaving the boat in complete darkness.

The arm of the Navy that is attracting more attention than any other at the present time is the submarine boat. Modern submarine boats are propelled by oil engines on the surface and electric motors when submerged, each propeller shaft being operated by an oil engine or motor according to the conditions of operation, the oil engines operating the motors as generators while on the surface and charging storage batteries, which in the submerged condition, supply current to the motors to drive the boats.

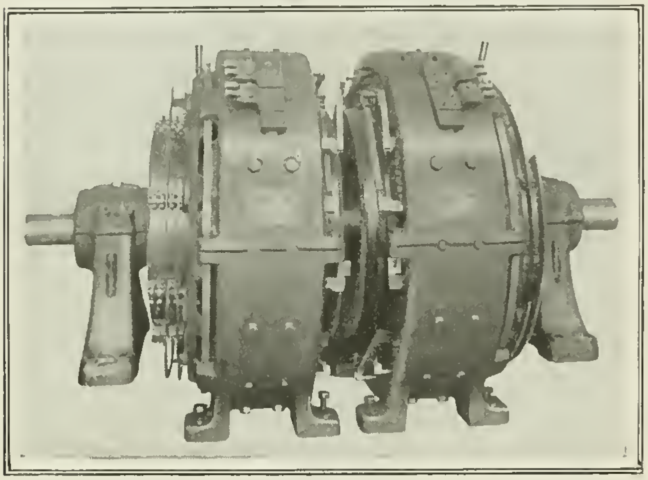


FIG. 17. PAIR OF SUBMARINE PROPELLED MOTORS

The main motors, Fig. 17, one on each propeller shaft, are of large size, varying from 500 to 800 hp. according to the size of the boats, and these motors are remotely controlled by automatic-contactor controllers from a central station. Each motor may consist of two units as in the figure or a single unit according to conditions.

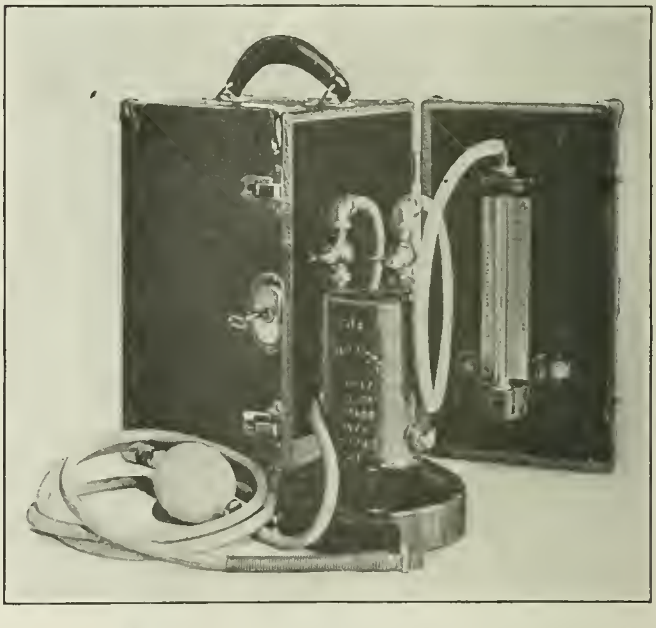
In addition to the main-motor equipments, each submarine is provided with a large number of auxiliary-motor equipments for operating pumps, air compressors, steering gears, diving gears, periscope-lifting gears, etc. The horsepower of these auxiliary equipments varies from about 0.5 to 50 or 60 hp., and the majority of them are operated by contactor push-button controllers. In addition, the submarines are equipped with electric cooking and heating devices and complete sets of wireless and other signaling apparatus.

[Considerable of the material in this article was compiled from articles in the *General Electric Review:* February, 1914, "Electric Propulsion of the U.S.S. 'Jupiter,'" by W. L. R. Emmett; and June, 1915, "Electricity in Marine Work," by Maxwell W. Day. "Electricity the Future Power for Steering Vessels," by H. L. Hibbard, Transactions of the A. I. E. E., Vol. XXXIII, was also drawn upon. This material has been added to when necessary to bring it up to date. The descriptive literature of the Sperry Gyroscope Co. was also consulted. Photographs were supplied by the Westinghouse Electric and Manufacturing Co., the General Electric Co., Cutler-Hammer Manufacturing Co. and the Sperry Gyroscope Co.—Editor.]

Mercury Column Indicates CO_2

The Dwight Manufacturing Co., of Chicago, has added to its line a second form of CO_2 indicator. The use of a mercury column calibrated to indicate directly the percentage of CO_2 is the distinguishing feature. The initial design, which is still retained, used a small spring-type gage for this purpose. Both types are accurate and so rapid in operation as to encourage the consistent use necessary to produce a material saving in coal.

The new instrument, known as type B, is shown in the illustration. It consists of the usual metal reservoir, a specially calibrated mercury gage and the carrying case for the complete outfit. When in service the reservoir is disconnected from the gage and a sample of flue gas pumped through the chamber. A comparatively large supply of potash solution fills the base, and on the surface of this solution floats a layer of mineral oil sealing from the chemical the gas sample being collected. When the gas sample has been obtained, both valves on top of the instrument are closed and the reservoir is shaken back and forth a few times to break the oil seal and allow the chemical solution to absorb the CO_2 from the gas sample. This "splash system" of mixing the gas and liquid produces rapid absorption of the CO_2 on account of the large surface area of fresh chemical brought in contact with the gas. Connection is then made with the mercury gage, as shown in the illustration, and upon opening the communicating valve the percentage of CO_2 in the gas is indicated on the gage.



MERCURY COLUMN CO_2 INDICATOR

In the design proper precautions were taken to trap the mercury so that it cannot spill even when the apparatus is inverted. The graduated scale is movable so that the zero point can be easily set opposite the mercury level when the gage is under atmospheric pressure.

The Canadian Commission of Conservation estimates the total possible water-power resources of the Dominion at 18,803,000 hp., while the developed water power is 1,813,210 hp.—*Commerce Reports.*

The Fifty-Thousand Kilovolt-Ampere Connors Creek Turbines

BY C. F. HIRSHFELD*

Largest single-cylinder turbine. The first of two units now being installed, each to be served by four 2365-hp. boilers. With 70,000 sq.ft. of surface the condenser is the largest yet attempted in a single shell. It has but one water pass, and drain plates spill the condensate into the steam belt, so that its temperature at the hotwell will approximate that corresponding to the vacuum.

THE Connors Creek plant of the Detroit Edison Co. was planned to contain six 25,000-kv.-a. 60-cycle machines supplied with steam from twelve 2365-hp. boilers operating at 225 lb. gage pressure and 200 deg. superheat at 200 per cent. of rating. The first unit was started Feb. 8, 1915; the second July 7, 1915, and the third Feb. 15, 1917. When the fourth unit came up for consideration, it became evident that the development of large turbine units and likewise the growth of the company's load had progressed to such a point that it would be desirable to choose a unit of greater capacity than originally planned. It was then decided to complete the plant by installing two 50,000-kv.-a. machines instead of the three 25,000-kv.-a. units originally contemplated. One of these larger units is now being placed.

EACH TURBINE SUPPLIED BY FOUR BOILERS

Each of these machines will be supplied with steam from four boilers[1] similar to those originally planned, so that the ratio of boiler capacity will not be altered. However, the change involves the ultimate installation of eight boilers instead of the six which would have been required to serve three 25,000-kv.-a. machines. The ultimate capacity of the station as now planned will be 175,000 kv.-a. instead of 150,000 as originally intended.

The turbine for the large unit is of the disk type and represents a development of the design used in the first machines installed in the station. It has 21 stages as against nine in the smaller machines. However, in spite of this fact and also in spite of its larger capacity, the new unit is only fifteen feet longer, over-all, than are the smaller machines. Other dimensions are also much smaller than one would expect from a direct comparison of capacities. The weight is only about 40 per cent. greater than that of the earlier models. The speed, 1200 r.p.m., is the same.

The small physical size in comparison with the earlier units is partly due to refinements in the design of the turbine which have made it possible to greatly decrease the distance between wheels. It is also due in a small degree to higher generating voltage, 12,200 instead of 4600.

The best indication of the tremendous capacity that has been incorporated in a single turbine barrel, and in a single generator, is given by the size of the exhaust opening. This is rectangular and measures 12 x 18 ft. in the clear.

Longitudinally, the barrel is made in two sections. The low-pressure section is of cast iron and is rigidly bolted to the concrete foundation. The high-pressure section is of cast steel and is bolted to the high-pressure end of the low-pressure section. It is hung free of the foundation between the low-pressure casing and the bearing on the high-pressure end of the turbine. It is thus free to expand radially in all directions. At the high-pressure end the bearing is held in guides in such a way that it can slide longitudinally under the effects of varying temperatures.

The unit is supplied with steam through two lines, each 14 in. diameter. These two lines run together in a special, cast-steel, inverted-Y fitting which carries the steam up to the turbine throttle. The exit of the inverted Y, that is, the vertical leg, has an internal diameter of 20 in. While the unit is nominally served by the four boilers located opposite it, crossover headers are so arranged that any of the boilers in the plant can supply it with steam. In practice these crossover headers are always open so that practically all the simplicity of a unit layout is obtained with the security characteristic of a collective layout.

The steam exhausted by the turbine passes directly downward through a short expanding neck into the condenser. This condenser contains approximately 70,000 sq.ft. of surface made up of 1-in. tubes with a length of 24 ft. The tube sheets have a diameter of about 15.5 ft. in the clear, which gives sufficient area to permit the use of numerous generously proportioned lanes to lead the steam to all parts of the surface. This action is assisted by a steam belt which is obtained by setting the tube sheet eccentric in the shell. The steam belt is so shaped and located that it connects the exhaust nozzle with the space directly over the hotwell. This will be referred to later.

LARGEST SINGLE-SHELL CONDENSER

This condenser, like the turbine, is the largest yet attempted in a single shell. It is also unique among condensers of this general class, in that it is arranged for but one water pass. The circulating water enters all the tubes at one end and leaves all at the other end, flowing away over a dam the crest of which is so located as to submerge the highest tubes.

It was feared that with a condenser containing such a deep mass of tubes as this one and with all the tubes carrying cold water, the condensate would be abnormally cooled before arriving at the hotwell. For this reason devices which have been called drain plates were installed. These have been tried in various forms in smaller condensers in the older, or Delray, plant of the company and have been found very satisfactory.

Drain plates are formed by placing light-weight metal plates in the steam space in such positions as to catch the condensate from the upper sections and lead it

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*Chief of research department, Detroit Edison Co.

[1] For description of initial installation see "Power," Sept. 14, 1915, pp. 388-396.

to the bottom of the condenser without allowing it to come in contact with the tubes in the sections through which it is led. These plates are not intended as steam guides or baffles, and their successful use depends on placing them in such positions that they do not interfere in any manner with the free flow of steam.

In the condenser under discussion the plates are arranged in such a way that the condensate is spilled directly into the steam belt in streams of comparatively small cross-section. It then flows toward and into the hotwell in contact with the steam in this belt. Provision is made to prevent a collection of air over the hotwell and at the lower end of the steam belt, and it is hoped that the condensate will enter the hotwell at a temperature very near that corresponding to the vacuum even under winter conditions.

The condenser is served by two hotwell pumps, either of which has sufficient capacity to handle all condensate made at full load. There are also two circulating pumps. These are 48-in. double-suction pumps and are driven by variable-speed direct-current motors. Each pump has a capacity of 60,000 gal. per min. and can therefore pass sufficient water to condense all steam used at the most economical turbine loading. The second pump will be required only at maximum output, or when the circulating water is above a normal temperature.

The air pump is of the rotative dry-vacuum type and is driven by a variable-speed, direct-current motor. It is arranged for two-stage operation in a single cylinder and has a diameter of 39 in. and a stroke of 30 in.

Coal-Pit Mouth Power Plants

By D. A. Shearer

The present abnormal conditions direct attention to the apparent economy of operating steam-power plants at the coal mines. Long-distance electrical-power transmission has long since passed the experimental stage, and lines carrying hydro-electric power many hundred miles furnish indisputable evidence of the practicability of so distributing power over a large territory.

It has been stated that 35 per cent. of the freight handled by the railroads consists of coal, only 15 per cent. of which is for domestic requirements. This means that the transportation of coal for power purposes is one of the big factors in the high cost of power and is moreover one of the causes of the present great freight congestion. It seems therefore that the establishment of many large central stations directly in the coal fields would mitigate this serious economic condition. The coal fields are situated in a comparatively central position relative to the manufacturing centers of the Eastern States and are within an economical transmission distance if electrical energy is used. By the use of large boiler capacity and large generating units a high degree of efficiency could be achieved and a network of high-voltage large-capacity transmission lines could be extended over the entire eastern part of the United States. This would relieve the railroads of much congestion, dodge labor troubles on the transportation systems, prevent much coal waste in hauling, probably increase the efficiency of many manufacturing plants and would lead to the electrification of many steam railways, with a further saving of coal. The entire output of all grades from any mine could be economically and efficiently changed to electric power.

The coal question will not be settled with the cessation of war, for it is a problem that will remain with us and grow more acute with years. The war has only been the means of drawing attention to economic problems in a pressing manner and a little ahead of the normal schedule. The problems were there before the war and will remain after it is ended, to be considered and perhaps solved by a future if not by the present generation. If the proposed development was in operation now, there would be no coal shortage.

Energy in Revolving Flywheel

To calculate approximately the energy stored in a revolving flywheel, first ascertain (by calculation) the weight of the rim (weight of spokes, etc., is usually disregarded) and its velocity in feet per second (at the given r.p.m.). This velocity multiplied by itself (squared) and by the weight of the rim and divided by the constant 64.32 gives the foot-pounds of energy. For example, a 20-ft. flywheel with a rim weighing 30,000 lb. revolving at 80 r.p.m., or 83.7 ft. per sec., would represent $83.7 \times 83.7 \times 30{,}000 \div 64.32 = 3{,}270{,}000$ ft.-lb. of energy.

Military Road Building

By Sergt. B. C. White

I am writing this from the field to describe an engineering feat by army engineers in building a road called Vanderbilt Ave., from camp to town, requiring several bridges, cuts, fills, etc., to straighten the one time "snake road." Owing to the lack of gravel crushed stone had to be used. Not far from the road there was an old quarry of bastard granite, but the only things in the way of machinery were parts of an old belt-driven drum hoist that Noah may have used. For tools they had one ax, one timber saw, a 2-in. wood chisel and a 2-in. auger.

They investigated the scrap yards in all the near-by towns and found in one place an old locomotive-type boiler and engine mounted on wheels (35 hp.). In another place they found an old stone crusher of perhaps five yards per hour capacity; in another old quarry they found a steam drill or, rather, scraps of several out of which they contrived one that would work some, and an old pump that works well after some little tinkering up. Out of another heap of scrap they got a piece of $1\frac{15}{16}$-in. shaft and a couple of car trucks with the flanges missing on one side. They also begged a few feet of canvas belt that had been discarded in a sawmill. I think there was about 225 ft. of 8-in. belt including bad spots, which were numerous. With this accumulation assembled, they now have 200 ft. of railroad trestle made of bents with rails spiked to headframes at about a 15 per cent. grade, on which they draw stone from the quarry to the crusher. One side of the track is raised two inches higher than the other so the stone car will not jump the track on the side where the flanges are missing. They also have a belt conveyor of 8-in. belt 28-ft. centers running in a trough over 12-in. pulleys at about 100 ft. per min. This belt drops the stone into a pocket from which the trucks are loaded. The conveyor is home-made, as it were—pipe for shafting, the bearings made of old tires when available, but many were made of wood, log ends for pulleys, etc. To make these pulleys they sawed off some pine blocks, bored a 2-in. hole through them, drove them onto the shaft projecting from the hoist and turned them to size with a 2-in. wood chisel. Some of the rails on the road are poles, and all the woodwork is of logs and poles cut in the woods. The railroad is known (locally) as the P. W. & MacD. R.R. (Pop White & MacDougal R.R.) Private Harry Cassey, who is our hard rock man, is better known as "Dynamite Cassey" in the regiment but as Captain Cassey to the natives. Little Willie O'Connors (6 ft. 3 in. tall) is a drill runner. Master Engineer Senior Grade MacDougal, who was formerly master mechanic in the subway, is in charge. The four master engineers in the group posing for their picture are, from left to right, "Pop" White, Dunagan, MacDougal and Conrow.

PREPARING STONE AT THE QUARRY FOR BUILDING A MILITARY ROAD

A Novel Method of Shipping Large Transformers

The method used by the Westinghouse Electric and Manufacturing Co. for shipping three 7500-kv.-a., water-cooled transformers from East Pittsburgh, Penn., to the Northern States Power Co., at St. Paul, Minn., is shown in Figs. 1 and 2. The weight of each transformer without oil is approximately 45,000 lb. Before placing each unit in its tank a corset of wood slats and ribs of steel was built up around it, as shown in Fig. 1, so as to give a circular shape to fit the inside of the tank. The cooling coils were left fastened to the transformer covers, and a bracing arrangement through the center of these coils against the top of the cover, which was in turn braced against the end of the car, served to hold the transformer in place inside the tank.

These transformers were so large that, even when loaded on a drop-frame car, if shipped in the upright position, they would barely be within the maximum height allowable by railroad bridges, etc., even when using special flat covers on the tanks. It was found by the engineering and construction department of the power company that if the transformers were to be shipped in this manner there would be difficulty in getting them over the streets at their destination and up a 30-ft. rise, without crushing through the streets or tipping over. They therefore suggested that the transformers be shipped lying on their sides if possible.

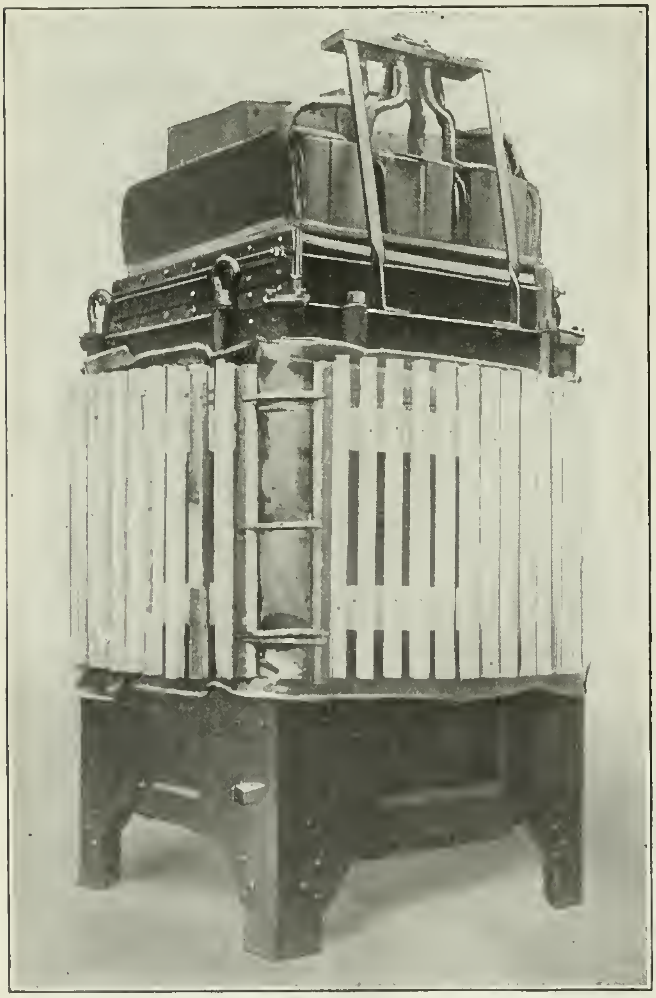


FIG. 1. TRANSFORMER READY TO PLACE IN TANK

The Westinghouse company has an ingenious cradle in which to place transformers when they are to be turned over on their sides. This cradle consists of a platform with one side projecting up at right angles to the floor of the platform. At the corner of the platform there is a rocker. Attached to the top of the side and to the outer edge of the platform are chains of equal length, which, after the transformer is placed on the platform, are attached to a crane. The crane starts lifting, and the chain attached to the platform is the one that carries the weight. This starts to tip the cradle on the rocker and when it is just half tipped, both chains are bearing the weight. As the transformer goes on over in the cradle, the chain attached to the top of the side bears the weight and the one attached to the platform is slack. By this means there is no rough jostling in tipping the transformer.

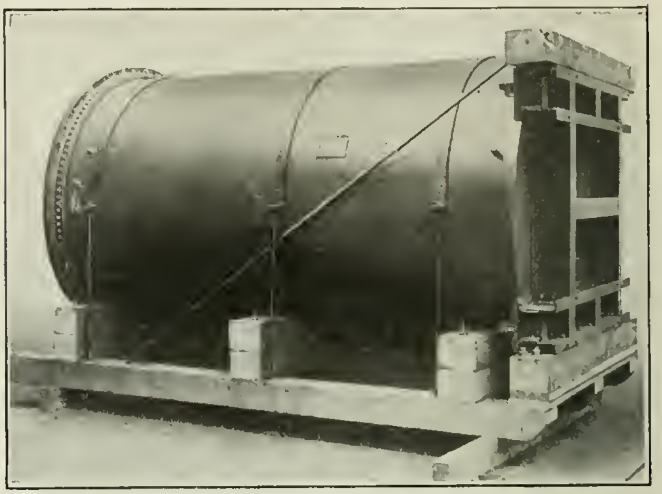


FIG. 2. TRANSFORMER IN CRADLE READY TO SHIP

A cradle arrangement, similar to the foregoing, was built for each transformer and used as a skid in shipment, and in moving the transformers over the streets and up the rise, at their destination. Fig. 2 shows one of the transformers in its cradle ready for shipping.

The transformers arrived in good condition and were skidded to position in the basement of the substation in St. Paul. Through a hole in the main floor a stationary hoist lifted the transformers out of their tanks, the packing was removed and the transformers were again lowered into the tanks and the oil put in; each unit was then lifted to the main floor and put into service.

Superheating steam increases its volume a different percentage for different pressures and temperatures. For example, steam at 100 lb. pressure when superheated 100 deg. is expanded approximately 16 per cent., while 200 deg. increases its volume 30 per cent. and 300 deg. 45 per cent. For any desired case see the steam tables giving the specific volume of saturated steam, subtract this from the specific volume for the degree of superheat and divide by the specific volume of the saturated steam; the result will be the percentage of increase in volume. The same process gives the percentage of difference in volume between two different degrees of superheat. The amount of work steam of a given pressure will do is very nearly in direct proportion to its volume. This is one of the advantages of superheating.

Troubles and Their Remedies in Gas-Engine Ignition Systems

By A. L. BRENNAN, JR.

The various troubles that may happen to either high- or low-tension ignition systems for internal-combustion engines are outlined, and how to go about locating and correcting these troubles is explained.

NEARLY all gas engines are equipped with batteries to supply the primary current to suitable coils to effect easy starting. However, in the majority of cases the magneto is relied upon to furnish the electrical pressure for constant operation. It must not be understood from this that battery ignition is not reliable, for in actual practice it is quite as dependable as that derived from a magneto.

Low-Tension and High-Tension Magnetos

Although there are many variations in the design and construction of magnetos, they can be divided into two general classes—low-tension and high-tension. In regard to the former the current is sometimes utilized direct in connection with a make-and-break igniter or is sent through a coil first and thence to the igniter. In other cases dynamos are used to supply a current for a high-tension system, the current being taken through an induction coil to obtain the necessary potential to overcome the resistance of the air gap. From this it is seen that the principal difference between low- and high-tension ignition is that a low-tension current has not sufficient voltage to break down the resistance of an air gap; therefore, in order to induce a spark, a current must be set up by a closed circuit. This closed circuit results from the movable electrode coming in contact with the stationary electrode of the igniter, which separates at a predetermined time according to the setting of the timer. As the points spring apart, the electric current has a tendency to maintain the circuit already formed, and in consequence an electric arc is formed between these two points for a sufficient length of time to ignite the compressed gas in the cylinder. One of the principal considerations involved in procuring a good spark from a low-tension igniter is to have the points in good repair and forming a complete contact; that is, their entire surfaces coming together. If two very small points only come in contact, the resultant spark will be small and may not be strong enough to ignite the gas.

The chief advantage of low-tension ignition over high-tension is absence of secondary wires and their danger to short-circuit; also, low-tension ignition is practically waterproof. It has several disadvantages, however. The timing of the break is controlled by mechanical means, and the rapidity of the rupture of current between the points is entirely dependent upon the tension of certain springs which operate under detrimental conditions, such as high temperatures. Low-tension magnetos are usually of the simple H type and have but a single coil of comparatively coarse wire. In operation the current induced in the armature fluctuates from zero to a maximum twice in each revolution, and so in order to realize high efficiency the magneto must be so timed that this maximum current will be supplied the igniter at the moment of break in the current. This is usually referred to as synchronism, meaning that the rotation of the magneto's armature and the engine crankshaft coincide in such a way that the maximum potential is utilized at the time of ignition of the compressed gas, as already mentioned. From this it is evident that a magneto of this type must be timed in such a way as to follow out the conditions cited, but this is not the case with continuous-current machines. Generators of the latter type are very easy to maintain and are surprisingly free from any complications.

The commutator should be kept bright by using fine sandpaper. The bearings should be properly lubricated, but care must be exercised against excessive oil, for it has a tendency to creep and thus destroy the insulation of the machine. The brushes should be kept clean and bear with their whole surface on the commutator.

High-tension magnetos can be divided into two classes: (1) Magnetos that merely take the place of battery and timer and deliver current to a coil where the secondary current is produced, and (2) magnetos that comprise in their construction all the elements of generating and distributing a high-tension current, which are commonly called self-contained generators, as they are only dependent upon the engine to furnish the power for their rotation, which of course must be in synchronism with the timing of the engine.

Magnetos of the latter type are subject to about all the troubles that have to do with high-tension ignition of other varieties. But as seemingly complicated as some of the troubles appear, they are in almost every instance easily traced and corrected.

Locating Faults by Elimination Method

A means of locating a fault, commonly known as the elimination method, often proves of value in quickly detecting an existing fault. For instance, suppose the engine is operating from current derived from a magneto; the first step to take is to disconnect the secondary wire from a plug and hold its terminal about an eighth of an inch from top of the latter and notice if a spark takes place. This operation is easily performed while the motor is in operation if the high-tension wires are fitted with terminals that pull off. Considering the setting of the points of a spark plug an eighth of an inch may seem excessive, but the fact should be remembered that the average magneto will produce a spark of this length under atmospheric conditions, but not in the cylinder under pressure, where the resistance offered to a spark gap is considerably more. Misfiring, although often due to faulty ignition, has other causes, such as faulty mixtures or mechanical defects that interfere with good compression.

High-tension generators are necessarily complicated to a certain degree; that is, there are several parts necessary to control and distribute the current, which require more or less attention from time to time. Chief among these may be mentioned the contact points of the circuit interrupters. These points often have a tendency to wear and become pitted and thus make inferior contacts and cause misfiring. In order to overcome this defect the contact points should be cleaned with sandpaper, care being exercised to rub the surfaces flat and not wear away the edges of the contacts and thus reduce their bearing surfaces. If the pitting is very bad, the contacts will probably need filing, which will necessitate their removal. In regard to their repair, there are two conditions to bear in mind: First, to file the points to produce a smooth even surface; and second, to adjust the surfaces of the points at such an angle that when they are together their surfaces will be parallel. It sometimes happens that the points will be evenly repaired, but only make contact on their inside or outside edges. In regard to the correct distance they should be set, it will generally depend upon the make of the magneto. However, the majority of manufacturers supply suitable implements and scales for the adjustment of their machines, which should be closely adhered to. At times dust, dirt or oil will find its way into the circuit-interrupter box and cause misfiring. To overcome this trouble the interrupter box should be washed with gasoline, using a stiff brush.

To Remove Scale Deposits

Continued operation will sometimes produce scale deposits in the circuit-interrupter box, but more often on the distributor segments and brush surfaces, which is usually indicated by misfiring, but this trouble is readily remedied by cleaning the contact surfaces with gasoline.

It is very seldom that a magneto fails to generate a current. Some years ago difficulty was sometimes experienced from the failing of the magnetos owing to loss of magnetism, but this is seldom the case at present.

Any deposits on the contact surfaces of these high-tension generators will invariably interfere with uniform operation, and so they should at all times be kept entirely free from foreign substances. Oil is especially liable to creep and render a magneto inoperative. The only remedy in this case is to take the machine apart and clean it off thoroughly with gasoline. There is one thing to bear constantly in mind when employing gasoline for this purpose, and that is, do not slop it all around, allowing quantities of it to collect around the engine, for the chances are that if you start the engine soon after cleaning the magneto with this fluid, the gasoline at the contact points will ignite and start a dangerous fire. But in any case do not shut down the machine, but turn the gasoline off, if of this type of motor, so that the fuel in the carburetor will be used up in the engine instead of perhaps injuring the generator.

In order to look after a magneto in an efficient way, it must be removed from the engine. However, before this is done, suitable marks should be made that will allow the ready replacement of the magneto without changing the timing.

If a motor is equipped with both battery and magneto ignition and operates satisfactorily on the battery and coil circuit, but faulty operation follows when the magneto is switched into circuit, the trouble is in the second method of ignition, and should not be attributed to other causes. On the other hand, if misfiring occurs when either system is in circuit, it would indicate that probably some fault exists in the ignition, and it should be tested as described in the foregoing.

Particular pains should be exercised to keep all wires free from excessive chafing due to vibration, for short-circuits will result if the insulation on the wires is broken down. All terminals should be kept secure—not only the primary, but the secondary wires as well. The spark plugs should be kept free from oil or moisture, their component parts tight and points bright in order to realize the best results.

Saving by Burning Slack Coal

By F. H. Guldner

While working as a special apprentice for a Middle Western railroad, the writer was called on to determine the fuel and labor costs in a stationary power plant at one of its larger repair shops. Some rather surprising results were found, and in view of the present difficulty in obtaining, and the urgent need of conserving coal, the data showing the savings effected seem timely in again calling to attention principles well known but too often overlooked.

The table shows the amount of coal burned each month, the labor and fuel costs and, in addition, the quantity of each of the three grades of coal used—engine, chute droppings and slack. In the interval given no great fluctuation in output occurred. The cost of labor for the various months was nearly uniform excepting the period from the latter half of December, 1914, up to and including March, 1915, during which time the old duplex-steam air compressor was replaced by a cross-compound two-stage compressor of high efficiency and a feed-water heater was installed. While the change was being made, air was furnished by a battery of locomotive air compressors of relatively low efficiency; this accounts for the high labor and fuel cost during these months.

FUEL ECONOMY EFFECTED

		Coal Burned in Tons				Total Coal
Month	Labor	Engine	Chute Droppings	Slack	Total	Cost
1913						
October	.....	1,115 95	28 85		1,144 80	
November	.....	1,415 60	120 40		1,536 00	....
December	.....	1,471 90	31 35	...	1,503 25	.....
1914						
January	$588 93	1,385 65			1,385 65	$2,577.31
February	584 11	1,443 80			1,443 80	2,671.03
March	686 24	1,629 25	31.00		1,660 25	3,102 47
April	630 73	1,351 50	26 60		1,378 10	2,590 83
May	613 76	877 20	42 60	55 75	975 75	1,839 97
June	596 67	895 50		12 65	908 15	1,906 46
July	606 49	1,045.90	61 90	18 70	1,126 50	2,123 53
August	603 86	919 85	57 95		977 80	1,825 95
September	589 83	1,041 35		86 05	1,127 40	2,087 94
October	669 21	1,250 35	39 10	2 50	1,291 95	2,421 61
November	670 82	1,242 65	75 80		1,318 45	2,428 56
December	723 85	1,621 35	26.40		1,647 75	3,099 42
1915						
January	861 41	2,231 80			2,231 80	4,271.74
February	779 90	1,634 60	88 10		1,722 70	3,213.61
March	700 34	1,644 45	65 75		1,710 20	3,186 24
April	588 05	1,153 50	70 95		1,224 45	2,280 26
May	576 29	713 95	66 95	163 55	944 45	1,621.29
June	585 37	439 25		274 90	714 15	1,136.99
July	567.92	329 90		385 55	715 45	1,056 44
August	587 99	85 00		482 85	567 85	731 84
September	594 46	84 00		477 05	561 04	692.76

In April, 1915, it was decided to change from engine coal costing about $1.85 per ton to slack at $1.10.

It was feared that it would be impossible to maintain the required steam pressure, but results dissipated this fear. About 164 tons was burned that month, and gradually the percentage of slack was increased and the amount of engine coal decreased until in August and September, 1915, the slack was nearly five-sixths of the total coal burned. About this time the writer was transferred to another position, and he was unable to get later figures. Those given, however, will be sufficient to illustrate the object of this article. By comparing the average (May to September, 1914) monthly coal cost with a corresponding period one year later, it will be noticed that it was reduced from $1956.77 to $1047.86, or 46.5 per cent. A more striking example would be to compare the average coal cost in August and September, 1914, when the old air compressor was in use and practically all the fuel was engine coal and little slack, with the same months in 1915, when the feed-water heater and the new compressor were in use and the coal conditions reversed to nearly all slack with a little engine coal. The average in 1914 for these two months was $1956.94, against $712.30 in 1915, a decrease of $1244.64, or 63.5 per cent.

This was accomplished by an investment of approximately $10,000 for the air compressor, $2000 for the feed-water heater and $6000 for removing the old compressor and installing the new equipment—a total of about $18,000—less the salvage value of the old compressor, which was sent to a smaller shop for use. No doubt there are many plants, not only in the railroad field but also in public utilities, manufacturing, etc., whose coal consumption could be materially reduced by the use of more efficient prime movers and the substitution of cheaper coal. Substitution, when possible, enables the conserving of the better coals for purposes that do not permit the use of poor coal and at the same time is profitable.

Spliced Conductors in Conduits

By B. A. Briggs

The National Board of Fire Underwriters' Rules specify that a splice in a conductor must not be pulled into a conduit. The wisdom of this ruling appears to be hard for many to appreciate. Nevertheless, that it is based on sound judgment has been proved in many cases by cable grounding on splices that have been pulled into conduits. One case in point that came to the writer's attention was that of a small rotary converter that blew one of its fuses infrequently for several months before the cause was discovered. All tests that could be made indicated nothing wrong during this period. The trouble was caused by a spliced cable, in a conduit running from the machine to the switchboard, flashing to ground at irregular intervals and each time burning itself clear without leaving any trace of the trouble except blowing the fuse. At last the conductor became grounded, and then the trouble was easily located and repaired by pulling out the old cables and replacing them with new ones.

In another case, in what is supposed to be one of the best isolated-plant installations in this country, the shunt-field winding of one of the machines of a three-wire balancing set was discovered to be dangerously hot, after the machine had been standing idle for about twelve hours. Investigation showed that one side of the shunt-field winding was connected permanently to one of the 220-volt busses and that one of the main cables running from the switchboard to the machine was grounded in such a way as to leave the shunt-field winding connected across the 220-volt circuit.

In this plant the cables from the switchboard pass down through bushings in the floor into a large $\frac{3}{16}$-in. iron duct, about 6 in. deep by 2 ft. wide, which runs the entire length of the switchboard. From this duct the cables run in conduit to the various circuits and machines. It was in this duct that the ground was located on the cable. The cable, like a lot more of them in this duct, had been cut too short and was spliced out to reach up to the terminals on the back of switchboard. In making the splice, points of solder were left, or maybe some of the ends of the wire were not properly forced down into the splice, so that in time, because of the vibration of the cable against the bottom of the duct, the insulation was broken down and a ground occurred. Some severe arcing must have taken place, since, as the illustration shows, considerable of the splice is burned away; also a large hole was burned into the $\frac{3}{16}$-in. iron-duct wall. This splice from all appearances had been thoroughly insulated by both rubber and friction tape, and could not have been subjected to any of the abuses that it would receive if pulled into a conduit; nevertheless, it failed as many other cable splices have failed in conduits. Consequently, there is but one safe rule: Obey one of the mandates of the National Electrical Code and do not pull spliced conductors into conduits.

CONDITION OF SPLICE AFTER BURNOUT

Burning Oil or Tar in Combination With Coal

The coal shortage has caused most engineers to consider using whatever fuels are available whether they be the various grades of coal, fuel oil, tar or bagasse, and to provide an auxiliary fuel should their coal give out. Dr. W. N. Best has lately brought forth an invention which makes possible the quick change from coal to oil or tar and vice versa. The usual location of an oil burner is at the ashpit or the fire-door. This invention leaves these doors free for use without disturbing the burner or the piping. It is sold by W. N. Best, Inc., 11 Broadway, New York City.

Referring to Fig. 1, it will be observed that the liquid-fuel burner is mounted on the side or front wall of the boiler furnace. Fig. 1 shows that the burner is in the operating position. Fig. 2 shows it in the idle position as it would be when no liquid fuel at all is being burned or when fuel on the grate only is burning. Notice that by moving the operating lever to the up position, the sliding gate closes the opening in the side wall so that no air is admitted here while the liquid-fuel burner is idle. It will be observed, also, that should it be desired to operate at rather low boiler capacity, the sliding gate may be operated so as to admit a little air, or rather so as to admit the quantity of air required by the amount of fuel being fed. Greater capacity may be had by opening the sliding gate more and more and feeding greater quantities of oil and steam for atomization.

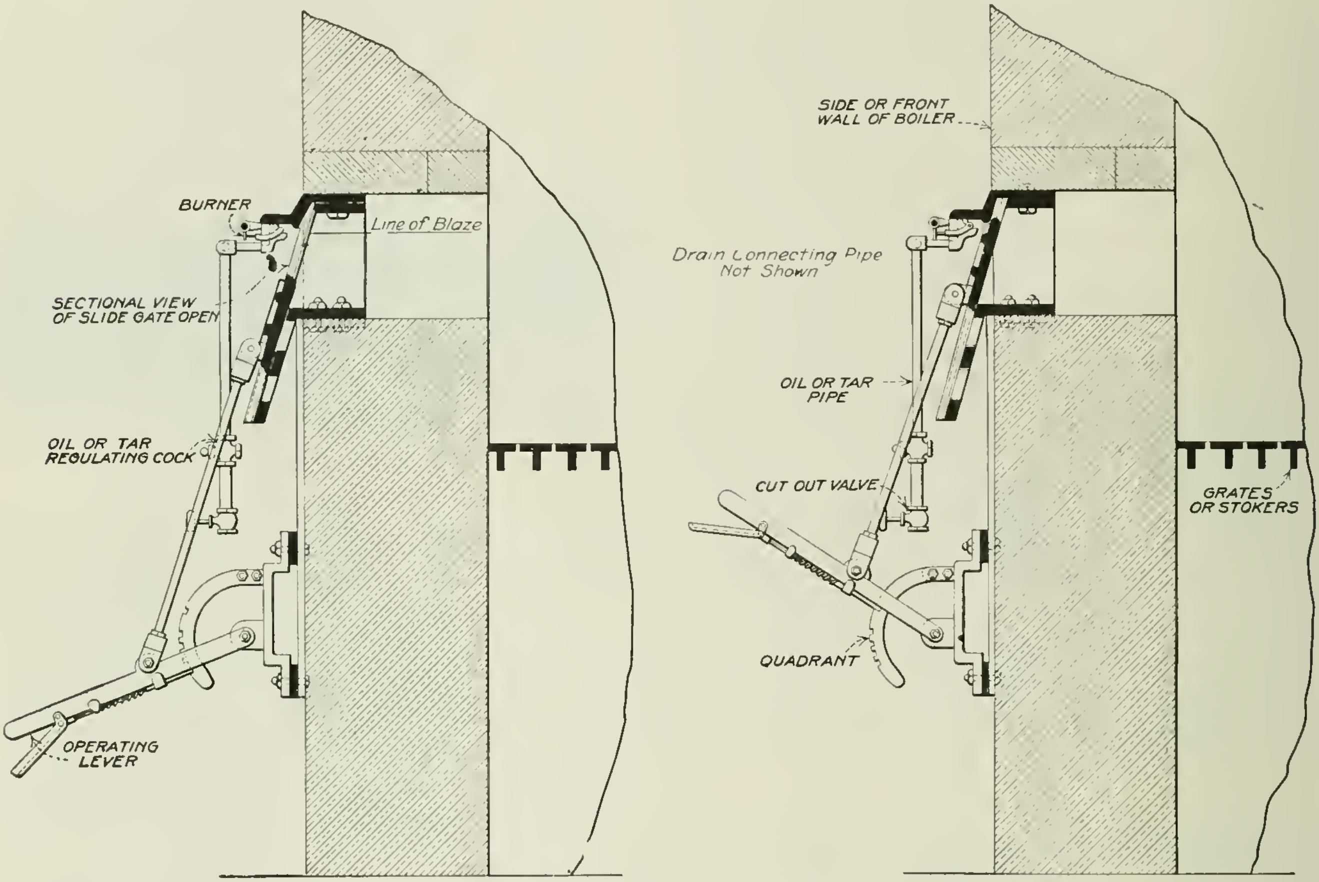


Fig. 1

Fig. 2

LIQUID-FUEL BURNING APPARATUS FOR USE IN COMBINATION WITH COAL
Fig. 1—Burner in Position for Use. Fig. 2—Burner Shut Off and Opening in Furnace Wall Closed

Readers will, perhaps, remember that an oil burner of similar design is in general use. With the old-style burner equipment designed by Dr. Best no provisions other than a few loose brick were made for closing up the openings in the side or front wall when the burner was not in use. This, of course, means that great quantities of excess air are admitted to the furnace when the oil burner is not being operated. With the new device the opening is closed tight when the burner is idle and is adjustable to accommodate various capacity demands. The apparatus lends itself to the use of auxiliary fuel.

Manifestly, no alterations are required to the boiler or the furnace to attach the burner. If liquid fuel is burned, the grate may be covered with ashes for protection.

The burner is one wherein the oil, tar or liquid-fuel opening or outlet is at right angles to the direction of the steam outlet; that is, the steam used for atomization. This steam sweeps directly over the oil or liquid-fuel outlet, thus keeping the outlet free of the carbon so frequently found on burner tips.

Where tar is burned, the fuel may gravitate to the burner from a tank mounted on top of the boiler or in an elevated and warm location in the boiler room. Heating coils are provided so that the fuel may be heated nearly to the point of vaporization.

One burner is used per furnace regardless of how large or how small the furnace may be. This is true for oil or tar. The atomized oil issues from the burner through a diverging groove in the burner tip. The flame is flat and, depending upon the shape of the groove, is long or short.

The oil or liquid-fuel control valve is provided with stops which may be set by the boiler-room engineer after he determines the limit of open position of the valve, thus preventing the fireman from exceeding this limit.

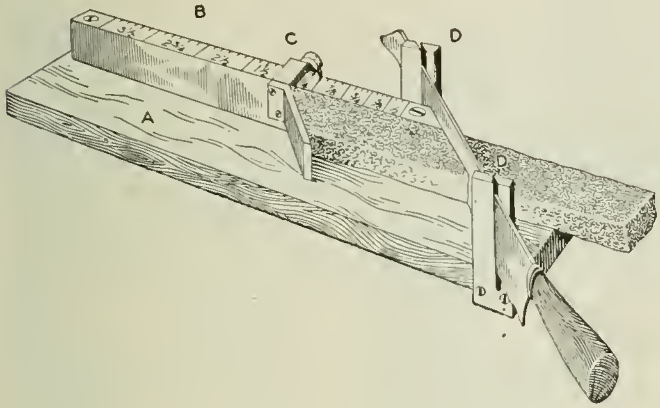
A Handy Packing Cutter

By J. A. Lucas

Many methods of cutting piston-rod packing have been published in *Power*, but I have never seen anything similar to the tool shown herewith.

The base A is made of wood 1 in. thick, 3½ in. wide and 21 in. long. The gage bar B is about 16 in. long and is made of hardwood. One end is cut to an angle of 45 deg. The sliding block C is part of an old motor brush-holder with a piece of $\frac{1}{16}$-in. iron bent to an angle of 45 deg. riveted to it. The bar *B* is made an easy sliding fit for the block, which is clamped to it by the thumb-screw placed on the back side. The knife guides *D* are made of $\frac{3}{16}$ x 3-in. iron and are about 4 in. high, with the slot cut on an angle of 45 deg. and set so that the knife will just clear the end of the bar *B*. A common bread knife with scalloped edge is used for cutting the packing. The top of the bar *B* is graduated so that the distance from the knife to the stop, when set at a certain number, gives the length of the circumference of a circle of that diameter, plus $\frac{3}{16}$ in. for expansion.

To lay off the graduations on the bar, get a table of circumferences of circles, and to the length of the circumference add $\frac{3}{16}$ in. for expansion up to 2 in. diameter; $\frac{1}{4}$ in. from 2 to 3 in. diameter, and $\frac{3}{8}$ in. for larger diameters. After measuring off their distances on the bar, stamp them with small figures or other suitable marks. The distance from the knife to the 2-in. mark by this method is $6\frac{1}{2}$ in.; to the $2\frac{1}{2}$-in. mark, 8 in., etc.



DEVICE FOR CUTTING PACKING

To operate, first get the diameter of the rod, which is, say, 2 in. Add the size of the packing, which in this case is, say, $\frac{1}{2}$ in., amounting to $2\frac{1}{2}$ in. This is the diameter of a circle passing through the center of the packing ring. Set the gage at the $2\frac{1}{2}$ mark on the bar, and cut the first end at an angle in the slot; then butt the packing against the stop *C* and cut off. This would be the length for a good fit, with the right amount of room left for expansion.

Vibration Effects on the Operation of Electric Generators

By R. K. Long

Vibration may be due to causes internal or external to a machine, or both, the result being cumulative or otherwise. The commoner causes of vibration are unbalanced rotors, bent shafts, improper foundations and fastenings, excessive speed, excessive and fluctuating loads, vibration of the structure housing the machine, its periodicity of vibration being superposed upon that of the machine. Some machines show less vibration with no load than with load. Others again vibrate only when running light or at a definite load, still others only with load changes. The effects of vibration upon direct-current machines is probably more serious than on alternating-current.

Vibration in direct-current machines may cause loose connections and open-circuits. Abrasion also often occurs, the effect of which causes short-circuits and ground in the windings. Brushes may chatter, causing sparking, poor commutation and rapid deterioration of the commutator and brushes, with accompanying higher cost of upkeep, as well as interfering with the capacity and regulation of the machine. With certain classes of brushes increased heating, due to sparking and unequal current distribution, causes the lubricant to exude from them, gumming the commutator and permitting carbon dust to collect, causing flashovers and making the brushes stick in the holders.

A bent shaft in setting up vibration also causes unequal air gaps as it revolves, which may result in overheating the equalizer rings or taps in some form of armature winding. Bad commutation results in any case; flat and burnt spots may appear at definite spacings around the commutation. A bent shaft may damage the insulation or cause breaking of armature conductors; unequal wear of bearings may occur, due to shaft out of alignment. Throwing lubricating oil may occur, which may soon eat into the mica of the commutators, doing serious damage, for oil is the arch enemy of mica.

Alternating-current generators are usually less influenced by vibration than direct-current machines, owing to the absence of the commutator. Where the units have a direct-connected exciter, however, they may suffer in the same way as the direct-current generators already referred to. Excessive vibration has often resulted in grounding and short-circuiting of the field winding of high-speed turbo-generator units, the result of which is that the field current is increased, causing overheating and finally failure, by burning out the entire field winding.

The stator, or armature, of alternators also suffers from vibration. Conductors work loose, enabling them to move with load changes, causing deterioration of the insulation and failure under normal potential. Another result of vibration sometimes encountered in large turbo-generators is that the emergency steam valve closes accidentally, shifting the generators' load to other machines—a somewhat serious matter where the load may be 20,000 kv.-a. or more. Vibration is perhaps more likely to occur in the rotating elements of steam-turbine units than in other types, because of the accumulation of scale. This is, however, a transitory condition.

In one case a machine was installed upon a girder so that it wabbled from one side to the other with load changes, a matter easily remedied by leveling the machine and grouting, at the same time solving a difficult commutation problem. Several boosters have run away with varying degrees of damage on account of broken field coils, due to vibration. Bent shafts have added their quota to strange voltage drops for no apparent reason, although brushes sticking in the holders may have helped in this case.

There are many degrees of vibration, causing as many effects, some obvious and others not so apparent. All unnecessary causes should be eliminated because vibration is always objectionable, since it shortens the life of materials, wastes energy in the form of noise and needless motion, which lowers the efficiency of the apparatus and increases the difficulties and cost of operation. Provided a machine is properly designed, installed and maintained, most of the troubles enumerated may be prevented, and prevention is always better than cure

Illustrated Crank Job

Editorials

The Coal Supply and the Railroads

WITH the extraordinary demand for fuel consequent upon the war the price of coal went to exorbitant figures. A contract was no protection, for the contractor simply avowed his inability to carry out his agreement, and those who had to have coal—and that means everybody who bought it, for nobody buys coal for bric-a-brac—had to go out in the market and outbid the others for it. The consequence was that notwithstanding the alleged inability of contractors, handlers and dealers to get coal, there was more coal than ever mined and sold, but at greatly increased prices.

And then the people spoke up and said, through their President: "This profiteering must stop. We will pay you producers so much per ton for the coal at the mine. The railroad haulage is fixed. You jobbers and retailers can have so much per ton"; and it looked as though the consumer was going to get his coal for cost plus a more or less fair profit.

But notwithstanding the price allowed per ton at the mine was away above what they had got before the war, the producers, or some of them, averred that they could not produce at that price; and the long-suffering people raised the price still higher with an intimation that if the producers could not and did not produce at that price, they would take over the mines and do it themselves.

And then it was found that the greater part of the coal had been already sold on contract at prices above those fixed by the Government; and again the long-suffering people, standing abashed before the sanctity of contract and the horror of upsetting business, said: "All right, we will pay these prices that somebody has contracted for us, for their payment will come upon us in the final analysis, but only on the contract coal. Let the free coal come along at the prices we have fixed."

But the price did not go down. The cost for railroad haulage was controllable, but there was a shortage of bottoms and of tugs, and prices for water transportation went soaring. When one must have coal or shut down and another has coal and wants to turn it into the most money that one's necessity will compel him to pay, it takes more than a Government dictum without penalties for its evasion to keep them apart. A bet that the Washington Monument will fall in two weeks; an intimation on the part of the coal merchant of his willingness to part with a treasured desk weight, a bull pup, an old white horse or some similar object of virtu upon sufficient inducement, offers an opportunity for the purchaser to pay the difference between the price at which the Government has said the dealer must sell and that which is fixed by the buyer's necessity and the dealer's cupidity. Speculators offered to furnish coal if they were permitted to bill at the Government price and collect at their own. Contracts were dated back to precede the Government order. Wagon mines sold coal at the Government price, but on condition that they be allowed to haul it; and made up in the haulage charge the extortion which the President's order was intended to inhibit.

And still the prices do not go down; the free coal does not come along and the shortage has increased until factories are shut down, ships lie in the harbors with empty bunkers, while the goods that they should transport glut the terminals and clog the railroads. War work is hampered, public utilities are crippled, hotels are without light and heat, and long lines of shivering men, women and children stand waiting for hours for the privilege of buying a pailful of coal at ten dollars a ton. The death rate from pneumonia in New York has gone up enormously.

Whose is the fault and what is to be done about it? The anthracite producers say they cannot produce on account of labor shortage, and they send, to a market which is in a condition where it must take anything, the ejecta of more exigent years, burdening the already overloaded transportation system with tons of worthless dirt and slate and ash sold at the price of good coal. Trainloads of this coal, large and small, good and bad, were held almost within sight of New York until shifting engines could pull out of the maze cars bearing particular numbers consigned to the particular man whose barge was ready, because, they say, some ridiculous Government regulation decreed it so. The Administration has now decreed that the coal shall be pooled and kept moving.

The bituminous producers claim that they can mine, with the plant and labor available, more coal than the railroads can furnish cars to take away and that they are filling cars as fast as they get them. The mine is the best storage for the coal until it can be shipped. The railroads say that they have cars enough, but that their systems are blocked by priority orders, excessive demands upon their equipment and lack of motive power.

It would take 5000 locomotives to replace those worn out in the United States every year. In the month of October there was ordered in the whole country just *one*. In the last five years the number ordered per year has been on an average 2391 and has never exceeded 3467; and just previous to the war the shops of the American Locomotive Company were almost shut down for lack of orders. With a mild winter and an ordinary amount of traffic the railroads might have pulled through again. A season of exceptional severity and the extraordinary traffic due to the war have swamped them. If the Government had been operating the railways and had gotten them into this self-confessed condition of impotency, Government ownership would have been indicted as long as the memory of it should last.

It is useless to inquire how we drifted into this condition, except as the inquiry may help us to avoid doing it again. The thing now is to get to running again. The combining of the railroads into a consistent unit under Government control, with the resources of the entire country back of them, was the logical first step, and if the railroad managements with whom the operation of the roads is still left will concentrate on getting the most that is possible out of them under the new coöperative conditions instead of worrying about when they are going to get them back or trying to discredit Government operation, the task will be easier. In the meantime let us not blame the Government if it cannot make a run-down cripple do a giant's task.

Developing the Water Powers

THE most insistent of the conservationists in and out of the Government have always been ready to permit private capital to develop the water powers upon terms which would insure the complete return of the investment with interest and a fair profit upon the business done, subject only to such risk as attends the development of any water power outside of Government control. After years of hampering argument and struggle between those who sought to obtain the control of the water powers and those solicitous for the rights of the people, the Administration has prepared a bill which, in view of a public sentiment created by months of vigorous propaganda by chambers of commerce, industrial committees and similar organizations, is likely to pass. This bill, while an improvement on former measures, does not appear to us to be without objection.

Any bill, while guarding absolutely the safety of the investment against confiscation or embarrassment by Government interference, should provide for the retaking of the privilege by the Government when the people need it or conditions make it advisable. This bill gives an irrevocable grant for fifty years, at the end of which time the Government "shall have the right" to take the property, not by paying back what the investor put into it, less what he has paid himself back besides his fair profit, but by paying "the fair value not to exceed actual cost of the property taken." Inasmuch as the fifty-year grant is insisted upon in order that the bonds may be retired out of earnings within the life of the grant, this would appear to allow the investor to recover his investment out of earnings, and then collect it again when the plant is sold.

A "fair value" is indefinite and indeterminable. The price of recapture should be fixed at actual investment less depreciation. Depreciation is simply retired investment and should be deducted from the capital account, leaving the amount upon which interest is allowed and which must be paid upon recapture.

"The United States shall have the right" to take the plant over. Who is going to exercise this right or determine that it shall be exercised—the President, the Congress, the Commission, or who? Unless the provocation is great, there will be no concerted movement on the part of the consumers, and a Congressman would have to be a radical spoiling for a fight to undertake the recapture on his own initiative.

We should like to see the bill stipulate that current should be sold at cost plus a fair (and stipulated) profit. This involves an oversight of the issue of securities and of expenditures to insure that all the investment incurred appears in the property in either material or service, and is essential also to establishing the recapture value. The Commission established by the bill is empowered to prescribe rules for uniform accounting, to examine books and to require full statements as to cost of operation and the production, transmission and sale of power, to hold hearings in connection with the regulation of rates or service; but the Commission has no rate-making power except for interstate business or in states where no such regulation exists. The delegation of such powers to state public-utilities commissions is not likely to be so positive and satisfactory as a specification of the allowable rate of profit and the methods of its determination in the grant.

Wherever licenses to states or municipalities are mentioned, it is prescribed that the power is to be generated solely for state or municipal purposes. Does this preclude the obtaining of a grant by a state or municipality for the purpose of generating power for the use of its inhabitants?

Altogether, the bill is a great improvement upon former attempts, but we should like to see it more specific and positive in the particulars mentioned.

Government Control of Fuel Oil

THE President's fuel-oil proclamation of February fourth, which went into effect the following Monday, or the eleventh, now gives the Government control of the transportation and distribution of the two chief fuels. Considering the troubles that producers, shippers and consumers of fuel oil have been having, it is assumable that they welcome the Government's action.

Take New England, for example. Oil displaces about one million tons of coal per year at the present consumption. It is used in many industries vital to the prosecution of the war. The shippers of the oil and the consumers have viewed with no small measure of alarm the commandeering of oil-carrying ships by the Government. One company transporting great quantities of oil to New England ports has six ships left out of a total of twenty-one, the Government having taken the difference. Much of this oil goes to Providence by water and then by rail inland to the points of consumption. The serious congestion of the railroads has caused excruciating delays of tank cars both going and coming. Lately, one car was six weeks from Providence to Lawrence, Massachusetts, and return. There is not an abundance of oil-tank cars even for normal conditions of demand and transportation. Now fuel oil will likely have a priority commensurate with its value as a war essential.

The situation had become serious for New England, and the President's proclamation is by no means premature. To cite another case: A consumer of fuel oil in Boston has been compelled to transport oil for his plant by motor truck from Providence to Boston because the shipper could not get oil beyond Providence. The truck or trucks had to be kept going night and day. The expense is obvious. Doubtless one of the first moves of Mark L. Requa, new head of the Oil Division, Fuel Administration, will be the elimination of conditions that impose such hardship upon the shipper and consumer.

The priority list for deliveries of fuel oil as announced from Washington are, in the order of preference, as follows: Railroads and bunker fuel; export deliveries or shipments for the United States Army or Navy; export shipments for the navies and other war purposes of the Allies; hospitals where oil is now being used as fuel; public utilities and domestic consumers now using fuel oil (including gas oil); shipyards engaged in Government work; navy yards; arsenals; plants engaged in manufacture, production and storage of food products; army and navy cantonments where oil is now used as fuel; industrial consumers engaged in the manufacture of munitions and other articles under Government orders; all other classes.

Plants not making munitions or other articles under Government orders are therefore twelfth on the list. The order of preference appears eminently fair. If the head of the Oil Division gets the right kind of coöperation from Mr. McAdoo and if the Navy Department and Shipping Board will not divert more ships from our coastwise oil trade than extraordinary emergencies demand, Mr. Requa will be free to devote his time to moving oil instead of needing all time available to care for complaints, as the state and local fuel administrators have to do.

Why Not Have an Ash Inspector?

TODAY we have fire inspectors to see to it that the means used for generating, transmitting and utilizing power are not allowed to become a fire hazard and endanger the safety of the community. We have boiler inspectors, in some cases backed up by the law of the state, whose business it is to have all boilers maintained in such condition that they will not become a menace to life and property. We also have fuel administrators, both national, state and municipal, whose good purpose it is to control the destiny of the nation's coal pile. All this may be very commendable, but how about what happens to the coal after it goes into the boiler room?

An inspection of the contents of the ash cans on the curb waiting to be removed from in front of many of our large buildings would indicate that many plants have coal to throw away. The time when we can afford to allow coal to be used in such a way that a large percentage of its carbon content is thrown away in the ashes has long gone by. Although the fuel supply will last for hundreds of years hence, nevertheless it has been the bitter experience of millions in this country and abroad recently that it is almost impossible to obtain fuel at any price. Landlords, using the coal famine as a pretext, have allowed their tenants to suffer for the wanted heat, and some of the traction companies have tried heating their cars with animal heat, while the public paid for something they did not get. Yet, after all we have been experiencing from a coal shortage, it is difficult by inspection to tell whether the contents of many of the ash cans waiting removal from in front of a number of our city buildings are intended for coal or ashes.

If the owner of a plant, whether it be for power or for heating purposes, is willing to allow a large percentage of the coal thrown into the boiler furnace to be carted away in the ashes when the nation is facing a coal famine like the present, it is time that some pressure be brought to bear from the outside by someone who has the power to have the conditions remedied or to cut off the offending ones' coal supply. One of the ways to get at this would be to enact a law limiting the carbon content of the ashes from boiler furnaces to a certain percentage and to appoint inspectors to investigate the ashes coming from every plant and see to it that the law is being complied with.

As long as the manner in which a power plant was operated did not in any way seriously affect the community, how it was run was very largely nobody's business but the owners; but when it has come to the time when it means that coal wasted in these plants is coal that somebody else seriously in need of it must go without, then it becomes the public's business how even a private plant is run. Many of the central stations throughout the country have been forced to curtail their output for certain illuminating purposes, consequently suffering a loss of revenue, in order to save coal for private industries and heating. In justice to these public utilities which have had their output restricted by Government control to conserve the nation's fuel supply, the same Government should see to it that the fuel used in private plants is utilized in the most economical way and not thrown out in the ashes.

That the electrical interests have been alive to the opportunities afforded by the exceptional fuel situation is evidenced by the general advice given by fuel administrators to power users to conserve fuel by patronizing the central station. The advice is honestly and disinterestedly given, but the shutting down of many an isolated plant would mean a waste rather than a saving. Many power users who would otherwise have put in or continued their own plants have been driven to adopt "street service" by the uncertainty of the fuel supply or the impossibility of getting deliveries on apparatus. On the other hand, many owners of plants depending upon central-station current and idle for the want of it are hustling for steam, gas and oil engines.

Now or never Rhode Island coal has its chance. There is said to be a large quantity of it above ground as the result of Henry M. Whitney's attempt to develop the mines some years ago. The coal is hard, almost graphitic, but will burn, and might be used to advantage mixed with bituminous. It was of these mines that William Cullen Bryant wrote,

> That men might to their inner caves retire
> And there, unsinged, abide the day of fire.

An expressive statement of the purpose of the American Association of Engineers, emanating from its secretary, is that it is to put scientific management behind the young engineer and get him into the place where he belongs in a nation organized for over-all efficiency.

At the Kansas State Agricultural College there are one hundred and fifty women studying electrical engineering. Many women are employed in the central stations of Europe. Welcome to our ranks.

Correspondence

Losing Water from a Heating Boiler

The attendant of a small heating plant had considerable trouble in keeping water in the 60-in. diameter boiler over night, and although it was filled nearly full it was necessary to put in considerable city water each morning before starting up. On one occasion it was impossible to get any heat in the system at all until it was drained, as it was full of water.

At one time some radiator repairs had been made and the steam fitter had, as a matter of safety, closed the stop valve on the return pipe and the attendant had closed the stop valve over the boiler. When the attendant opened the stop valve on the top of the boiler, he forgot to open the valve on the return pipe, and the condensed steam filled the heating system full of water, as it could not return to the boiler. When the stop valve on the return pipe was opened the boiler filled and some of the water had to be blown out through the blowoff. This freed the heating system, but the next morning the water was again out of sight in the gage-glass and considerable water had to be supplied.

It was noticed that there was water in the ashpit, and it was supposed that it seeped through the ground. Investigation showed water trickling out through the brickwork just below the grates on the water-column side. The boiler was shut down, the brickwork was torn away, and just back of the water column the bottom connection from the front head to the water column was found badly corroded externally; and although the brickwork was dry at this time, it evidently had been wet during the summer months while the boiler was out of service, as it was customary in the spring to play the hose over the top of the boiler brickwork to settle the dust before brushing it down. Probably because of this considerable moisture remained in the side walls and caused corrosion at the pipe connection. After repairs were made, the boiler gave no more trouble for several days, when the water again disappeared from the boiler and the radiators and pipes began to hammer furiously.

Investigation showed that the attendant had closed the stop valve on the top of the boiler while making a radiator repair, and he either forgot to close the stop valve on the return line or else depended on the check valve to hold the water in the boiler. But the check valve was out of order and allowed the water in the boiler to back up in the return pipes to the radiators, thus causing the water-hammer. Opening the stop valve on the top of the boiler equalized the pressure, and the boiler quickly filled up. Luckily, there was but little fire in the furnace or the fusible plug would have been melted.

The check-valve disk was found to be disconnected from the hinge plate, the nut holding it being missing; one side of the bolt end was also broken off. Someone had slotted the end of this bolt on the back of the valve disk and, after putting on the nut, had driven a blunt chisel into the slot to spread the end of the bolt and thus prevent the nut from working off, but in doing so had fractured the metal on one side, which had eventually come out, leaving the nut loose, which also dropped off and then the disk dropped from the hinge.

It is always best to close the stop valve on the return pipe before closing the stop valve on the steam line, but do not forget to open it. If it is forgotten, however, the water will not escape from the boiler very rapidly by evaporation and it will be noticed at the water glass before the water becomes too low.

In one instance the floor in front of the boiler was covered with several inches of water one morning. The blowoff pipe passed beneath the floor of the next room, which was about 30 in. higher than the floor in the front of the boiler. The blowoff-valve stem had been leaking, corrosion had eaten the pipe through, and water escaped from the boiler overnight.

Where pipes go through a brick wall, they should pass through a sleeve of a larger diameter, and underground blowoff pipes should not be buried, but should be surrounded by a box to keep the earth moisture from the pipes to prevent corrosion. R. A. CULTRA.

Cambridge, Mass.

[These experiences of a man who evidently did not know his business emphasize the need of a license law to protect such men and others against their own ignorance. The owner of the plant evidently hired an inexperienced man because he was cheap, and at the same time ran a very favorable risk of ruining the boiler by burning and the piping system by water-hammer, to say nothing of a possible boiler explosion.—Editor.]

Inadequate Provision for Expansion

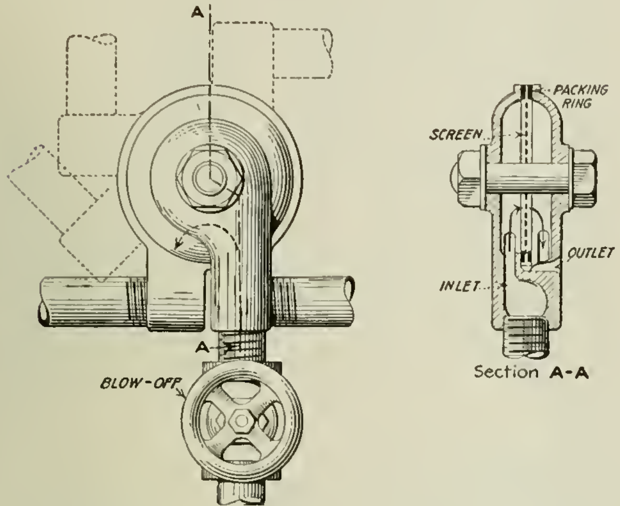
A practical demonstration of the necessity of allowing liberally for the expansion of a pipe line to carry steam came under my observation several years ago. The 2-in. pipe line was intended for use in emergencies, to serve a tank pump when the boilers were off in that part of the plant. About 400 ft. was laid under ground, ending with a tee to make the turn into the building and a nipple and valve for a bleeder, in a shallow wooden box about 2 ft. square.

When steam was turned on slowly, the engineer went down the line to close the bleeder, but he found the pipe had lengthened and pushed the valve and nipple through the side of the box, so the only thing to do was to shut off and wait for the line to contract enough to take the nipple out and screw a plug into the tee and do the draining at a point beyond. All the expansion had gone one way because of the considerable pitch downward in that direction. J. LEWIS.

New York City.

Strainer for Pipe Lines

Attention is frequently called to the necessity of connecting strainers to the inlet piping of steam traps and other such apparatus, and considerable trouble is caused at times by dirt getting into them. This led me to design a strainer in accordance with my own ideas, as shown in the illustration. It can be put in a line in place of a union or a pipe fitting, can be used to form any desired angle and is extremely simple.

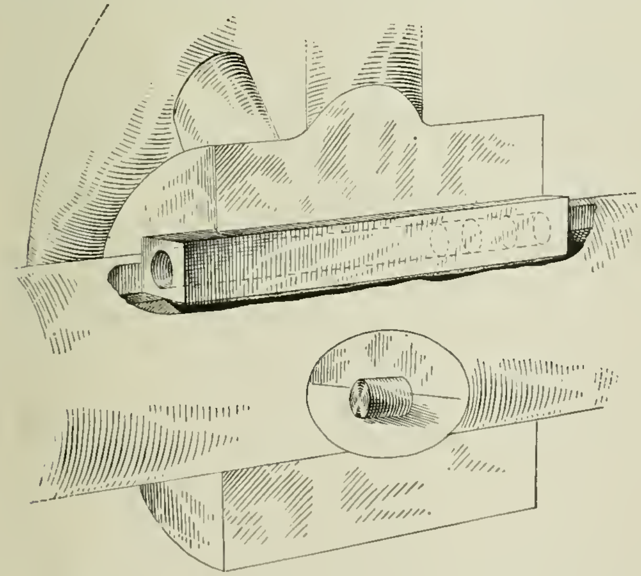


NOVEL TYPE OF STRAINER TO GO IN PIPE LINE

Hasbrouck Heights, N. J. GEORGE J. LITTLE.

"Buttoning a Key"

This is a means of tightening a key in its keyway when it is difficult to remove it, as in some cases it means dismantling a lot of parts to take a key out. Drill the key lengthwise, being sure not to cut through the sides of it, then cut off pieces of round steel about half an inch long and a little larger than the hole and drive them in separately until they fill the hole solid. When the job is done, you have as tight a key as you ever had. GEORGE H. DIMAN.



KEY DRILLED AND TIGHT-FITTING PLUGS DRIVEN IN

Lawrence, Mass.

Three Motors Heated

The connections for two single-phase transformers when operated open-delta from a three-phase circuit are shown in Fig. 1. The voltages of the secondary side are displaced 120 deg. from each other and are of the same value, therefore any three-phase device that is operated from the secondary will, under normal conditions, be subjected to balanced three-phase voltages.

A construction contractor complained that three three-phase motors which he had just started on a new job heated so badly when operated for only five minutes without any connected load, that it was impossible to use them. He further stated that their operation had been entirely satisfactory on the preceding job.

The fact that all the motors heated in this case, whereas none had ever heated before, suggested trouble in the 220-volt service line. As there was no voltmeter available, the voltage at the motors was roughly measured by means of two 110-volt lamps connected in series. From the middle to either outside wire the voltage appeared to be about normal, but between the two outside wires the voltage was abnormally high. It was determined that in using supply transformers that were made by different manufacturers, the two secondaries had been connected with the wrong polarity, as indicated in Fig. 2. Reversing the polarity of one transformer not only increases the value of the voltage between the outside legs 1.732 times over that of one phase, or in this case 220 × 1.732 = 381 volts, but also changes the phase displacement between the resultant voltage across the two transformers and that of each unit from 120 deg. to only 30 deg. As a result of the error, not only was one phase winding of all motors subjected to 73 per cent. overvoltage, but the torque characteristics were so much modified that the rotors, even when free, would not come up to full speed. E. C. PARHAM.

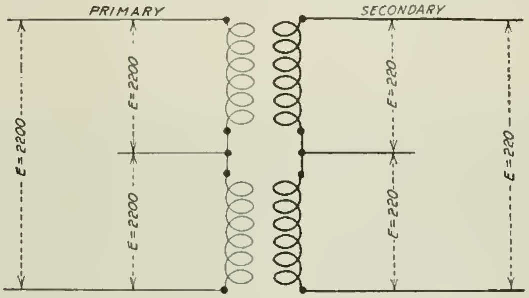


FIG. 1

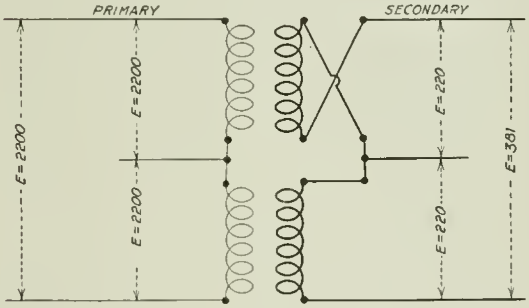


FIG. 2

FIGS. 1 AND 2. DIAGRAMS OF TWO TRANSFORMERS CONNECTED OPEN-DELTA

Brooklyn, N. Y.

Ideal Power-Plant Location

Mr. Dow. in his article on "Production of Electricity by Steam Power," in *Power* of Dec. 11, speaks of the location of power plants, and this brings to my mind the ideal location of a small country plant. Of course they wanted to get as near the center of distribution as possible, and in looking for such a site found a creek running through this section. They decided that by making a reservoir near a railroad they would be sure of water and also be accessible to a coal supply. After excavating a few feet, solid rock was found, which was blasted out and considerable of it used in the construction of the plant.

So here we had an ideal location, with plenty of water, and in making the reservoir we secured enough stone to build the plant, which was erected within one hundred feet of the main-line railroad, with the plant located in about the center of distribution.

New York City. D. R. HIBBS.

Lamp Bank as a Rheostat

In connection with electrical work there are innumerable instances where some form of rheostat is required for reducing the current in a constant-potential circuit. There are many forms and types of rheostats, using metallic or carbon resistance units or a liquid; but they may all be classed under one of two categories, those for continuous service and those for intermittent service. Rheostats used in charging storage batteries or in motor circuits for speed control must be designed for continuous service; rheostats used for starting duty only need be designed for intermittent service.

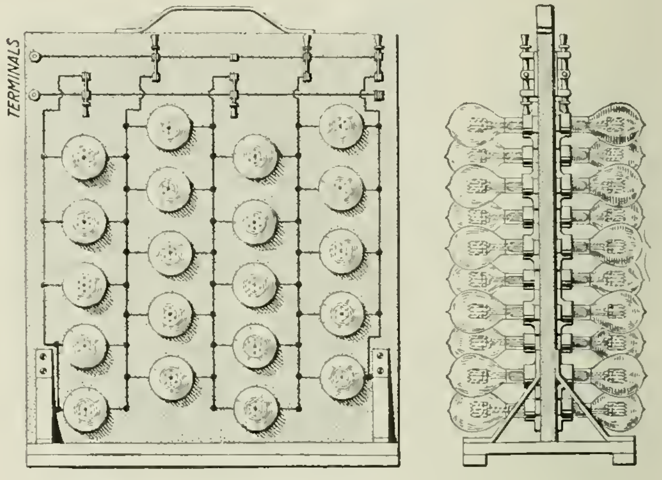
The ordinary electric lamp offers a convenient means of designing a rheostat for continuous duties, which is easily made from material readily obtainable almost anywhere.

The figure shows a rheostat that is made up of 110-volt lamps arranged so that they may be used on 110, 220 and 440 volts. The shape and size of such a rheostat depend upon where it is to be used. For use around a power station or an industrial plant, lightness and portability are important features. For this purpose a ¾-in. wood board treated with asphaltum paint or, better yet, a piece of asbestos board, or slate if the rheostat is for stationary purposes, may be used. At one end of this board are placed five 5-amp. single-pole knife switches, two of them double-throw and three single-throw, mounted on porcelain bases, which should be left on, since the porcelain insulates the live parts of the switch from the wood. These switches are mounted as shown in the figure, with the lamp sockets in four rows, where five switches are used. The number of lamps per row depends upon the desired capacity of the rheostat and the permissible length. The lamp sockets may be mounted on about 4½-in. centers.

From the figure is obtained an idea of the wiring scheme, an arrangement that permits closing switches, counting from the right-hand side. Nos. 1, 3 and 5 down and 2 and 4 up for 110-volt service; Nos. 1 and 5 down and 3 up for 220-volt use; thereby connecting two rows of lamps in series; likewise for 440-volt service, four rows of lamps would be connected in series by closing No. 1 down and No. 5 up.

A single-throw double-pole switch may be installed at the top of the board to permit the opening and closing of the rheostat without interfering with the position of the smaller switches. If portable, a handle should be mounted on the top of the board to carry the rheostat from place to place. This handle may be a hole of suitable shape cut in the board.

If the rheostat is equipped with a base so that it will stand in an upright position, both sides of the board can be used for the mounting of lamps and switches as shown in the figure. Installing lamps and switches on both sides of the board makes the rheostat twice the former capacity. If so desired, metal guards may be placed on the board to prevent the lamps from being broken. This device may be filled with any size lamps that the spacing will permit and from one to forty lamps may be cut in at will; also, four lamps can be connected in series. Therefore, it is readily seen that the individual resistance may be varied over a wide range. Where the lamps are to be connected in series, care must be taken to see that they are all of the same size.



FRONT AND SIDE VIEW OF LAMP RHEOSTAT

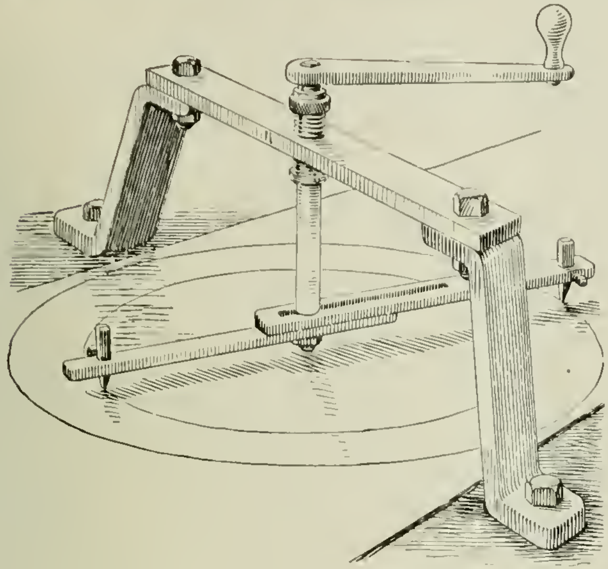
The uses to which a rheostat of the foregoing type may be put around every power house and industrial plant are almost endless. It may be used for meter checking, for testing small machines or for drying out new or damp equipment by current control, or as a heater; also for charging small storage batteries. It can be placed in the armature or shunt-field circuit of motors to vary their speed, although in the latter case care must be exercised that the field is not accidentally opened or the motor may run away and destroy itself.

It permits apparatus designed for a given voltage to be operated at a higher, by absorbing the excess voltage in the rheostat, this being accomplished by connecting a voltmeter across the terminals of the current-consuming apparatus, which is connected in series with the lamp bank. The rheostat is then manipulated until the voltage indicated by the voltmeter connected across the device is of the desired value. Another use for the rheostat is as a light cluster, and I have used it as such on several occasions to good advantage. In fact, it will be found a useful and frequently used adjunct to ary electrical equipment.

Chicago, Ill. M. A. WALKER.

An Easily Made Gasket Cutter

Having wasted considerable packing by hacking it out on the flange with a ball-peen hammer, I made a gasket cutter of the design shown in the illustration.



GASKET CUTTER MOUNTED ON A BENCH OR BOARD

The cutter bars are adjustable to suit a large range of sizes. Considering the large number of gaskets used to keep things tight, such a device is worth while.

Concord, N. H. CHARLES H. WILLEY.

Synchronoscope Needle Stuck

Paralleling a rotary converter with another machine of the same type is generally an easy job, but one morning a machine in the substation where I was working, caused considerable disturbance. The machine had been brought up to the correct speed, and we were watching the synchronoscope so as to close the oil switch at the right moment. Finally the hand revolved very slowly, indicating about synchronous speed and then suddenly swung to the zero position and stayed there. The operator waited for an instant and then closed the switch. There was a succession of flashes from the commutators of the machines, accompanied by bangs and flashes as the reverse-current relays operated and tripped out the circuit-breakers on the direct-current side. The machines began to slow down, indicating that the transmission line from the main station had opened.

The end cells of the storage battery were cut in to hold up the voltage until the machines could again be started. One of the rotaries was cut in on the starting circuit before it stopped and was brought up to speed again ready to be connected in on the alternating-current circuit as soon as the transmission line was made alive.

When the synchronizing plugs were put in again, the hand on the synchronoscope still remained at the zero position. Evidently, something was wrong with the instrument since a pair of lamps, which were also connected to indicate synchronism, were fluctuating properly; these were used as an indicator and the machines put in service. When the synchronoscope was opened, a piece of insulation was found jammed between the rotating member and the poles of the instrument, which must have happened as the needle came to zero position.

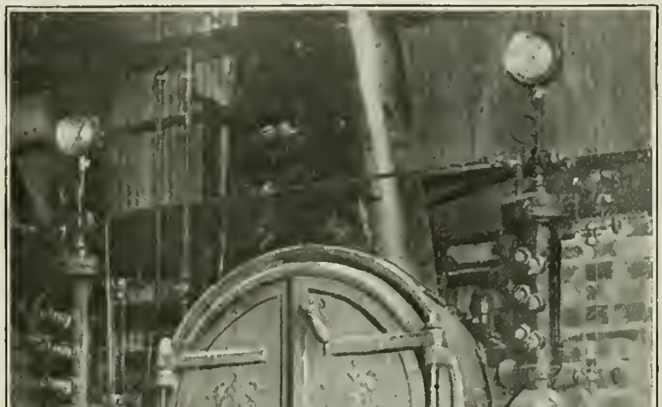
If the operator had watched the lamps as well as the indicator, he would have noticed that something was wrong and would not have closed the switch until the trouble had been investigated; which we all received strict orders to do after the experience related.

Minneapolis, Minn. E. W. MILLER.

Unusual Equipment on Small Boilers

The complaint in most small power plants is the absence of devices that render the operation less of a care. In striking contrast the photograph shows some of the equipment on a pair of 36-in. by 10-ft. return tubular boilers (normal rating 20 hp.) that have been rather overburdened.

These boilers furnish steam to the oil burners of a number of kilns and, as shown, are provided with feed-water regulators, automatic stop and check valves on the 2½-in. steam nozzles and automatic regulators for the oil burners; also damper regulators are about to be installed. One thing that catches the eye, however, is that the water columns are several sizes too large. The lower gage-cock is correctly located, but the upper one is about level with the top of the boiler.

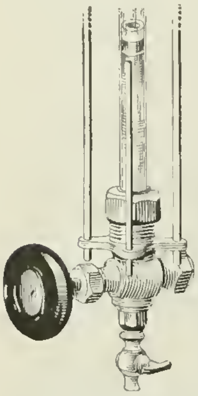


OIL BURNER AND FEED-WATER REGULATORS

Kansas City, Mo. C. O. SANDSTROM.

Water-Level Indicator in Gage-Glass

It is sometimes hard to see just where the water is in gage-glasses on the fronts of boilers, heaters, etc., that have become fogged and dirty. The trouble can be obviated by placing a hollow cork in the glass, as shown in the illustration, as the cork can be readily seen and being hollow and a loose fit in the glass, will not affect the level of the water. This, of course, is not a new or original "stunt," but is simply a reminder or suggestion to someone who has not thought of it. There have been numerous floats, to go into gage-glasses on the market in years past, but the cork will serve the purpose just as well and costs nothing. Giving the cork a color, red for example, that will make it more clearly visible is also advantageous in extreme cases, but is not often necessary.



CORK IN GAGE GLASS

New York City. D. R. HIBBS.

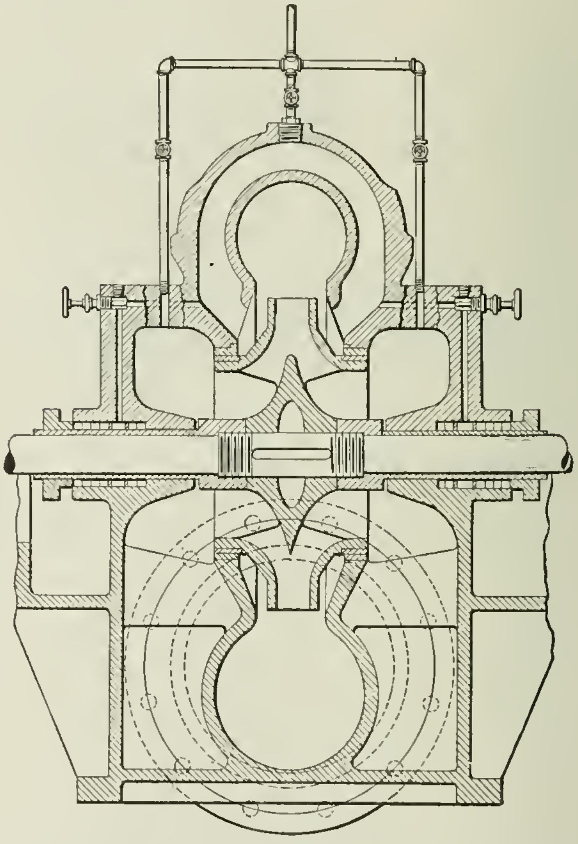
Priming Centrifugal Pumps

All high-grade centrifugal pumps are equipped with wearing rings, the duty of which is to act as packing and prevent the liquid in the pump from flowing back to the suction chamber. Therefore they must be a close running fit and have sufficient surface to prevent excessive leakage. The best pumps are equipped with double wearing rings which can be easily replaced when wear occurs. If such a pump is run without water even for a short period, there is great danger of these rings heating and scoring. Pumps have sometimes been run without water until the rings, usually made of brass, have become hot and seized and have either broken or stopped the pump; in fact, there is danger of wrecking the pump, especially a new one, when this happens. For the foregoing reasons no centrifugal pump should be run until the operator is sure that it is primed.

A centrifugal pump cannot handle air alone and for that reason is not self-priming, and air must be prevented from entering it while in operation, or its capacity will be reduced to a marked degree or the flow of water may stop entirely. The shaft is often provided with water seals or lantern glands. In operation these glands are filled with water, under some pressure, which prevents air leaking into the pump through the packing and also lubricates the packing, preventing any heating or scoring of the shaft. Some engineers have used grease successfully in these lantern glands and prefer it to water.

A centrifugal pump can be primed in a number of ways. If the water flows to the pump under a suction head, the only thing required is to open the suction valve and the vent at the top of the pump until all air is expelled, and the pump is then ready to run. If operating against a suction lift, it will be necessary to get the air out of the suction line and pump casing before it will be possible to begin pumping water. If there is a check or foot valve in the suction line, water can be run back down the discharge line against this foot valve, allowing the air to escape at the top of the pump casing. If there is no check or foot valve, the pump can be primed by exhausting the air from the pump and pipe with a water, steam or air ejector. In this case the discharge valve must be closed to prevent air coming in from the discharge line. Connect the ejector to the top of the pump casing and draw off all air; start the pump with the discharge valve closed, and when the pump is up to speed, open the discharge valve gradually and the pump will promptly go into service.

A permanent vacuum connection can be used to advantage when operating a centrifugal pump on a high suction lift. Vacuum connections should be made to all closed chambers or spaces not in open communication with the main vent opening, as shown, and when starting a pump all valves should be open; but when the pump is in operation, the valves should be open just enough so that any air coming in with or being released by the liquid will be drawn off by the vacuum. When a pump is so connected, a small amount of water is apt to be drawn over into the vacuum, but this can be controlled by the regulating valves or by running the pipe high enough above the pump to prevent any water flowing to the vacuum. If the latter method is used, it will be necessary to connect an enlarged section of the pipe in the line in order to separate the air and water and break up the air-lift action. It is possible to operate pumps provided with vacuum connections at practically full capacity on a suction lift of 27 in. of mercury with the temperature of the liquid from 70 to 80 deg. F. H. L. THOMPSON.



VACUUM CONNECTIONS FOR PRIMING CENTRIFUGAL PUMP

St. Louis, Mo.

Inquiries of General Interest

Heat Value of Coke—What is the heat value of coke? H. M.

The heat value of coke depends mainly upon the percentage of ash, which varies from 5 to 20 per cent. With theoretically perfect combustion a pound of average coke yields about 12,000 B.t.u.

Advantages of Cylinder Counterbores—What is the advantage of counterbores in the ends of steam-engine cylinders? E. L. B.

The principal advantage is to allow the piston to override the ends of the main bore and thus prevent the wear by the piston from leaving a shoulder in the main bore at each end of the stroke. Counterbores also are advantageous in requiring less length of reboring and in affording convenient means for determining the original centering of a cylinder.

Setting Boilers in Battery at Different Levels—When boilers of different sizes are set in the same battery, what advantages, if any, are to be obtained by placing them so their water lines will be at the same level? W. R. P.

The boilers will have different rates of evaporation, and to maintain proper water levels when in operation, each will require special adjustment of its feed valve. Hence no advantage is to be obtained by having a uniform level of the water lines, excepting for filling the boilers when cold by regulation of a single water-supply valve.

Soft Bearing Metal of Lead and Antimony—We wish to use a quantity of soft bearing metal and are thinking of making a mixture of 80 parts of lead to 20 parts of antimony. Would this be good proportions? F. F. B.

The high crystalline structure of antimony is likely to cause it to separate and become "rubbed out" of an alloy of lead and antimony if the proportion of antimony is higher than 17 per cent. of antimony to 83 per cent. of lead. "Carbox" metal is made in the proportions of about 15 per cent. antimony and 85 per cent. lead.

Use of Motor Below Rated Capacity—We have a 250-hp. three-phase induction motor that is used for driving a centrifugal pump requiring 170 hp. input to the motor. Is there enough loss in efficiency on account of the motor being underloaded to warrant installation of a smaller motor? A. H.

The efficiency of standard types of electric motors of 250-hp. capacity, when in good working order, ranges from 92 to 94 per cent., and the efficiency of the motor when operated at 170-hp. would be practically the same. The efficiency of the present motor is probably quite as high as might be expected of a 170-hp. motor of the same type, and a change on ground of superior efficiency would not be warranted.

Adiabatic Compression of Ammonia—What is the formula that expresses the relation of pressure to volume in adiabatic compression of ammonia? C. W.

The equation for adiabatic compression of ammonia gas is

$$p_1 = p\left(\frac{v}{v_1}\right)^{1.32}$$

where v = the volume at the initial absolute pressure p, and v_1 = the volume at the absolute pressure p_1. This formula signifies that the ratio of the volumes is to be raised to the 1.32 power and then multiplied by the initial pressure for obtaining the final pressure, or pressure obtained for an intermediate volume v_1. For compression to 0.9 of the initial volume, the equation becomes $p_1 = p\left(\frac{10}{9}\right)^{1.32} = p \times 1.149$; for 0.8, $p_1 = p \times 1.342$; for 0.7, $p_1 = p \times 1.601$; for 0.6, $p_1 = p \times 1.962$; for 0.5, $p_1 = p \times 2.496$; for 0.4, $p_1 = p \times 3.352$; for 0.3, $p_1 = p \times 4.900$; and for 0.2, $p_1 = p \times 8.368$.

Advantage of Spiral Form of Crank Arm—What benefit is derived from having a spiral form of crank arm such as sometimes used for transmitting foot power to lathes and to spindles of grinders? B. R.

The spiral form of crank arm is beneficial only when, from its flexibility, it permits of smoother conversion of reciprocating to rotary motion, or when appropriately designed, the flexibility causes the force applied to the crankpin to throw it off the dead-center, in which there may be advantage for starting off the stroke, but no less energy is required to overcome resistance that may be offered to complete revolution of the crankshaft. Various other forms of flexible mechanism have been proposed for the crank motion of reciprocating engines with the erroneous idea that they effected a saving of power, though some have been successfully employed for permitting the engine to start up from any point of stroke of the piston.

Relation of Piston Clearance to Cylinder Clearance—How is the percentage of clearance of a compressor determined, knowing the distance of the piston from the cylinder when the compressor is on a dead-center? C. W.

"Distance of the piston from the head of the cylinder" is understood to signify what is commonly termed "piston clearance," or distance the piston would have to be moved beyond the end of its stroke to place it in contact with the cylinder head. Cylinder clearance is the volume of the space in the end of the cylinder and connected passages and spaces when the valves are closed and the piston is at the end of the working stroke. The cylinder-clearance volume can be found by filling the clearance space with water and determining the volume of water required. Cylinder-clearance volume usually is expressed as a percentage of the volume displaced by one stroke of the piston: hence the percentage would be 100 × volume of cylinder clearance ÷ volume displaced by 1 working stroke of the piston.

The cylinder clearance for any assumed piston clearance will be the cylinder clearance for 0 piston clearance plus the piston displacement due to a stroke that is equal to the assumed piston clearance.

Factor of Evaporation Generating Superheated Steam—What would be the factor of evaporation under the following conditions: Steam generated at 168 lb. boiler pressure; temperature of steam, 394.5 deg. F.; feed water, 143 deg. F.? G. A. E

The formula for factor of evaporation is

$$F = \frac{H - h}{970.4}$$

where F = factor of evaporation, H = total heat of 1 lb. of the steam, h = heat of 1 lb. of the feed water, and 970.4 = the latent heat of evaporation at atmospheric pressure, or number of B.t.u. required to evaporate 1 lb. of water from 212 deg. F. into steam at atmospheric pressure.

Dry saturated steam at 168 lb. boiler pressure, or 168 + 15 = 183 lb. per sq.in. absolute, has a temperature of 374.5 deg. F. and if the temperature is 394.5 deg. F. there would be 20 deg. of superheat. According to Marks and Davis' Steam Tables of properties of superheated steam, the value of H in the formula, for the total heat of 1 lb. of the steam, would be 1209.7 B.t.u. above 32 deg. F., and as the value of h for the heat per pound of the feed water would be 143 − 32 = 111 B.t.u. above 32 deg. F., by substituting these values in the formula, it becomes $F = \frac{1209.7 - 111}{970.4}$, or factor of evaporation = 1.1322.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Absorption Refrigerating Machines*

By F. C. Spangler†

Fully describes the absorption machine, high- and low-pressure, and tells how to operate and care for them. Causes of lack of capacity, making a charge of ammonia, purging the system, thawing the freezer coils, care of the ammonia-pump regulator, cleaning coils, locating slight leaks.

A SECTIONAL view of the Carbondale exhaust-steam refrigerating machine is shown in Fig. 1, and briefly described, the method of operation is as follows: The generator is filled with sufficient aqua ammonia to cover the steam coils, and the absorber with enough to submerge the water tubes. The brine pump is started and brine is circulated through the cooler coils. Then the water is turned into the machine. The inlet water enters the bottom header of the condenser and, after it passes through the condenser, enters the absorber. It circulates through the tubes of the absorber; thence through the weak-liquor cooler, and finally into the rectifier. By this arrangement the water is used four times, each stage being at a somewhat higher temperature than the preceding. Thus the water consumption of the machine is greatly economized.

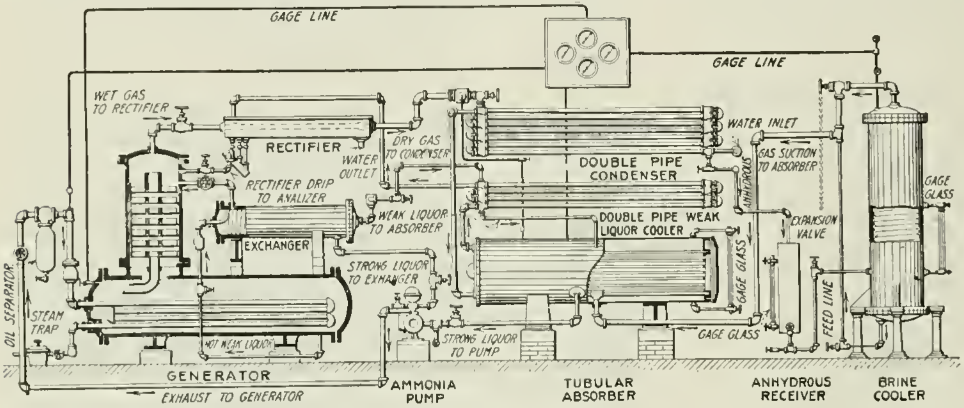


FIG. 1. TUBULAR TYPE ABSORPTION SYSTEM

Steam is now gradually turned into the generator coils until the full exhaust-steam pressure is reached. As the steam heats the ammonia in the generator, the "generator" pressure, which indicates the pressure in the generator, condenser and rectifier, will rise until it reaches a point sufficiently high to condense the ammonia gas in the condenser.

As the gas passes through the rectifier on its way to the condenser, the cool water circulating through the tubes of the rectifier chills the gas sufficiently to separate any entrained moisture that may be contained in it. The dry, or anhydrous, gas passes to the condenser, where it is condensed and falls in liquid form into the anhydrous receiver. The liquid anhydrous ammonia thus formed is then allowed to pass through the expansion valve into the brine cooler, the same as in the compression system. The expansion valve is throttled so as to keep a constant liquid level in the anhydrous receiver.

The pressure in the brine cooler is much below that of the condenser, and this drop in pressure causes the ammonia on entering the cooler to boil and absorb the heat from the brine in the coils. This changes it from liquid form on entering the cooler into a gaseous state on leaving it. The method of condensing the ammonia gas and the refrigeration that is produced in the brine cooler are identical with the compression system.

The problem now is to recover this gas. To do this, the weak ammonia liquor, which was left behind in the generator, and from which the gas has been expelled by the heat in the steam coils, is drawn from the bottom of the generator, through the exchanger, and thence through the weak liquor cooler into the absorber. Owing to the great affinity of water for ammonia gas, this weak ammonia liquor absorbs the gas in the absorber as it comes from the brine cooler, and by this means keeps down the pressure in the cooler. In turn, this weak liquor becomes enriched or strengthened by the ammonia gas and forms a strong liquor. This strong liquor is drawn from the bottom of the absorber by the ammonia pump, which discharges it into the exchanger, where it circulates around the coils that contain the weak liquor and then passes into the generator. The exchanger is simply a heat exchanger and answers the same purpose as a feed-water heater in a steam boiler plant. It heats the strong liquor on its way to the generator and cools the weak liquor.

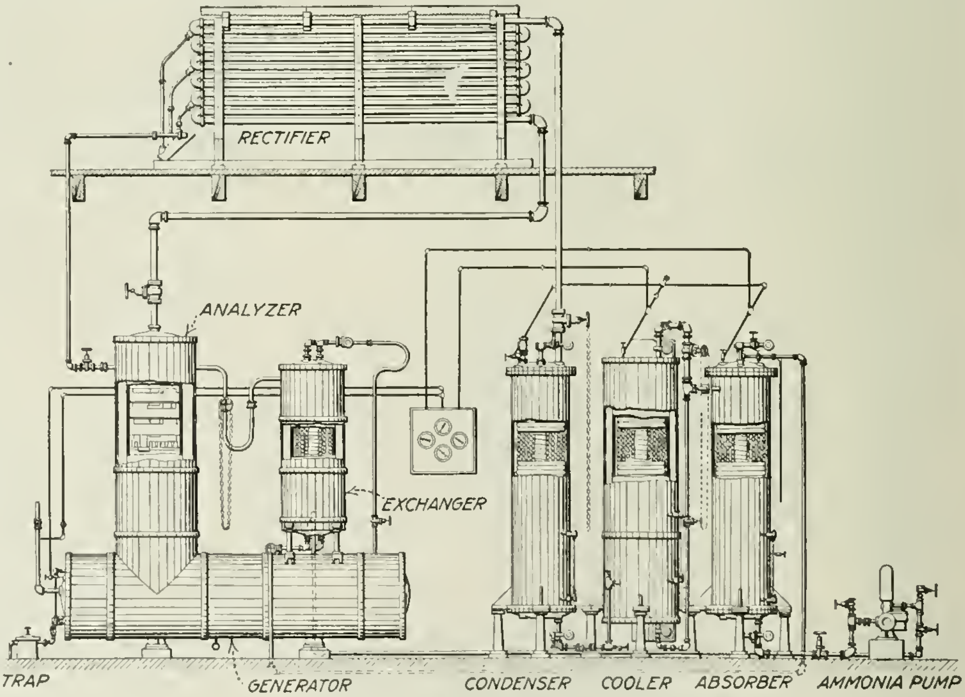


FIG. 2. SHELL TYPE ABSORPTION SYSTEM

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*From a paper before the New York Engineers' Protective Association, November, 1917.

†Engineer, the Carbondale Machine Co., 50 Church St., New York City.

We now have the strong liquor back in the generator, ready for redistillation, and the cycle is complete.

The Carbondale Machine Co. builds three types of ice and refrigerating machines—the shell, atmospheric and tubular types. The original Carbondale construction was of the shell and coil type, shown in Fig. 2. This machine was the development of the old Pontifex design, which was brought to this country in 1884 and has been gradually improved until it has produced high efficiency. This type of machine is admirably suited for condensing water that is free from dirt and incrusting solids.

A number of these machines have been in operation for over twenty years without any coil renewals or repairs, and are giving good service today. The generator used with all three types is of the same construction and is provided with return bend coils of extra-heavy pipe. The condenser, exchanger and absorber of the shell type have cast-iron or steel shells, supplied with spiral wound coils of suitable proportion for the work contemplated.

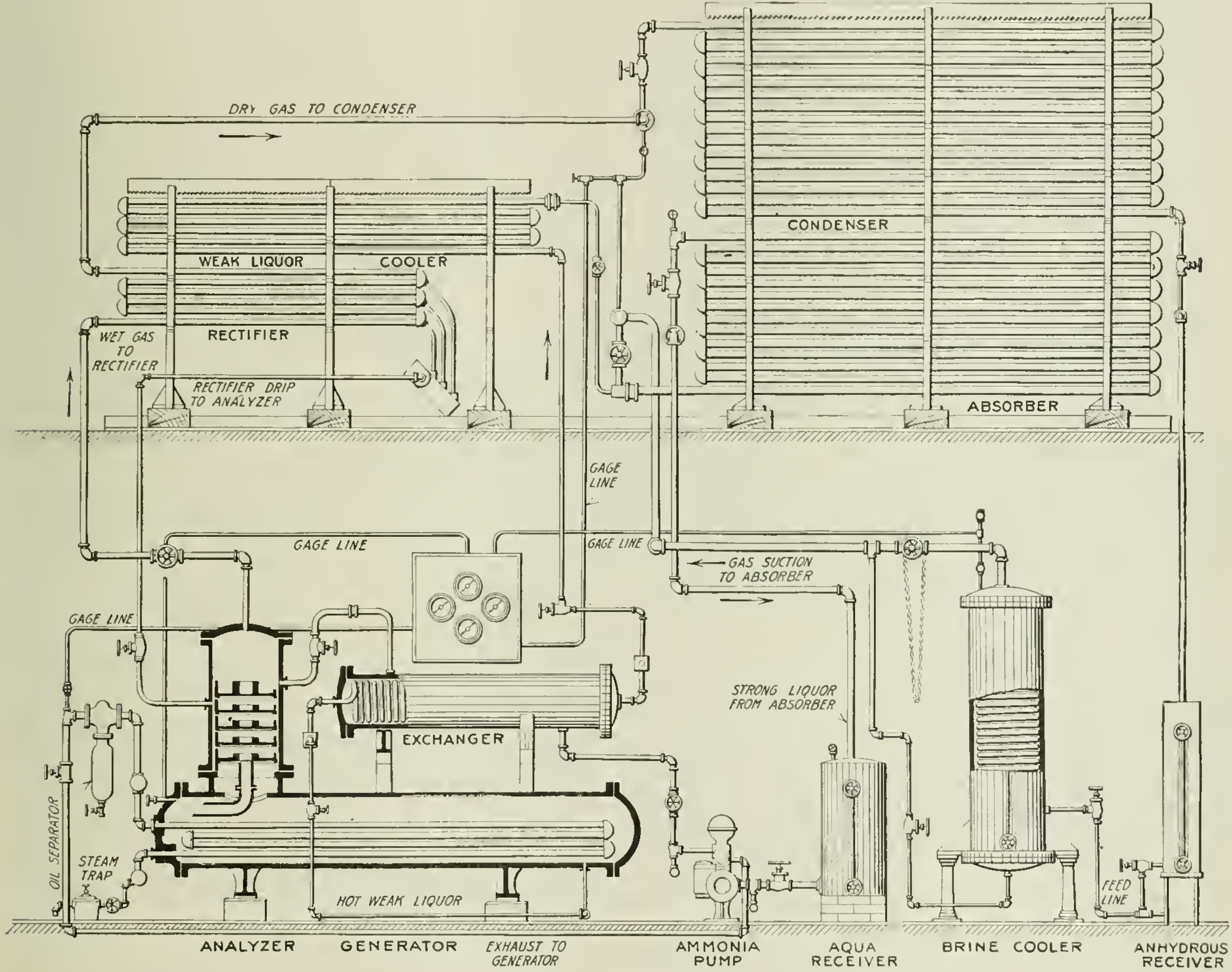

FIG. 3. ARRANGEMENT OF ATMOSPHERIC ABSORPTION SYSTEM

In case of warm or muddy water the atmospheric type of machine shown in Fig. 3 is recommended. In this machine the exchanger is of either the double pipe or shell type, the latter construction being shown. In case the water is sea water or at all corrosive, I would recommend the use of extra-heavy galvanized pipe in the rectifier, weak-liquor cooler, condenser and absorber; but in case it is of high temperature, such as comes from a water tower, full-weight ammonia pipe will answer the purpose and, if properly painted, will last for years. The rectifier is placed under the weak-liquor cooler, so that the cooling water is used by this cooler before it descends to the rectifier. The condenser is placed above the absorber, so that the water passing over it runs down over the absorber, and by this means the quantity of condensing water is economized. With the majority of atmospheric absorption machines, the condenser and absorber are located side by side and the water is used independently over each part of the apparatus, thereby increasing the consumption. The absorbers are provided with an injector arrangement.

Though a helical-coil cooler is shown, this construction can be used with expansion coils in the ice tank or with a horizontal-tubular cooler, if preferred.

The tubular type of machine, Fig. 4, is the latest development of the Carbondale construction, and consists of a generator similar in construction to the preceding types, a double-pipe rectifier, double-pipe exchanger, weak-liquor cooler and condenser and a tubular absorber. This is particularly adapted for low headroom and is easily accessible for repairs. Furthermore, containing nothing but straight pipes, it can be readily inspected and cleaned. In cases where the condensing water is corrosive, the use of galvanized tubes is recommended.

Special attention is called to the water connections. To economize, the water first enters the bottom header of the condenser, the overflow passing to the absorber. From there it passes to the weak-liquor cooler and thence to the rectifier. By this means the water is used through all four parts of the apparatus progressively and consequently the quantity of water is no greater than that required with a compression machine.

The advantages of the absorption system are: (1) It takes very little steam at 30 lb. per hour per ton refrigeration effect; (2) if exhaust steam or waste heat is available it takes no live steam except that required to run the small ammonia pump; (3) it has no heavy moving parts and cannot be materially damaged by carelessness; (4) it has no oil to clog and insulate the pipes; (5) it does not require heavy foundations, can be placed on the top floor of a building and makes no noise or vibration; (6) it can easily and economically produce low temperatures.

Operating and General Information

To start the machine, assuming that the machine has a normal charge, proceed as follows: (1) Start water circulating through machine; (2) start brine pump, making sure that the brine is circulating through cooler; (3) turn steam gradually on the generator (this steam should never be entirely shut off); (4) open the gas line between the cooler and the absorber; (5) open the weak liquor valve setting it as in usual running; (6) start the ammonia pump; (7) when the generator pressure is raised to about that usually carried, slowly open the valve between the rectifier and condenser; (8) open the expansion valve and set it. The machine now is in regular operation.

To stop machine: (1) Shut off steam on the generator, leaving a little turned on; (2) shut the expansion valve; (3) shut down the ammonia pump; (4) close the weak liquor valve; (5) close the cooler and absorber gas line valve; (6) close the valve between the rectifier and condenser; (7) shut down brine pump; (8) shut off water supply.

The causes of lack of capacity are: (1) Insufficient water supply; (2) insufficient brine supply; (3) insufficient ammonia charge; (4) air or foul gas in the machine; (5) dirty condenser, absorber and rectifier coils; (6) cooler in need of purging.

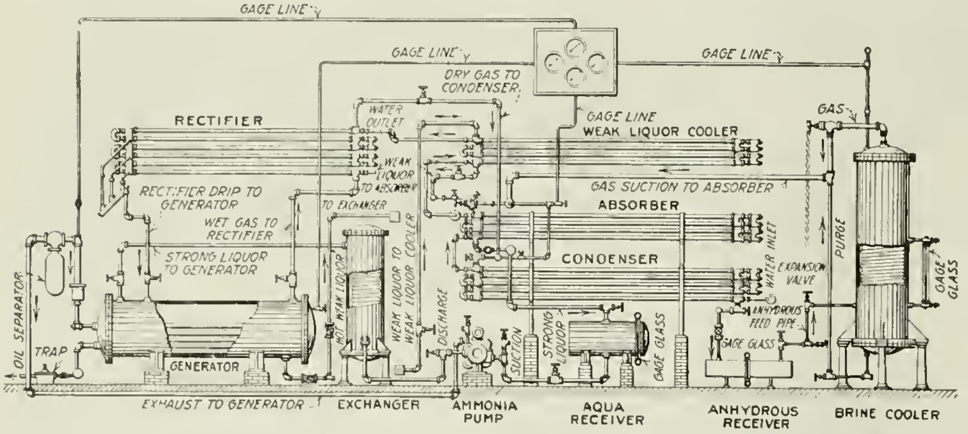

FIG. 4. DOUBLE-PIPE TYPE ABSORPTION REFRIGERATING MACHINE

Steam pressures: In case of the exhaust machine the steam pressure is usually in the neighborhood of three pounds, and does not vary. In case of the standard machine the steam pressure should be regulated according to the water temperature. Ordinarily, the steam pressure should never be in excess of one-third of the generator pressure. For example, with 150-lb. generator pressure, 50-lb. pressure on the generator is the maximum. If the machine is properly charged to do full capacity, a higher steam pressure will tend to dissociate the ammonia gas. Make sure that the generator steam coils are clear of condensation. An air-cock is provided on the bottom header for the purpose of relieving air from the coils and also indicating whether any condensation backs up in the coils. At times traps do not work properly, and it is always well to keep this air-cock open slightly to indicate any accumulation of condensation. When the machine is shut down, except for a long period, a little steam should always be allowed to enter the generator, so as to keep the shell warm.

Ammonia charge: With the machine in regular operation, and a normal charge, the following will be the conditions as indicated by the gage-cocks on the various shells. The generator will have 1 to 2 in. of liquor covering the coils. The absorber will have 1 in. of liquor covering the tubes or, if a shell type or atmospheric machine, it will have about 6 in. of liquor in the shell or receiver. The condenser will have 4 to 6 in. of anhydrous in sight, and the brine cooler will have enough anhydrous in it to frost over both gage-cocks and show a flush of soapy fluid in the glass when the cocks are opened. The gas line should be slightly frosted back to the absorber. This, however, should never frost sufficiently to show frost on the purge line.

Water supply to machine should be as regular as possible and a branch should be taken off the main at a point where other connections would not interfere with the flow to the machine.

Purging the cooler may have to be done as often as once a week, and then again not for two or three months. A cooler needs purging under the following conditions: (1) If both gage-cocks are frosted, as with normal charge; (2) if the cooler pressure is only a little, if any, in excess of the brine temperature; (3) if, on opening the cooler gage, the liquor looks watery and not soapy, then the indication is that some aqua has worked over into the cooler and that the cooler needs purging.

To purge the cooler, close the expansion and gas-outlet valve and open the purge valve leading out of the bottom of the cooler. This will drain all the liquor out of the cooler into the absorber. The pressure will rise in the cooler at first, but after fifteen minutes, will gradually fall. During the purging the pump should be run slowly and the liquor be allowed to accumulate in the absorber, which will prevent the pump from losing its suction. When the cooler has been well drained out, open the expansion valve for about thirty seconds. This will force the remaining liquor out of the cooler. After this is done two or three times and when the cooler pressure drops back to zero, the cooler has been completely purged. The machine can then be started, care being taken not to open the expansion valve too wide at the start.

The brine should preferably be made of chloride of calcium rather than from ordinary salt; it is more expensive than the latter, but does not have any corrosive action upon either pipes or valves and does not deposit solids in the coils. The gravity of the brine should occasionally be tested with the hydrometer. Brine of a specific gravity of 1.165 is safe at 6 deg. F. above zero; that of 1.200 does not freeze until it gets about 14 deg. F. below zero. If the brine is weak, there is liability of the cooler coils freezing, which would be indicated by a sudden stoppage of the brine pump. In such event immediately close the gas valve and open the expansion valve wide for at least five minutes. This should sufficiently heat the brine to thaw it and permit the pump to start.

To thaw freezer cooler, close the gas line from the cooler to the absorber and open the expansion valve wide and warm gas from the condenser will thaw out coils. Never allow the brine pump to stop when the cooler is in operation, as this is one of the causes of freezing.

When running at full capacity, the ammonia pump should circulate about ⅝ gal. of liquor to the ton of refrigeration. If a steam pump does not run steadily, but with a jerk, it is probable that there is some difficulty with the valves. These are of hard rubber or steel and should be inspected occasionally. If they become pitted in the crossbars of the valve seats, it is best to replace them with new valves. Pump rods should be kept smooth and true; any difficulty experienced in properly packing the pump end can usually be traced directly to the fact that the rod has become worn, tapering from the middle to the ends, which has a tendency to burst the stuffing-box by the wedge-like action of the rod. A properly packed box requires only a very light pressure of the gland and follower on the packing to prevent leakage. A small quantity of oil is to be used occasionally to lubricate the rod. If it is found that the pump is air-bound or gas-bound, it can be relieved by closing the suction and discharge valves and emptying the pump into a bucket of water through the pumping-out valve at the discharge of the pump. The suction valve should then be slowly opened and the pump allowed to fill with ammonia.

A regulator is provided on all modern steam ammonia pumps. It is connected top and bottom with the absorber, the liquid level line of the regulator being placed on a line with the liquid level desired in the absorber. It is of the ball-float type, the rise and fall of the ball operating the steam-inlet valve to the pump. In case the regulator does not work properly, it may be due to a stoppage in the lines to absorber or the collapse of the float. The float is of a special spun-steel type and should be purchased of the manufacturer. The regulator connections are provided with the valves on inlet and outlet, which should be closed in case it is desired to examine the float.

To get good results it is important to keep condenser, absorber and rectifier coils clean. They should be cleaned at least twice a year or oftener if possible.

Helical coils can be cleaned by blowing air and water through each coil or using some good coil compound. Tubular "coils" can be cleaned by using an ordinary tube scraper and brush. After the tubes are thoroughly cleaned it is well to coat them with noncorrosive solution, which is especially prepared for this purpose.

When the charge of ammonia is too weak, the process of distillation will not be uniform and continuous, and difficulty will be experienced in maintaining a reserve of anhydrous ammonia in the receiver, and an increased steam pressure will be required on the generator to distill over the ammonia. When this is the case, the ammonia charge must be strengthened. It should always be remembered that a weak charge entails a loss in the capacity of the machine, and that more fuel and more condensing will be required to do the work.

When starting the machine, some trouble will be experienced for a few days on account of the pressure of air in various parts. The same is true when at times the machine is recharged with aqua ammonia, which holds a considerable amount of air in solution. The air is gradually driven off from the aqua ammonia during the process of distillation and finds its way through the machine. A hose should be attached to the air valves on the absorber and receiver and dipped into a bucket of clean, cold water. If the gas coming from the hose is at once absorbed by the water with a sharp rattling noise, and no bubbles rise to the surface, and the water turns slightly bluish, all the air is out; if, however, bubbles continue to rise there is still air in the machine. When there are indications of a large amount of air in the machine it is best to shut down and blow out the air in one operation. At other times it is sufficient to slightly open the air-cocks and carefully watch for air and ammonia.

The presence of air in the machine is generally indicated by an excessive and misleading pressure in the generator and by the inability of the absorber to properly and promptly absorb the gas. It thus affects both the economy and the capacity of the machine.

With proper care and attention and by a systematic inspection of all joints, cocks and valves at convenient times, no ammonia leaks should occur; but in case of any, however small, they should be stopped at the first opportunity: these leaks are usually of anhydrous ammonia gas, and loss of ammonia rapidly diminishes the capacity and efficiency of the machine.

When the sense of smell is not sufficient to definitely locate a leak, the same can be found by holding a glass rod, moistened with muriatic acid, at or near the place of the suspected leak. A bluish-white cloud forms at the leak and immediately discloses its location. The same results can be obtained by holding burning sulphur near the leak.

Qualifications of Employees in Russian Refrigerating Industries

At a meeting of the Council of the Russian Refrigerating Committee of the Association Internationale du Froid the following resolutions, here given in part, were adopted, according to the association's bulletin.

The committee for the propaganda of knowledge on artificial refrigeration adopted the following classification concerning conditions with which employees in different sections of these industries shall comply:

Machine Section—Besides being experienced as regards the running of steam engines and dynamos, the machinist and his assistants must be perfectly familiar with the construction and operation of refrigerating machines, not only as regards the machine itself, but all its parts (condenser, coils, manometers, recording instruments, thermometers, etc.), as well as the starting of a machine and its supervision during operation. They shall have sufficient rudimentary knowledge on this subject to enable them to draw up plans, replace bolts, clamps, etc., and understand a technical description of a machine.

Cold-Storage Warehouse—The first and second inspectors shall have a good conception of cold-store construction, the operation of various refrigerating systems and their different organs and recording instruments for temperature and humidity and understand thermometer and hygrometer indications. They shall have charge of the supervision of rooms, doors and ventilating appliances and are expected to be able to distinguish the different grades of goods stored in the cold-storage plant; they shall also be familiar with the various packing systems and know the proper storage temperature for different kinds of perishables.

Icehouses—Workmen making a specialty of ice making will be employed in this branch of the business. An accounting system especially adapted for icehouses will be used.

Railway Icing Stations—Employees shall possess enough instruction on this subject to understand the rational construction and operation of icehouses and factories, ice making, ice loading into refrigerator cars, etc.

Specialists in Refrigeration (Technics and Engineering)—The general direction or management of a cold store shall be confided exclusively to a refrigerating engineer or a specialist in refrigeration. As regards the construction of a cold store, it shall be intrusted only to a refrigerating engineer.

In order to manage a cold-storage warehouse, a technical engineer must have received special instruction as regards artificial refrigeration, from both a theoretical and a practical standpoint and especially as regards the management of refrigerating machines; he shall further be familiar with the requirements of all parts of a cold store.

For agriculturists wishing to make a specialty of artificial refrigeration, a thorough knowledge of all branches of this subject is required, especially as regards the storage and transport of different kinds of perishables; inspection of all parts of the plant at regular intervals shall be organized in order to obtain the best results from the standpoints of temperature, hygrometry, etc.

Every specialist in refrigeration shall be perfectly familiar with the commercial part of this industry.

A list, appended, gives the names of schools, institutions and courses which applicants may attend in order to fit themselves for service in the refrigerating industry.

Price-Fixing and Coal Quality

Ever since coal prices were fixed by the Fuel Administration, long before the coal shortage became acute, there have been complaints of the poor quality of the coal delivered, and since the shortage these complaints have been getting more strenuous. A big coal man was asked the reason back of this recently, and he answered: "Well, for instance, we have two coal properties. One produces an unusually good quality of coal, of high heating value, with very little slag or sulphur. Before they fixed prices we commanded about forty cents a ton above run-of-mine prices for this coal, which we sold, on tests of its heating value, to public-service corporations and other institutions which were willing to pay extra for quality. Our other mine produced a much inferior grade of coal, which, however, was easier to mine. But the Fuel Administration, in fixing prices, said in effect, 'Coal is coal,' and fixed the same price for both mines. What's the answer? Naturally we are tempted to concentrate our surplus producing power on the poorer mine. Probably there are plenty of other coal men in exactly the same situation."—*The New York Times.*

Engineers in Government Service

Engineering Council, through its American Engineering Service Committee, has during the past few months supplied to various Government departments and bureaus in response to their requests, several thousand names of engineers from which men were to be selected to fill a great variety of positions in uniformed and civilian service for Army and Navy and other branches of the Government's activities in connection with the war, as well as for indirect service for manufacturers and contractors engaged upon Government war work.

To meet these demands the American Engineering Service Committee has assembled in its offices in the Engineering Societies Building, New York, extensive lists and much detailed information concerning engineers in all branches of the profession throughout the length and breadth of the land. It will readily be appreciated that if these lists are to be maintained in the most useful condition to the Government and to Engineering Council, the committee should receive promptly information concerning each engineer who has gone into any kind of Government service, direct or indirect, so that a record may be made on his cards in the committee's office.

Engineers reading these lines, to whom this request applies, are urged to send at once their names, present addresses and occupations in the Government service, with brief statement as to whether or not they are available for other service, to American Engineering Service Committee, Room 901, 29 West 39th St., New York. Other readers are asked to bring this request to the attention of such engineers or to send information directly to the committee.

Engineering Council is an organization of national engineering and other national technical societies of America of approximately forty thousand members, each member society having duly elected representatives therein, created to provide for the proper consideration of subjects of general interest to engineers and the public and for united action upon matters of common concern to engineers in all branches of the profession.

New York N. A. S. E. Offers Aid to Fuel Administrator

The following is the copy of a letter addressed to the New York State Fuel Administrator by the Combined Associations of Manhattan, Bronx and Queens National Association of Stationary Engineers:

Mr. A. H. Wiggin,
State Fuel Administrator.

Dear Sir: As the Government has for some time been considering ways and means to promote the economical consumption of fuel wherever and whenever used for the generation of heat, light and power, the National Association of Stationary Engineers, recognizing its responsibilities and duties in the present fuel crisis, hereby tenders its services to the various fuel-conservation commissions to coöperate in any capacity as their judgment may dictate.

We are anxious to demonstrate a true and patriotic spirit of coöperation to our Government in its efforts to bring our fighting forces up to the highest standard of efficiency.

We note that you have appointed a committee to report back to you on ways and means whereby the consumption of fuel may be reduced. If this is so, may we not suggest that men be represented on this committee who are actually in touch with the fuel-burning situation at all times, men who have been trained through the hard knocks of experience in fuel burning from the ground up, men who have come from the fireroom to the actual charge of the operation of the largest steam, electrical and refrigeration plants in the country?

This organization represents eleven subordinate locals in Greater New York, who are affiliated with nearly 25,000 operating engineers in the country.

Conservation of fuel does not only mean the proper burning of a combustible or the reduction of power consumption. It also means the proper application of steam through the various appliances and apparatus that are auxiliary to every power plant. In many plants changes could be made that would result in considerable saving of fuel if the necessary changes in equipment were made as suggested by the chief operating engineer.

May we further suggest that if your time permits, a personal interview be granted to a committee representing this organization, where the various phases of the question could be discussed.

Yours very truly,
D. Larkin,
President.

Discharging Warm Water in Stream

Where warm or hot water or steam is discharged into a stream in the winter time, when ice has formed on the surface and is being used by skaters, the owner of the plant is legally bound to take all reasonable precautions to guard against drowning of persons skating and exercising due care for their own safety. This should be done by erecting barriers where the ice is rendered unsafe, or by other suitable warning of danger that may not be appreciated by persons on the ice.

This statement of the law is supported by the recent decision of the Michigan Supreme Court handed down in the case of Parsons vs. E. I. du Pont de Nemours Powder Co., 164 Northwestern Reporter, 413. In this case, the court upholds liability of defendant for drowning of a boy who skated upon ice which had been rendered insecure by warm water discharged into a stream from defendant's plant, in the absence of proof showing that the boy was guilty of contributory negligence. It is decided that unless such proof be made, it must be presumed that the boy used due care for his own safety.

Personal Mention

Most men have limitations as to the quantity, quality and variety of work they can conduct with credit. Not so with J. C. McCabe, head of the Department of Safety Engineering, Detroit, Mich. The city fathers have already given him twelve distinct duties, and there are rumors of more to follow. In fact, when there is a choice bit of engineering work to do, testing or what not, requiring originality and unusual ability, an appropriation is made and McCabe is the man to do the work. The present activities of the department are as follows: 1, boiler inspection; 2, licensing of steam engineers; 3, inspection of ice-making and cooling plants; 4, inspection of elevators for construction, freight or passenger service; 5, analysis of gas; 6, use, handling, storage and sale of inflammable liquids and their products; 7, smoke inspection; 8, plumbing inspection (pending); 9, inspection of air tanks; 10, use of acetylene and calcium carbide; 11, testing of inflammable liquids and such other duties as the common council shall assign; 12, purchasing and handling coal for city departments and, in the recent shortage, diversion of city coal for industrial use.

A New Fuel—"Carbocoal"

Announcement is made of the invention of a commercial process for converting bituminous coal into a fuel called "Carbocoal," the equivalent of anthracite. A feature of the process is that by it there is recovered valuable byproducts from the coal that in present practice are wasted. The Smith process, as it is termed, takes the raw coal and separates the oils from the carbon and in turn presses the carbon into convenient shape for use.

This fuel is said to contain only 1½ to 4 per cent. of volatile matter and consists mainly of fixed carbon; in combustion it is smokeless, ignites with comparative ease, burns freely and under all draft conditions, is dustless, clear and uniform in size and quality. It is said to be suitable for use in marine and stationary boilers, for domestic use, kilns and gas producers. This fuel is to be put on the market by the International Coal Products Corporation. No address is given.

To keep polished iron or steel from rusting, mix five parts of fat oil varnish with four parts of spirits of turpentine. Apply with a sponge.

New Publications

DIRECTIONS FOR SAMPLING COAL FOR SHIPMENT OR DELIVERY—

By George F. Pope. Technical Paper 133, Department of the Interior, Bureau of Mines.

This is another one of the many publications of the Bureau of Mines on sampling coal. It deals with the time of sampling, the collection of gross samples, the size of samples, storage of gross samples, sampling from wagonloads, carload sampling, ship or barge sampling, and with the preparation of the gross sample; that is, crushing, halving and quartering. For the power-plant man this paper is probably the most useful of all that the Bureau has published on this subject. It may be had free by addressing the Director of the Bureau, Washington, D. C.

HYDRO-ELECTRIC POWER STATIONS

By Erie A. Lof and David B. Rushmore, Published by John Wiley & Sons, Inc., New York, 1917. Cloth; 6 x 9 in.; 822 pages; 408 illustrations; 66 tables. Price $6.

Water-power developments have become so closely allied with electrical engineering that it is practically impossible to give due consideration to the former without considering the latter; or, as the authors have pointed out in the preface of this book, "The work of planning, building, operating a hydro-electric power development requires a full understanding of the economic factors which enter into the problem and a thorough knowledge of both the hydraulic- and electrical-engineering sides of the subject." It is with these elements in mind that the authors have prepared this work. The book is divided into 11 chapters and 3 appendixes. Chapter 1 is a general introduction and gives data on the history of water power and electrical developments, available and developed water powers in the United States, primary power and its uses, power from inland waterways, etc. Chapter 2 deals with properties of water, rainfall, disposal of rainfall, stream flow, energy of flowing water and convenient equivalents. Chapter 3 considers the different kinds of water-power developments. Chapter 4 treats of dams, flashboards, fishways, intakes, etc Chapter 5 is on water conductors, water-hammer and surge tanks, gates and valves Chapter 6 deals with storage reservoirs. Chapter 7 takes up the problem of power-house design, embracing buildings, arrangement of apparatus, transportation and erection, starting up, general precaution, drying-out equipment, etc. Chapter 8 deals with the various types of turbines and their characteristics; governors, their operation and methods of control; pressure regulators or relief valves, water-flow meters, water-stage registers. Chapter 9 takes up the subject of electrical equipment. This chapter is very comprehensive, covering 373 pages, and gives consideration to practically every piece of electrical equipment entering into a hydro-electric power plant. Chapter 10 is also very comprehensive, occupying 100 pages and embraces the economical aspects of water-power development, such as preliminary considerations, general guide for the compilation of water-power reports and the securing of field data. This particular section is illustrated with different forms used for obtaining the foregoing data. Another very important section of this chapter is that on costs of hydro-electric power plants. This latter section gives cost data on 17 different hydro-electric power stations, varying in size from 600- to 200,000-kw. capacity. Chapter 11 gives consideration to the problem of organization and operation. Appendix 1 gives a reference to the descriptions of hydro-electric power systems in North America that have been published in the engineering publications of the United States and Canada; Appendix 2 is a table giving principal data on transmission systems operating at 70,000 volts and above; Appendix 3, standard testing code for hydraulic turbines.

In this book an endeavor has been made to describe the most recent engineering practice, and a considerable amount of information that has not heretofore been available is included. The authors, for many years being connected with one of the largest power-plant equipment manufacturing companies in the world, have had an excellent opportunity to collect valuable information over a wide range of experience The book is not a mathematical treatise, although formulas are given where necessary, but is a practical presentation in readable language of the problems that must be solved in connection with the construction, management and operation of hydro-electric power stations. Although written for the engineer and engineering students, a great deal of the material is presented in such a way that it can be easily understood by the practical power-plant operator, and should be well received by all those who have to do with hydro-electric power plants.

COLLAPSE OF SHORT THIN TUBES

Bulletin No. 99 of the University of Illinois Engineering Experiment Station contains the results of a series of experiments on the collapse of short thin tubes, made by Prof. A. P. Carman of the department of physics. The purpose of these tests was to find an equation by the application of which the pressure required to collapse a tube can be calculated when the dimensions of the tube and the elastic properties of the material are known. The bulletin gives a brief summary of earlier experiments on collapsing pressure, such as those of Fairbairn, Stewart and others, together with the formulas developed by these investigators. Then follow the description of the testing apparatus used by Professor Carman, the graphical and tabulated results of his experiments, and his conclusions. The data as given represent the results of the collapse of about 150 tubes. The majority of these were cold-drawn steel tubes from 1 to 3 in. in diameter. The remainder were of brass, aluminum, glass and hard rubber. The number of experiments on the last two materials, however, was too small to justify much generalization. The glass tubes, on collapsing, were reduced to a fine powder. The metal tubes collapsed in two, three, or four lobes, depending on the length. Copies of this bulletin may be obtained gratis by addressing the Engineering Experiment Station, Urbana, Ill.

DETERMINATION OF MOISTURE IN COKE

Technical Paper No 148, of the Bureau of Mines, Department of the Interior, deals with The Determination of Moisture in Coke, and is written by A. C. Fieldner and W. A. Selvig. The following is from the summary of the bulletin:

1. Investigation shows that the influence of temperature, time, humidity of drying atmosphere, and fineness of sample on the determination of moisture in coke may be varied over a considerable range without affecting the result appreciably.
2. Oven temperatures ranging from 105 to 200 deg. C. produced a maximum variation in moisture of not exceeding 0.3 per cent.
3. Coke can be dried to "constant weight" without any gain in weight taking place.
4. The circulation of air dried by sulphuric acid, through the oven atmosphere, as specified for coal analysis, is unnecessary, there being no measurable difference of results between circulating perfectly dry air through the oven and using in the oven the natural circulation of air from the room.
5. Moisture can be determined quickly with adequate accuracy of 0.5 per cent. by simply heating to constant weight a large sample of lump coke, in any convenient oven or on a stove, hot plate or steam coil at a temperature of 100 to 200 deg. C

Because of its simplicity and flexibility, this method may be used advantageously at points when coke shipments are sampled

Personals

S. D. Levings has resigned as Eastern representative of the automobile equipment department of the Westinghouse Electric and Manufacturing Co.

Engineering Affairs

The Association of Iron and Steel Electrical Engineers announces the following meetings: Cleveland District Section, Feb. 23, at Hotel Statler, at which B. W. Gibson, of the Carnegie Steel Co. will deliver a paper on "Generation, Distribution and Consumption of Power." The Philadelphia Section on Mar. 1, at the Majestic Hotel; John S. Rowan, of the Rowan Controller Co., Baltimore, Md., will present an illustrated paper on "Standardized Mill Table Controllers." A joint technical session, A. I. E. E. and Cleveland District Section, A. I. & S. E. E. will be held on the evening of Mar. 8, of which complete announcement is to be made later. The Pittsburgh Section's regular meeting will be held on Mar. 16 at the Hotel Chatham.

The Association of Ohio Technical Societies was organized at a conference of the engineering societies of the state held at Columbus, Jan. 29, with Clyde T. Morris, professor of civil engineering, of Ohio State University as president, and C. E. Drayer, of Cleveland, as secretary. The societies included in the association embrace every local society and local section of the national societies, twelve in number, as follows: Cleveland Association of Members of the A. S. C. E.; Cleveland Enginering Society; Cleveland Section, American Institute of Electrical Engineers; Columbus Chapter, American Institute of Architects; Engineers' Club of Cincinnati; Engineers' Club of Columbus; Engineer's Club of Dayton; Engineers' Club of Youngstown; Northwestern Ohio Surveyors' Association; Ohio Engineering Society; Ohio Society of Mechanical, Steam and Electrical Engineers; Toledo Society of Engineers.

Miscellaneous News

A Boiler Exploded on the lease of the Ohio Co. in Lawrence Co., Ill., on Jan. 29, instantly killing one of the oil workers and probably fatally injuring another. The cause of the explosion is not known.

Business Items

Fred F. Woolley, president, and John T. Sibley, chief engineer of the Hammel Oil Burning Equipment Co., Inc., of Providence, R. I., are now covering the southern power plant field from the Carolinas to Cuba and along the Gulf of Mexico to New Orleans. They are receiving numerous large orders and report that fuel oil burning in this territory will be active. Their temporary headquarters for this district is at Tampa, Fla.

The Westinghouse Electric and Manufacturing Co's. automobile equipment department has removed its manufacturing operations to the company's Newark works, Plane and Orange Sts., Newark, N. J. At this works the company has for many years been manufacturing small motors and instruments of accuracy and precision. At the same time the general sales office of this department will be moved to 110 West 42d. St., New York City, where the Eastern District Sales Office will also be located.

Trade Catalogs

Industrial Heating Apparatus. Westinghouse Electric and Manufacturing Co., East Pittsburgh Penn. Catalog 8-E. Pp. 32; 8 x 11 in.; illustrated. Describes the many different types of industrial heaters built by this company and their application.

The Yarnall-Waring Co., Chestnut Hill, Philadelphia, Penn., has issued two new bulletins illustrating and describing Simplex "Seatless" Blow-Off Valve and Simplex Pipe-Joint Clamp, also a pamphlet listing some of the users of Simplex blow-off valves and containing some sample reports and photographs of installations.

Bakelite Micarta-D Gears and Pinions. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn. Booklet 1579-A. Pp. 12; 8 x 11 in.; illustrated. Gives technical information regarding this type of gear, such as methods of attaching to the driving shaft, that have proved suitable for these gears, tables of pitch, teeth and other gear data, formulas for horsepower rating, amount of power that can be transmitted through a press fit and for calculating other variables in gear practice.

The Moloch Stoker Co.'s Type H catalog. The Moloch Stoker Co., Continental and Commercial National Bank Building, Chicago. Pp. 30; 8½ x 11 in.; illustrated. This catalog is quite unusual in character, in that it presents the subject in a most common-sense way. Beginning with a paragraph entitled "The Economy of Mechanical Firing" and proceeding in a logical and natural manner to a clear, although nontechnical description of the apparatus featured. The text matter proceeds in a logical manner to a well-developed conclusion in which the advantages of the Moloch stoker are summarized. The catalog is well illustrated throughout with assembled and detail views of the various parts and mechanism, as well as numerous typical installations.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 14. 1918	One Year Ago	Feb. 14. 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Feb. 14. 1918	One Year Ago	Feb. 14. 1918	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.69. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago
Pea	$5.05	$1.00	$5.80	$7.25—7.50
Buckwheat ..	4.30—5.00	2.75	5.50—5.80	6.25—6.50
Barley	3.25—3.50	1.95	4.00—4.25	3.50—3.75
Rice	3.75—3.95	2.20	4.50—4.80	4.50—5.00
Boiler	3.50—3.75	220	....	3.25—3.50

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)................	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		
	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago	Independent One Year Ago
Buckwheat ..	$3.15–3.75	$2.50	$3.75	$3.40	$4.15
Rice	2.65–3.65	2.10	3.65	3.00	3.35
Boiler	2.45–2.85	1.95	3.55	3.15	....
Barley	2.15–2.40	1.85	2.40	2.05	2.35
Pea	3.75	2.80	4.65	3.70	....

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago	Feb. 14 1918	One Year Ago
6-in. lump..	$2.65 2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.50-2.75
2-in. lump..	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Steam egg ...	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Mine-run ...	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

PROPOSED CONSTRUCTION

Ark., El Dorado—The Arkansas Light and Power Co. plans to build an 18 mile transmission line from here to Junction City. J. L. Longino, Arkadelphia, Ch. Engr.

Fla., St. Petersburg—The St. Petersburg Lighting Co. plans to increase the capacity of its lighting plant. Estimated cost, $40,000.

Ga., Albany—The Albany Power and Manufacturing Co. is in the market for a 185 lb. hand fired 600 hp. water tube boiler. E. S. Killebrew, Supt.

Ga., Jeffersonville—City plans an election to vote on $15,000 bonds for the erection of an electric-lighting plant. W. Goodlee, Macon, Engr.

Ind., Monterey—The Monterey Electric Light and Power Co. is having plans prepared by C. Nielson, Engr., 154 West Randolph St., Chicago, for the erection of a 1 story, 50 x 125 ft. power house.

Ind., Williamsport—City plans to install new machinery in its plant including a 3 phase generating unit, directly connected, to replace the single phase unit now being used. B. Scott, Supt.

Kan., Colby—City voted $30,000 bonds for improvements to its electric-lighting plant. C. V. Parrott, City Clerk.

Kan., Wellsville—The Wellsville Electric Light, Power and Ice Co plans to purchase 5 or 10 kva. transformers soon. C. A. Smith, Mgf.

Mass., Palmer—The Central Massachusetts Electric Co. plans to issue $200,000 additional stock; the proceeds will be used to build additions and improvements to its plant. H. M. Parsons, Gen. Mgr.

Minn., Pine City—The Eastern Minnesota Power Co. plans to build a 10 mile transmission line and install a 500 kw. turbine in its plant. R. P. Allen, Mgr.

Mo., Oregon—City plans to build an electric transmission line from here to St. Joseph in order to secure electricity from there. M. R. Martin, Supt.

Neb., Dalton—The Village Board will receive bids until February 26 for the erection of a power plant and the installation of the necessary machinery. R. D. Salisburg, 1415 East Colfax Ave., Engr.

N. Y., Rochester—The Department of Public Works will soon receive bids for the erection of a central heating plant and will install a heating boiler and coal and ash handling machinery. Estimated cost, $75,000.

N. Y., Utica—The West Brewery is in the market for new machinery including motors, two 150 hp. boilers, belting and conveying and bottling machinery.

N. C., Rocky Mount—City is having plans prepared by J. N. Eley, Engr., Empire Bldg., Atlanta, Ga., for the erection of an electric-lighting plant. New equipment including a 300 hp. Heine type boiler, will be installed.

Ohio, Akron—The Northern Ohio Traction and Light Co., Hamilton Bldg., will soon receive bids for the erection of a power plant and meter building. Estimated cost, $100,000. F. C. Warner, 767 Hippodrome Bldg., Cleveland, Arch.

Ohio, Chardon—City voted $25,000 bonds to rebuild and improve its electric-lighting plant. New electric-generating units and an entire change of system from 133 to 60 cycle, will be installed. Noted Nov. 27.

Ohio, Cleveland—The Board of Education will receive bids until February 25 for the installation of three 350 hp. water tube boilers, stokers for same, 2 boiler feed pumps and one 150 ft. radial brick chimney, 96 in. diameter for its central heating plant.

Ohio, Wellington—The Board of Trustees of Public Affairs is in the market for flywheel, 40 x 10 in. to 14 x 6 or 6½ in. bore to weigh about 1000 lb. C. E. Gadfield, Supt.

Penn., Philadelphia—The Colver Electric Co. has petitioned the Public Service Electric Co. for authority to issue $25.000 additional stock; the proceeds will be used to build additions and improvements to its plant.

Penn., Reading—The Metropolitan Edison Co. plans to issue $97.500 in bonds; the proceeds will be used to build additions and improvements to its plant.

Tex., Dallas—The Dallas Light and Power Co. plans to build an electric transmission line from here to Norwood. R. C. Brooks, Supt.

Va., Richmond—The Richmond, Fredericksburg and Potomac R.R. is having plans prepared for the erection of an addition to its engine house. Estimated cost, $20,000. W. D. Duke, Gen. Supt.

Wash., Seattle—The Union Lake Co. plans to build a third addition to its power plant. Estimated cost, $600,000. K. J. D. Ross, Supt.

Ont., Stratford—The G. McLagan Furniture Co. is in the market for a horizontal steam boiler, 16 ft. long and 6 ft. in diameter

Que., Warwick—The Warwick Overall Co. is in the market for a 20 hp. electric motor.

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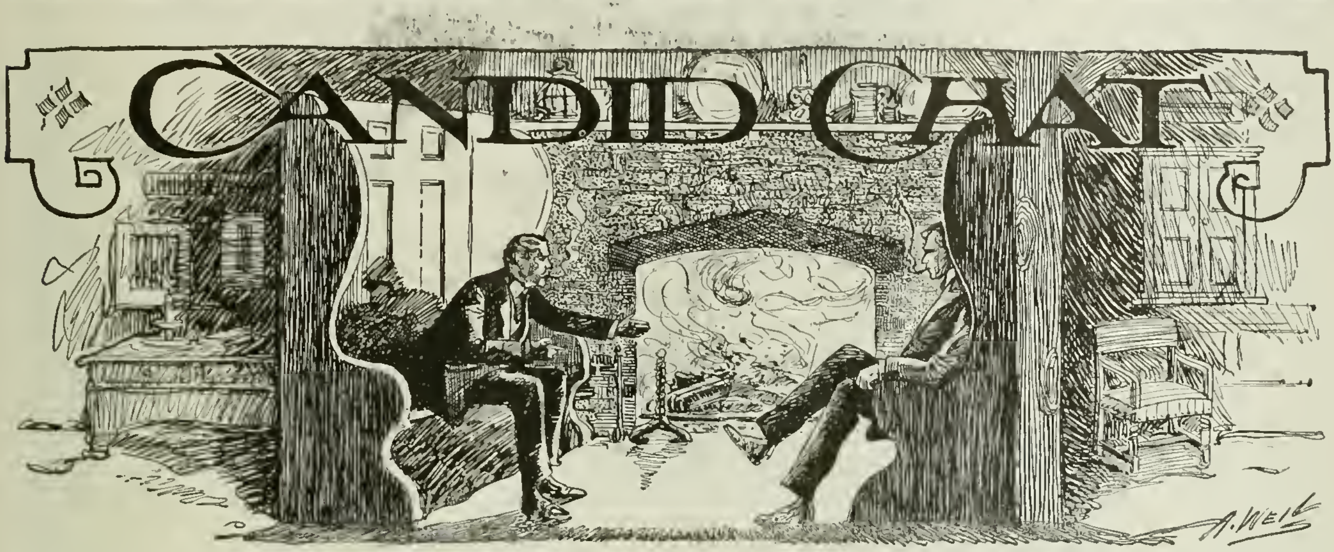
[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, FEBRUARY 26, 1918 No. 9



The Engineer and His Position

THE era of efficiency having arrived, what has the operating engineer done to prepare himself to meet it?

Operating a power plant, whether it is in a hotel, mill, office building or railway station, is not what it was some years ago.

Power-plant engineering has advanced rapidly in recent years, and for the engineer to keep pace with it requires continuous study. If he does not read and become acquainted with the new appliances and methods that are being introduced, he will slide into a rut and hold his position only until the owner becomes convinced that he can find someone who can operate the plant efficiently.

DOES your plant operate efficiently? If not, are you to blame, or is it the boss' fault? If you're guilty, how long do you think the owner is going to keep you when there are others competent to handle your job and glad of the chance?

When a manufacturer finds that competitors sell the same goods for less than he can, he investigates the cause. If an expert reports that one great contributing cause is poor plant management, who "gets it in the neck"?

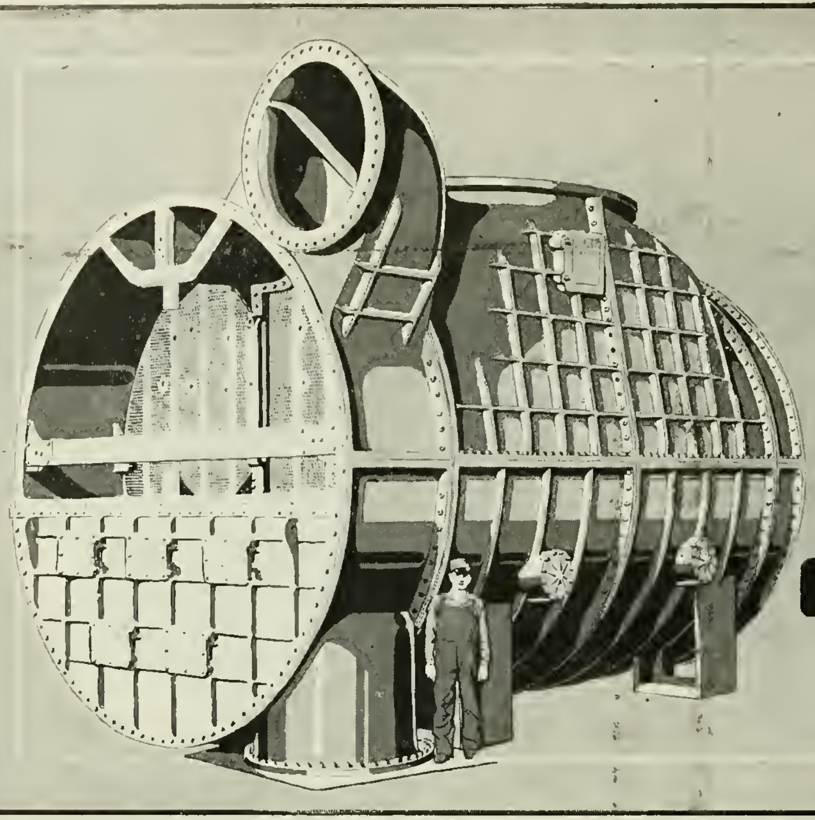
Sometimes it is difficult to operate efficiently because you have not the equipment for doing so, but no matter how bad the machinery or equipment may be, you can make an attempt at keeping a record sheet or log. When this is done, it is convincing proof that you are onto the job.

Your vest pocket is not the place for a log or record sheet. Keep it where it will create a healthy rivalry between the men, and also get their co-operation. That is what makes for success.

UNITY in the department should be the watchword. It is a pleasure to see the competition between the men, as one watch is trying to beat the record of the other, and you, checking up each day, are devising some way to make a better record than the previous one.

After you have started to keep up-to-date records, possibly you find you do not have the instruments or apparatus necessary to keep them accurately, but if you will take the matter up with the manager and a good reason is shown him why you should have them, he will, no doubt, after seeing what you are striving for and knowing that it is going to save money, acquiesce and give you all the assistance desired. It is then that you are headed right and becoming the kind of man the management wants you to be, the kind you want to be and the kind your fellows like to call acquaintance and friend. You are then headed for a better job.

Contributed by David Larkin, Chief Engineer, Fifth Avenue Building, New York City.



A FIFTY-THOUSAND SQ. FT. CONDENSER

A surface condenser having 50,000 sq.ft. of cooling surface, serves a 30,000-kw. turbine. The condenser is in a pit 74 ft. deep, and the exhaust pipe between the turbine and the condenser is 13 ft. diameter and 40 ft. long. It is provided with a special design of expansion joint. The circulating pump is below the low-level stage of the river.

WITH the increase in the capacity of turbine-generator units for power-plant service the sizes of the condensers that serve them have also increased, and improvements and refinements in design have been made. Some of the notable condensers that have been developed and put in service during the last year or two are, for instance, the 50,000-sq.ft. surface condenser of the New York Edison Co., and also one of the Chicago Commonwealth Edison Co., that serves 30,000 kw. generators. Another large condenser, a Leblanc, serves a 45,000-kw. turbine of the Narragansett Electric Light Co., Providence, R. I. It is designed to handle 18,000,000 lb. of circulating water, condensing approximately 500,000 lb. of steam per hour, an equivalent of 36 lb. of circulating water per pound of steam. The largest condenser so far built is one for the Detroit Edison Co., which has 70,000 sq.ft. of cooling surface.

Another installation of large surface condensers, of which there will be six, the largest yet built of the Leblanc surface type, is to be located at the bottom of a pit 74 feet deep, Fig. 2. At present there are two 50,000-sq.ft. surface condensers that serve the two 30,000-kw. turbines installed in the present structure of the Windsor power plant of the American Gas and Electric Co. (See headpiece.)

Both condensers are of the straight downflow type, with the tubes so spaced that steam lanes are provided so that all parts of the cooling surface can do their proportionate share of the condensing and thus insure a minimum pressure drop between the steam inlet and the air-pump connection. Each condenser contains muntz-metal tubes, of 18 B.w.g. and 18 ft. long. The condensers are 18 ft. inside diameter and 25 ft. long. A portion of the tubes in the upper portion of the condenser, aggregating about 2400 sq.ft., are used as a primary feed-water heater through which the condensate is pumped before going to the two open feed-water heaters. The primary heater brings the temperature of the condensate up very near to that of the incoming steam. Each condenser is set below the turbine which it serves, as shown in Fig. 2. As the turbine must be above the highest point which the river reaches and the condenser must be low enough to avoid lifting the water at low stages, the 13-ft. diameter exhaust pipe is 40 ft. in length.

Expansion of the pipe and the vertical expansion of the condenser are taken care of by a mercury expansion joint, Fig. 1, designed especially for and constituting one of the really novel features of the installation. It is 13 ft. in diameter and consists mainly of a fairly close-fitting cast-iron sleeve so formed as to permit a manometric column of mercury to make a seal to prevent air leakage and at the same time permit of a free motion of the upper and the lower halves of the joints relative to each other. The upper part of the joint is built so that if for any reason the mercury arrangement part of it should fail, an ordinary slip joint with soft packing could be used. This is not installed, inasmuch as the mercury joint operates very well, but it is readily seen that in case the mercury joint should fail, the part of the joint around the gland and packing could be immediately turned into an ordinary slip joint with soft packing in the part that is marked "Rope for Packing."

The dotted portion marked "Expansion Joint Clamping Block" is not used with the joint in service. This is simply an arrangement whereby the two portions of the joint can be firmly fastened together for shipment. That portion is removed after the joint is in place.

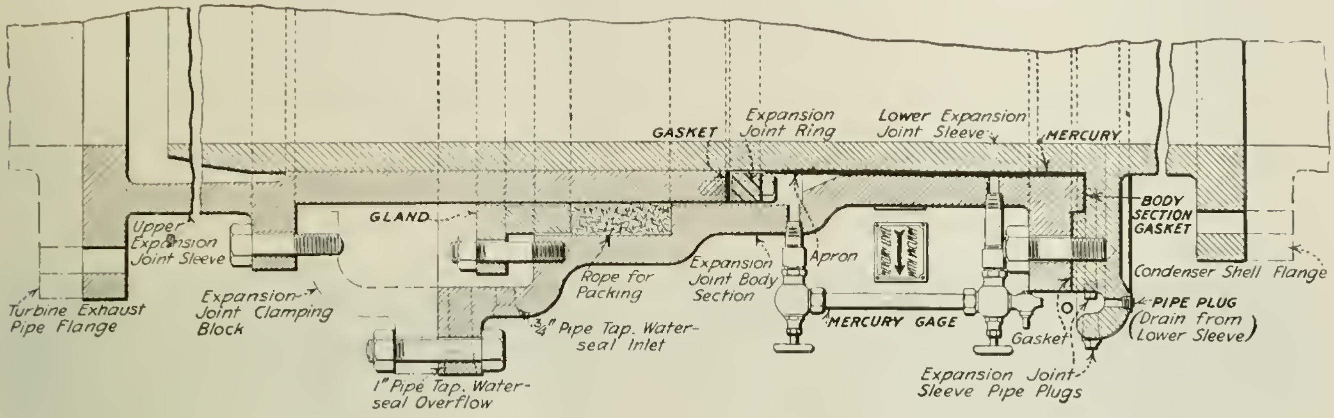


FIG. 1. DETAILS OF THE 13-FT. DIAMETER MERCURY EXPANSION JOINT

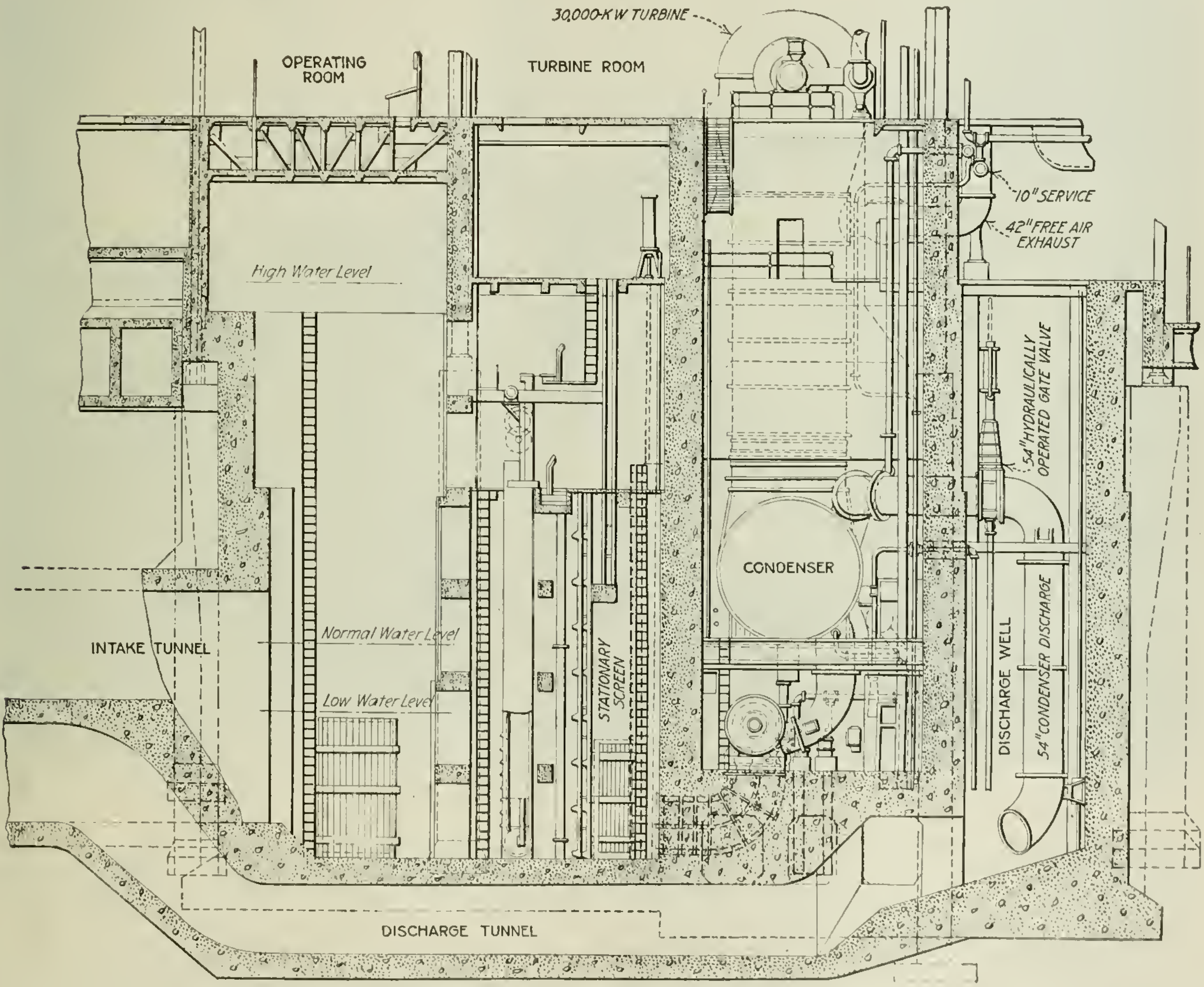


FIG. 2. ELEVATION OF THE INTAKE WELL AND CONDENSER PIT

It was decided that this type of joint was necessary because the great vertical distance between the condensers and the turbines entailed an extraordinarily great expansion in case the apparatus should be much changed in temperature. The mercury expansion joint can take up an indefinite amount of expansion, whereas there would be a danger that a copper joint, with the great distortions necessary, would ultimately fail.

With each condenser is furnished a horizontal motor-driven circulating pump having a capacity of 50,000 gal. per min. There are also two motor-driven Leblanc rotary hydraulic-type air pumps and two motor-driven hotwell pumps. Water from these pumps is supplied from two steel tanks in the basement of the power plant, and it is discharged back into the tanks. Makeup water is taken from the discharge of the circulating pump. The centrifugal hotwell pumps are driven by 550-volt three-phase 60-cycle squirrel-cage induction motors that are provided with special insulation to withstand the damp atmosphere of the pit.

At this writing no plant tests have been made on the turbines, but assuming 12 lb. of steam per kilowatt-hour, each condenser will take care of 360,000 lb. of steam at rating or 7.2 lb. per sq.ft. of cooling surface and 8.3 gal. of circulating water per pound of steam condensed at rating. Per kilowatt of generator rating the condenser contains 1.67 sq.ft. of cooling surface.

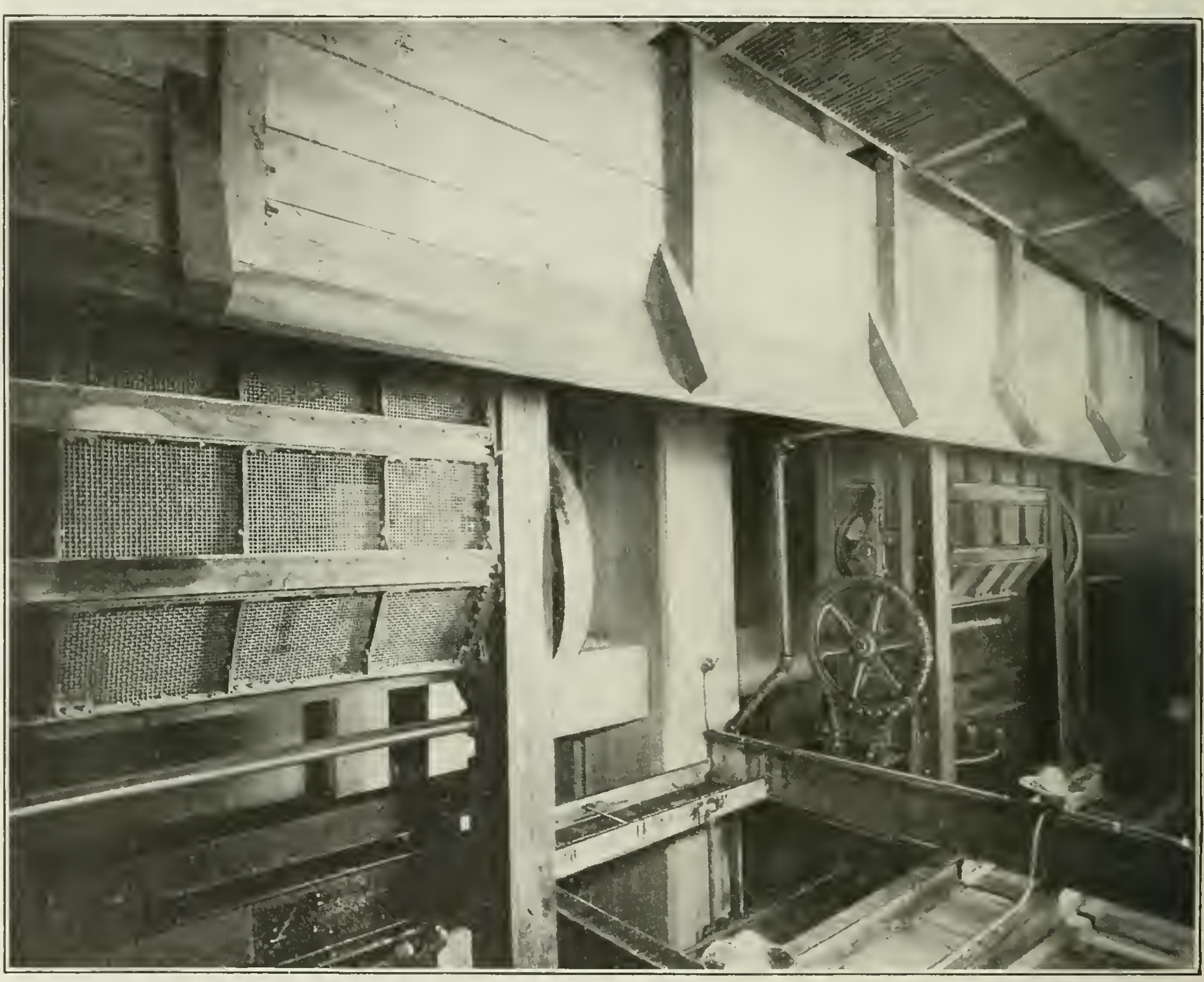


FIG. 3 VERTICAL REVOLVING SCREENS AT THE INTAKE TUNNEL

The opening into the condenser pit is centrally between the steam ends of the two turbines, the foundations of which are formed by the walls of the condenser pit. The Ohio River at Windsor has a rise of 50 ft. from extreme-low to extreme-high water, which necessitated the construction of a condenser pit with the bottom 74 ft. below the turbine-room floor. The basement floor is just above the high-water mark, and the main floor is 18 ft. higher. With the condenser-pit floor 74 ft. below the turbines, it was possible to place the center line of the circulating pumps at the same elevation with the extreme low level of the river, thus reducing the cost of pumping the circulating water to a minimum.

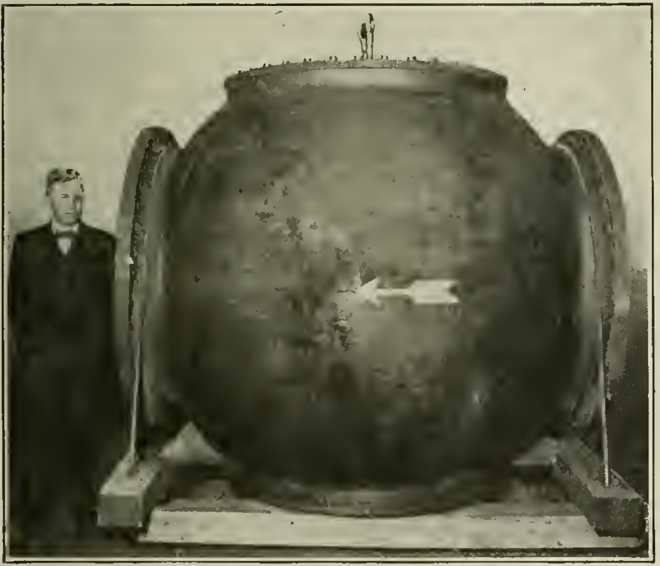
Steel cross members support the condenser at a height of about 15 ft. above the floor of the condenser pit, which provides space for the circulating air and hotwell pumps. The concrete intake and discharge tunnels for the condensing water are built to take care of the proposed ultimate capacity of 200,000 kw. Water coming from the Ohio River through the intake tunnel goes to an intake crib inside the turbine room at the condenser well of Nos. 1 and 2 condensers. From this crib the water passes successively through bar-iron grills, traveling screens and stationary screens to a rear chamber of the crib. The 84-in. diameter cast-iron suction pipe of the circulating pumps drops to this chamber. Water from the condensers discharges from a side outlet on the upper side at one end through a 54-in. cast-iron pipe into a discharge well that connects to the discharge tunnel, and is returned to the river below the intake.

When the remaining four condensers are installed, they will receive circulating water through tunnels running from the crib to the intakes of their circulating pumps. Each circulating-pump intake pipe is provided with an extra-heavy sluice gate, Fig. 3, operated by a hydraulic cylinder for controlling the flow of water to the pumps. The general station arrangement permits the screens in the crib to be handled by the 110-ton turbine-room crane, which is provided with a 15-ton auxiliary hoist. The traveling screens are mounted in a vertical position and are so arranged that they can be raised or lowered.

Figures regarding the construction of the tunnels and condenser pit are of interest. The intake and the discharge tunnels from the river to the intake in the station building required approximately 30,000 cu.yd. of excavation, 5300 cu.yd. of concrete and 270 tons of reinforcing. The condensing pit, which is 25 ft. 6 in. wide, 91 ft. long inside and 74 ft. deep, required approximately 32,000 cu.yd. of excavation, 13,500 cu.yd. of concrete placed and 514 tons of reinforcing steel, as well as 315 tons of structural steel used in the construction.

A Forty-Eight-Inch Relief Valve

There has recently been built one of the largest relief valves ever manufactured, for the Conners Creek plant of the Detroit Edison Co. It is a 48-in. horizontal exhaust relief valve, and is hydraulically operated. It will serve as a safety relief for the condenser on a new turbine unit. The complete valve weighs 14,000 lb. and measures 7 ft. 5 in. from face to face of the flanges. The cast-iron valve disk is 48 in. in diameter and has a metal ring face which seats on a brass ring. It is water-sealed and is double-cushioned with brass-lined dashpots above and below the disk. The valve stem is 3½ in. in diameter. The illustration gives an idea of the relative size of the valve; it was built by the G. M. Davis Regulator Co., Chicago, Ill.



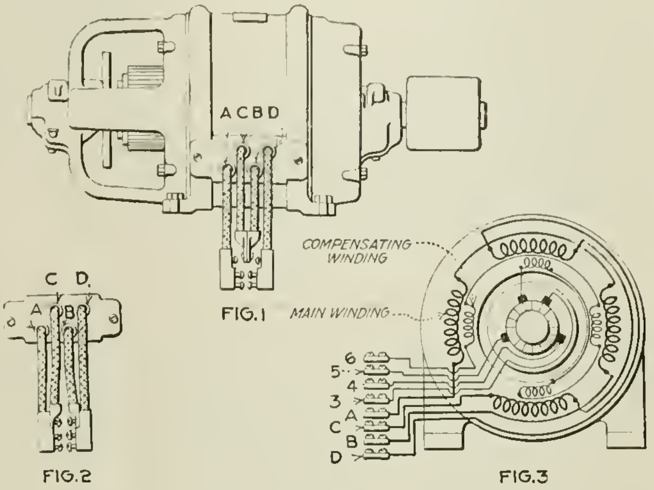
A 48-IN. EXHAUST RELIEF VALVE

Variable-Speed Motor Used in Constant-Speed Service

By E. C. Parham

Repulsion-induction motors of the constant-speed type have four leads coming from the stator winding, as in Fig. 1. If the supply voltage is 220, the two short leads are connected together as in the figure, thereby connecting the two sections of the stator winding in series. If the supply voltage is 110, then each short lead is connected to a long lead, as in Fig. 2. This connects the two sections of stator winding in parallel.

In some types of repulsion-induction motors they are equipped with a set of energy brushes and a set of compensating brushes on the commutator. Inside of the motor frame the two energy brushes are connected together and the two compensating brushes are connected to the compensating field winding. Where such a motor is to be used on variable-speed duty, the energy and compensating circuits are opened and the ends appear at the outside of the motor as two more pairs of leads that are to be connected to the controller by means of which the speed is varied by varying the amount of resistance included in the energy and compensating-field circuits. Where such a motor is to be used on constant-speed duty, no controller is required and the two energy-brush leads are connected together, also the compensating leads, the stator leads being grouped according to the voltage and connected to the starting switch.



FIGS. 1 TO 3. ARRANGEMENT OF LEADS FROM A REPULSION-INDUCTION MOTOR

Figs. 1 and 2—Constant-speed motor. Fig. 3—Variable-speed motor.

A second-hand repulsion induction motor was bought and applied to the driving of a pump through a worm and gear. The motor was complained of because it could not be started. What puzzled the local electrician was that the motor had eight leads and the starting switch had connections for only two wires coming from the motor. Investigation developed that the motor formerly had been used on variable-speed duty and it now was to be used in constant-speed service.

The leads of the energy brush-holders always are tagged 3 and 4 and those of the compensating brush-holders, 5 and 6 as in Fig. 3; and in this particular case the tags were still in place. By lifting the brushes, so that the holders would not be connected together through the armature, and testing, the energy leads 3 and 4 were identified and connected together, also the compensating leads 5 and 6 were found and joined. The stator leads were easily identified because each short lead was connected to the long lead nearest to it, showing that the motor formerly had been operated on a 110-volt circuit. As the work in hand called for 220-volt operation, the short leads were disconnected from the long ones and connected together, as in Fig. 1, and the two long leads connected to the motor side of the starting switch. On closing the switch, the motor started promptly, and it gave no further trouble.

Measuring High Pressures With Dead Weight

BY SANFORD A. MOSS

Engineer, Turbine Research Department, General Electric Co., Lynn, Mass.

Complete details are given for using the equivalent of the dead-weight pressure-gage tester for measuring pressures during tests as used in the steam-turbine department of the General Electric Co., Lynn, Mass.

EVERYONE who has had any experience with the use of Bourdon pressure gages, even of good quality, knows that they are more or less troublesome when extreme accuracy is desired. Frequently the calibrations before and after the test disagree. Even if the calibrations do agree, there is often a question as to whether the temperature effect has been properly taken care of. Most Bourdon gages are not accurate to a per cent., therefore, they are usually read to one per cent. by estimation between graduations. Accuracy of the construction probably does not warrant closer graduation than the coarse one usually given.

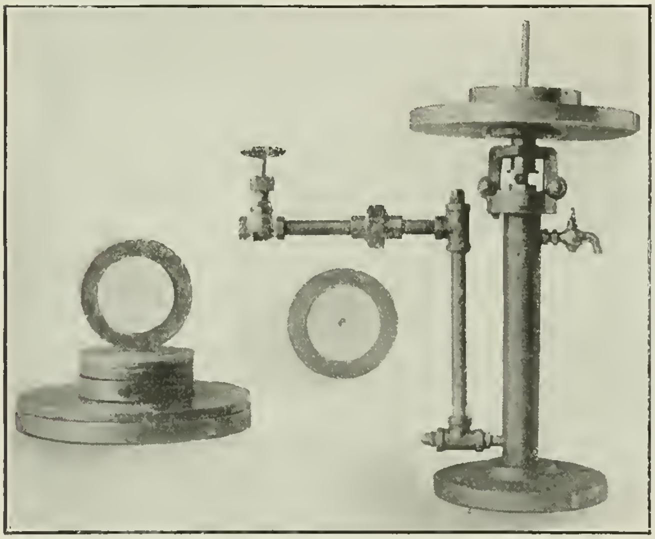


FIG. 1. DEAD-WEIGHT PRESSURE GAGE

The dead-weight pressure gage consists of an accurately bored cylinder, usually having an area of one-eighth of a square inch, with a closely fitting piston, at the top of which is a platform on which are placed weights sufficient to keep the gage floating. The instrument in this form has been in use for many years for testing pressure gages. For use in direct measurement of pressure, the addition of a stop must be made to prevent the piston from rising out of the cylinder, and an oil trap and reservoir so that there is sure to be oil in contact with the cylinder and piston. The construction can also be cheapened from that usually adopted in dead-weight testers. The platform and piston must always be spun by hand when the apparatus is in use.

The use of a dead-weight apparatus thus attached directly to the pipe where pressure is being measured, gives accuracy to within about 0.25 of one per cent. without any difficulty whatever. The dead-weight apparatus is cheaply and easily made and easily operated. Considerable experience indicates that it is satisfactory in every way. Fig. 1 shows the apparatus used in the turbine department of the General Electric Co.'s Lynn works, where there are about fifteen outfits, all in more or less regular use. This system has been in use in this department for over ten years. Fig. 2 indicates the manner of installation, operation and a machine on test. Fig. 3 gives a sectional view of the apparatus.

The apparatus is primarily adapted for testing work where the pressure is constant or nearly constant and where the exact value, whatever it may be, must be known at frequent intervals, or where an exact value must be held by hand regulation. Following are some tests in which dead-weight gages have been used.

A. Laboratory test of a steam turbine, or the like, at a given load point such as full-load, half-load, etc. Steam pressure is held by hand regulation at an exact value for which the turbine is rated. In such a case of course the boiler pressure must be somewhat higher than the rated pressure and an attendant at all times holds the pressure at the exact rated value. If the Bourdon gage were used, there would be more or less uncertainty about the pressure due to variations of the boiler pressure or governing of the turbine; the throttle valve is being opened or closed slightly at all times during the test. The Bourdon gage, for pressures that vary, gives an appreciable difference. On the contrary, with a dead-weight gage, the attendant, after ten or fifteen minutes' practice, can hold the rated pressure within 0.25 of one per cent. or less. In such a tes

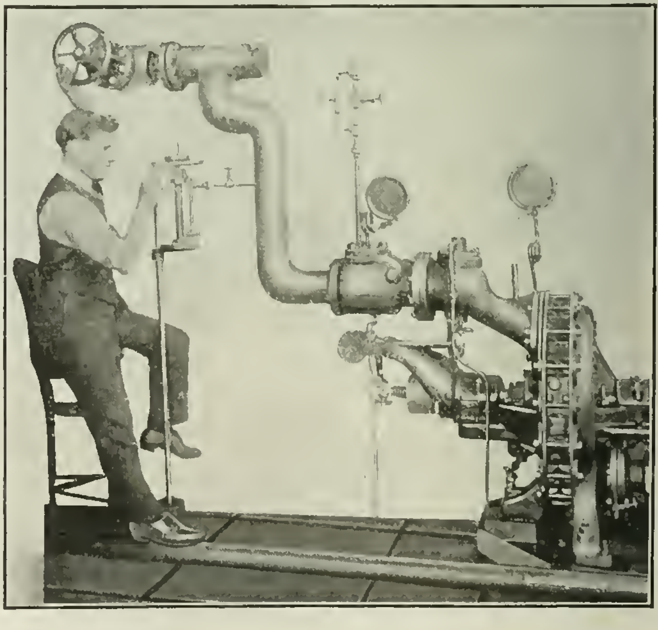


FIG. 2. DEAD-WEIGHT GAGE INSTALLED ON TURBINE

the load, which is an electric generator, is either held exactly constant by hand regulation of water rheostats or the like, or else is set at nearly desired value and allowed to drift up and down near the correct value. If the load or steam pressure varies rapidly, the dead-weight pressure gage cannot be used.

B. Calibration of steam-turbine nozzles or other work on flow of steam, or high-pressure air through orifices. Here there is a constant opening through which a fluid is discharged, and a constant pressure is to be held by hand regulation of a throttle valve just as in the preceding case. The steam is of course condensed and weighted at successive intervals. The flows during each interval should be all alike. Much greater precision is secured in this particular with a dead-weight gage than with a spring-pressure gage.

C. Test of any other type of steam or high-pressure air machinery where an exact pressure is to be held by hand regulation at all times during the test.

D. Test of a high-pressure centrifugal pump. Here a dead-weight gage can be used with great satisfaction to measure the discharge pressure. If the volume flowing is measured by means of orifices, another dead-weight gage can be used to measure the orifice pressure.

E. Test of a high-pressure air compressor. If the compressor is a reciprocating machine, there must be the usual air receiver with capacity enough to smooth out the pressure fluctuations so that the dead-weight gage will give the average value. Here also, if the air-compressor flow is being measured by means of an orifice, a dead-weight gage can be used to give orifice pressure. If the flow of the reciprocating compressor is being measured, the arrangement of the orifice must be especially attended to. There must be a large receiver, and a throttle valve between discharge pressure and orifice pressure so as to reduce the orifice pressure a very considerable amount. This throttling smooths out the flow so that the pressure is not pulsating at the orifice. As is well known, the average value of a pulsating orifice pressure does not give the average flow. If the orifice can be made large enough, it is best to reduce the orifice pressure by throttling until it is about 15 lb. per sq.in. Then the orifice dead-weight gage could be discarded altogether and a mercury column used.

In orifice tests of pumps or air compressors, as in D or E it is necessary to have two dead-weight gages or one dead-weight gage and one mercury column, since there are two distinct pressures. One of these is a discharge pressure measured in the pipe between the throttle valve and the machine and gives the pressure with which the machine is to be credited in computing its performance, efficiency, etc. The throttle valve cuts down this pressure so that any desired pressure can be had on the orifice so as to give any desired volume or amount of flow, which is computed from the orifice pressure. This orifice pressure may be measured by means of a static hole in the pipe wall with a pipe connecting to the dead-weight gage or mercury column, or an impact tube may be used in the jet discharged from the orifice as explained in the paper, "The Impact Tube," A. S. M. E. *Transactions*, December, 1916.

F. Measurement of high pressures during any experimental work such as hydraulic work, high-pressure steam work, or the like, or calibration of thermometers by means of high-pressure steam. The dead-weight gage of the construction here described has been successfully used for pressures up to 500 lb. per sq.in. without any difficulty. For very high pressures, pistons of larger diameter, as well as lever devices for balancing the piston, have been proposed. Just how far the one-eighth-inch piston with direct balancing can be used, and the magnitude of the pressure when it is necessary to resort to other devices, cannot be definitely stated.

During use of the dead-weight gage in any test such as the preceding ones, if the pressure variation is such as to require constant adjustment by an attendant, there must be provided a throttle valve at a convenient location and the gage must be piped near-by. The attendant then has one hand on the throttle valve and with the other hand spins the dead-weight gage, as in Fig. 2. He turns the throttle valve backward and forward so as to keep the gage floating between the top and bottom stops. After about ten minutes' practice anyone, even an unskilled laborer, can keep the gage floating without any difficulty whatever.

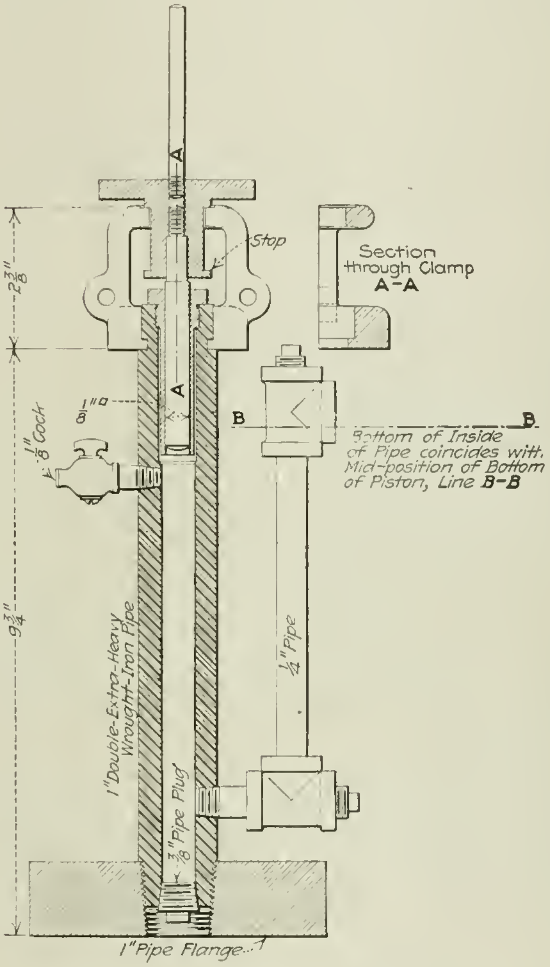


FIG. 3. SECTIONAL VIEW THROUGH DEAD-WEIGHT PRESSURE GAGE

In some tests the pressure does not vary much, so that no hand regulation is required. In such cases, whenever a pressure reading is needed it must be taken by adding or subtracting one-pound weights until the gage floats. During all periods when reading of the gage is being observed, it must be spun by hand. For this reason it is an advantage to have the heavier weights thin and of large diameter rather than thick and of small diameter, so that a single spin will persist for a long period.

The valve used to regulate the pressure which is read by dead-weight gage must be adapted to that purpose. If the valve is too large, the motion is so small as to be difficult. If it is too small, the motion is too large. The easiest way of handling this matter is to have two throttle valves in the line. One of these is set at such a point as to give easy manipulation of the second one, which is thereafter the one regulated to keep the gage floating.

TABLE I. WEIGHTS TO GIVE ABSOLUTE PRESSURES FOR VARIOUS BAROMETER READINGS

Uncorrected Barometer Reading Inches of Mercury	Temperature of Mercury, Degrees F.								
	60	65	70	75	80	85	90	95	100
28.5	6.05	6.05	6.05	6.05	6.05	6.10	6.10	6.10	6.10
28.6	6.00	6.00	6.00	6.00	6.00	6.05	6.05	6.05	6.05
28.7	5.95	5.95	5.95	5.95	5.95	6.00	6.00	6.00	6.00
28.8	5.90	5.90	5.90	5.90	5.90	5.95	5.95	5.95	5.95
28.9	5.85	5.85	5.85	5.85	5.85	5.90	5.90	5.90	5.90
29.0	5.80	5.80	5.80	5.80	5.80	5.85	5.85	5.85	5.85
29.1	5.75	5.75	5.75	5.75	5.75	5.80	5.80	5.80	5.80
29.2	5.70	5.70	5.70	5.70	5.70	5.75	5.75	5.75	5.75
29.3	5.65	5.65	5.65	5.65	5.65	5.70	5.70	5.70	5.70
29.4	5.60	5.60	5.60	5.60	5.60	5.65	5.65	5.65	5.65
29.5	5.55	5.55	5.55	5.55	5.55	5.60	5.60	5.60	5.60
29.6	5.50	5.50	5.50	5.50	5.50	5.55	5.55	5.55	5.55
29.7	5.45	5.45	5.45	5.45	5.45	5.50	5.50	5.50	5.50
29.8	5.40	5.40	5.40	5.40	5.40	5.45	5.45	5.45	5.45
29.9	5.35	5.35	5.35	5.35	5.35	5.40	5.40	5.40	5.40
30.0	5.30	5.30	5.30	5.30	5.30	5.35	5.35	5.35	5.35
30.1	5.25	5.25	5.25	5.25	5.25	5.30	5.30	5.30	5.30
30.2	5.20	5.20	5.20	5.20	5.20	5.25	5.25	5.25	5.25
30.3	5.15	5.15	5.15	5.15	5.15	5.20	5.20	5.20	5.20
30.4	5.10	5.10	5.10	5.10	5.10	5.15	5.15	5.15	5.15
30.5	5.05	5.05	5.05	5.05	5.05	5.10	5.10	5.10	5.10
30.6	5.00	5.00	5.00	5.00	5.00	5.05	5.05	5.05	5.05
30.7	4.95	4.95	4.95	4.95	4.95	5.00	5.00	5.00	5.00
30.8	4.90	4.90	4.90	4.90	4.90	4.95	4.95	4.95	4.95
30.9	4.85	4.85	4.85	4.85	4.85	4.90	4.90	4.90	4.90
31.0	4.80	4.80	4.80	4.80	4.80	4.85	4.85	4.85	4.85

As seen in the figures, the dead-weight gage is connected so that there is a "U" of oil with the piston at the top of one leg and the applied pressure at the top of the other. The pipe from the latter point must be led downward to the place where the pressure is being measured, so there will be no chance of a water trap giving error. The point from which the pipe is led downward must be nearly on a level with the average position of the bottom of the piston, so as to automatically maintain the liquid level the same in the two sides of the "U."

If the gage is filled with oil at the beginning of a test, there is usually not enough oil leakage to require any refilling. The gage was originally filled by removing the stop casting and lifting the piston out of the cylinder. However, with the piping arrangement shown in the figures, removal of the stop casting and piston is avoided as follows: The two plugs in the tees at the top and bottom of the side-pipe leg are removed and the vent cock opened. After the water has run out, the bottom plug is inserted and oil added at the top opening.

In air tests, a slight oil leakage during the test gives an error of a head of oil equal to an inch or so. In steam tests the gage oil is replaced by water so that the error will only be that due to the difference between an inch or so of oil and an equal amount of water. As in all pressure measurements, the pipe connecting the dead-weight gage to the place where pressure is being measured, must be absolutely tight. This pipe is usually ¼-in. standard material. However, if there is any appreciable length of pipe, it should be made ½ inch.

Any dead-weight gage tester can be used as a dead-weight gage by arranging a stop so that the piston cannot be ejected from the cylinder. However, the gages on the market are of more expensive construction than is desirable for ordinary pressure-measuring purposes, so that home-made ones similar to that shown in Fig. 3 must be used, until some manufacturer produces a gage whose cost is considerably less than that of the present types on the market. The gage shown was made by purchasing pistons and cylinders from a manufacturer, which were made with the precision necessary for this work. A stop was fastened to the piston and holes bored in the platform so as to leave the weight the same as before. The weights were carefully made by use of a precision scale, so as to weigh within 0.1 of one per cent. of the correct amount. The pressure in pounds per square inch for each weight is of course eight times that of the weight in pounds.

In the course of comparative tests with a given machine on different days, if the same dead-weight gage pressure is held, the absolute pressure will vary. For accurate work this is avoided by use of a set of barometer weights. These vary from 4.85 to 6.05 lb. per sq.in. by 0.05 lb. and are selected according to the barometer so as to give the same absolute pressure each day, as per Table I.

The first column of the table (as well as Table II) gives the actual reading of the mercury column of the barometer without correction for mercury temperature. The headings of the other columns give various values of the temperature of the mercury column of the barometer, and the body of the table gives that one of the barometer weights which is to be added on the gage. The other weights to be used must total the desired absolute pressure minus 20; that is, the weight placed on the gage should be the desired absolute pressure in pounds per square inch, minus 20, plus weight in table.

TABLE II. INCHES OF WATER TO GIVE 15 LB. PER SQ.IN ABSOLUTE EXHAUST PRESSURE

Uncorrected Barometer Reading Inches of Mercury	Temperature of Mercury, Degrees F.								
	60	65	70	75	80	85	90	95	100
29.0	21.9	22.1	22.3	22.5	22.6	22.9	23.0	23.1	23.4
29.1	20.5	20.7	20.9	21.1	21.2	21.5	21.6	21.8	22.0
29.2	19.2	19.3	19.6	19.7	19.9	20.1	20.3	20.4	20.7
29.3	17.8	18.1	18.2	18.4	18.5	18.8	18.9	19.0	19.3
29.4	16.5	16.7	16.8	17.0	17.3	17.4	17.5	17.8	18.0
29.5	15.1	15.4	15.5	15.6	15.9	16.1	16.2	16.5	16.6
29.6	13.7	14.0	14.1	14.3	14.6	14.7	14.8	15.1	15.2
29.7	12.4	12.6	12.8	12.9	13.2	13.3	13.5	13.7	13.9
29.8	11.0	11.3	11.4	11.7	11.8	12.0	12.2	12.4	12.5
29.9	9.7	9.9	10.1	10.3	10.5	10.6	10.9	11.0	11.2
30.0	8.3	8.6	8.7	9.0	9.1	9.3	9.5	9.7	9.8
30.1	6.9	7.2	7.3	7.6	7.8	7.9	8.2	8.3	8.4
30.2	5.6	5.8	6.0	6.3	6.4	6.5	6.8	6.9	7.1
30.3	4.4	4.5	4.6	4.9	5.0	5.2	5.4	5.6	5.7
30.4	3.0	3.1	3.3	3.5	3.7	3.8	4.1	4.2	4.5
30.5	1.6	1.8	1.9	2.2	2.3	2.4	2.7	2.9	3.1
30.6	0.3	0.4	0.5	0.8	1.0	1.1	1.4	1.5	1.8
30.7	—1.1	—1.0	—0.8	—0.5	—0.4	—0.3	0.0	0.1	0.4
30.8	—2.4	—2.3	—2.2	—1.9	—1.8	—1.6	—1.4	—1.2	—1.0
30.9	—3.8	—3.7	—3.5	—3.3	—3.1	—3.0	—2.7	—2.6	—2.3
31.0	—5.1	—5.0	—4.9	—4.6	—4.5	—4.4	—4.1	—3.9	—3.7

Fifteen pounds per sq in. equals 30.35 in. of mercury; 1 in. of mercury equals 13.6 in. of water.

Change of barometer also affects the absolute exhaust pressure in comparative tests made on different days of a noncondensing steam turbine or the like. Although this point has nothing to do with dead-weight gages, a method of handling the absolute exhaust pressure will be given. This is to always hold such back pressure on the exhaust line as will give exactly 15 lb. absolute pressure. This is accomplished by putting a water U-tube on the exhaust line and throttling the exhaust until the back pressure indicated by the U-tube plus the reading of the barometer is such as to give the desired absolute pressure. Table II gives the inches of water to be held in the U-tube to secure this effect, taking into account the temperature of the barometer column.

Some Why's of the Coal Shortage

There have been many assertions as to the cause of the prevailing coal shortage in that those interested in the production, transportation, handling at the terminals and in the delivery to the coalyards claim that the trouble has been due to the failure of some other arm of the coal-handling organization. Some of the causes for the scarcity of coal are enumerated in this article.

IT HAS been asserted almost countless times that the American public do not realize that we are at war. This may have been true to a great extent prior to Jan. 16, when, by the order of Dr. Harry A. Garfield, Fuel Administrator, practically all of the industries east of the Mississippi River were closed for a period of five days and by which order, countermanded now, Mondays were to be workless until Mar. 30; but the assumption does not now apply. The five workless-days bomb was an effective awakener for the American people to the fact that war does exist. Furthermore, the average citizen knows more about the coal situation today than he ever did before the closing-down order went into effect.

SHORTAGE TRACEABLE AS FAR BACK AS JULY

That there is and has been a serious shortage of coal, both for domestic and manufacturing purposes, is without question a fact. Thousands of individuals have their belief as to the cause, and they are varied. It is evident to many that the coal shortage does not date back to the extreme cold weather of the past few weeks, but rather that it is traceable as far back as July of 1917.

Previous to this date the coal operators had reduced their rates from $5 and $6 to $3 per ton, and a few days later the Secretary of War reduced the price to $2.50 a ton for all coal sold to the Government. Those who thought they were foresighted and who were accustomed to put in winter coal during the summer months held off with the idea that a better price would obtain later on. The result was that the movement of coal during the summer months was greatly retarded because consumers delayed their buying, and the possibilities are that orders for thousands of tons of coal were cancelled. It is easy enough now to see that this was a mistake and that this coal should have been purchased and delivered before the cold weather came to delay traffic and freeze the coal in the cars, which so seriously delays the unloading. Naturally, the time lost because of the public waiting for a lower price could not be made up after the price of coal was fixed at $2 a ton, during the latter part of August, and which was later found too low and increased to $2.45.

Has price fixing saved the public money? This is a debatable question. One thing is certain—there has been a loss to the country in the extra coal produced because the price fixed by the Government is for run-of-mine coal and the added tonnage mined is largely slate and refuse. That some of the coal operators have no scruples about putting their hands in the pockets of those who cannot afford to spend an extra nickel for coal is evident when they ship trash that is being sold for fuel at a price that is high for a good grade of coal.

There was produced 642,340,134 short tons of coal in 1917. This coal in normal times should run not higher than 8 per cent. ash, but much of it is running as high as 18 per cent. at the present time and some of it as high as 35 per cent. It is safe to assume that there is at least 6 per cent. more ash included in the total coal shipped to consumers last year than in the year previous, which if true would mean that 38,540,408 tons of last year's coal output is in the form of increased ash and bone. Taking an average of 45 tons per car, this would mean that 856,453 carloads of ash is being added to the transportation difficulties of the railroads. At 60 loaded cars per train there would be required 14,274 locomotives to move this material that has no heating value.

EFFICIENCY OF FUEL DECREASED

This useless transportation of noncombustibles does not stop with the delivery of the cars at their destination. It has been determined by experiments conducted by the Bureau of Mines, that there is a decrease of approximately 1.5 per cent. in efficiency for each 1 per cent. additional ash contents to the coal, and an increase of 6 per cent. in ash content over normal conditions means that the efficiency of the coal is reduced about 9 per cent., which, plus 6 per cent. additional ash in the coal now being sent to the consumer, makes a 15 per cent. reduction in the efficiency of the fuel.

It would seem, then, that although more fuel was shipped from the mines last year than during the previous year, there is an actual decrease in the effective coal received by the consumer. This is certainly a matter that the Fuel Administration at Washington should take in hand. The writer has seen coal that looked fully 40 per cent. slate and incombustible, which is being sold to the consumer. Selling such coal at the prevailing prices makes the offense of stealing pennies from a dead man's eyes look like a virtue in comparison.

THE RAILROADS SAID TO BE AT FAULT

The tying up of 14,000 locomotives in hauling as many trains of 60 loaded cars of ash is one of the several reasons for the present fuel shortage. More than one man occupying a responsible position asserts, and with apparent justification, that the railroads are at fault in that they have failed to render the full measure of car service of which they have been capable, and some believe that this has been done deliberately to make it appear that the recent demands for higher freight rates were justifiable.

It has also been claimed that for every period of decline in coal production since the United States entered the war figures show that the railroads were rendering less car service than in the corresponding weeks or months of the preceding year, and furthermore, that there has been misuse and nonuse of available cars. That is, if the empty cars had been shipped back to the mines as soon as they were unloaded instead of being held on side tracks, there would have been enough cars to move all the coal required both by the manufacturers and by the public at large. The coal shortage is reported as being approximately 10 per cent. of the requirements, and it is also claimed that the railroads' performance is about 10 per cent. less than it was in 1916.

Inefficiency on the part of the roads is also charged, and this applies to the repairing of motive power, the lack of which is one of the principal causes for the freight congestion at various points of the railroad systems. The demand for locomotives is so great that only such repairs as are absolutely necessary are made, and minor repairs, such as would increase their efficiency, are left undone.

CONDITION OF EQUIPMENT BELOW NORMAL

That the railroads have neglected to maintain their equipment at normal is shown in the orders they have issued from new locomotives during the last year. The following figures regarding this feature of the railroad difficulties are of interest: A total of 3467 locomotives were ordered by the American railroads in 1913, 1262 in 1914, 1612 in 1915, 2910 in 1916 and 2704 in 1917, an average of 2391 per year during the past five years. In 1905 there were 6255 locomotives ordered for use in the United States. At least 5000 new locomotives, it is estimated, are needed each year by the railroads of the United States. Foreign orders for 1916 totaled 2983, and in 1917 there were ordered by our Allies 4938 locomotives, of which 2057 were for the use of the United States in France. The actual deliveries to our railroads were 5332 locomotives in 1913, 1251 in 1915, 2708 in 1916 and 2587 in 1917. The deliveries to foreign countries were 2861 in 1917. As the railroads of the United States have for the last three or four years ordered but a little more than half the number of locomotives required to move the tonnage consigned to them, there is little cause for speculation as to why they have fallen down in their attempt to move freight and do away with congestion that appears to block the freight yards throughout the country.

INCREASE IN CAR MILEAGE AND TONNAGE HANDLED

On the other hand, railroad statistics for 1917 show that the average car mileage per day was 27.7, as against 27.5 for 1916, and that there was 18 per cent. increase in the coal tonnage handled in 1917 over 1916. Railroad officials claim that they can deliver to terminal points only such coal as is consigned to them and that they do not control the acts of the shipper. As an example, one railroad had one day recently 600 steel cars of 50 tons capacity each, or sufficient to carry 30,000 tons of coal, distributed at the anthracite mines that it serves. When these cars were loaded, they went in all directions—not as the railroad's manager chose, but as the shippers directed.

That something is radically wrong is self-evident, and some of the trouble that has resulted in a gigantic freight jam may be due to a cause similar to that recently published in the Boston *News Bureau:*

> A. R. Whaley, former operating vice president of the New Haven, recently inspected the congestion in the Jersey terminals and was discussing it with the yardmaster, an old-time railroad man.
>
> "What is the basic trouble?" asked Whaley. "We used to handle things better."
>
> "I'll tell you," said the yardmaster. "Twenty-five years ago, when you and I started, they had wooden cars, but they had men of steel handling them. Nowadays, they've got steel cars, but there's a blamed lot of wooden men handling them."

Snow and extreme cold weather have contributed to the coal shortage by delaying rail transportation and the unloading of the frozen coal from cars into barges for water transportation.

New England, as well as New York and other Eastern cities, is a sufferer. In Boston about 90 per cent. of the 45 coalyards are bare of fuel. The railroads have been unable to increase their shipments, and but little coal has been coming in by water.

Among other things that contribute to this condition is the order that was given earlier in the season to ship coal to the Northwest, with the result that it could not be absorbed and thousands of loaded coal cars have been standing on the tracks between the mine and the West; this is one cause of car shortage. The condition is traceable back to the fixing of prices of coal and the uncertainty of getting it. Much of the trouble that New England is experiencing is due, it is believed, to the holding up of coal shipments during several weeks during the summer months and fall, in the endeavor to obtain lower rates to the tune of one dollar per ton.

New England uses approximately 25,000,000 tons of coal per year, most of which comes from the Virginia coal mines. This year there was required about 7,000,000 tons more.

Another reason why New England is out of coal is because the Government commandeered five of the thirty-five collieries that brought coal to that section and also took over seven out of forty-five tugs that were used in towing from two to four coal barges at a time. As a matter of fact, then, there has been 1,000,000 tons less of coal brought to New England by water, and on the other hand the roads have brought in about 1,000,000 tons more than usual.

The coal-mine operators claim that the coal shortage is due to lack of cars. They maintain that it is idle to talk of increasing the output of the mines until the cars are available to transport it. They claim that the coal production could be greatly increased if there were cars in which to load it. It is pointed out that on the average 200,000 coal miners are idle each day in the year because the output cannot be handled by the railroads; that there has been no falling down in the production of coal at the mines, but that the trouble is due to distribution.

Loss of coal output can be easily traced to the method of shipping, whereby coal going to one section passes coal going in the opposite direction. That is, it is a waste of mileage, locomotives and car haulage to ship coal to a consumer, say 400 miles or so from the mines, when coal could be obtained in a mine not more than 200 miles distant. This method of distribution has been carried on unchecked and has undoubtedly cost the nation thousands of dollars. Recently, S. Peabody advocated before the Senate Investigation Committee a zone system dividing the country into thirty distinct districts, and he stated that it would increase the country's output of coal by 20 per cent. Under such a system no coal would be sent out of one zone into another without a license from the Fuel Administration.

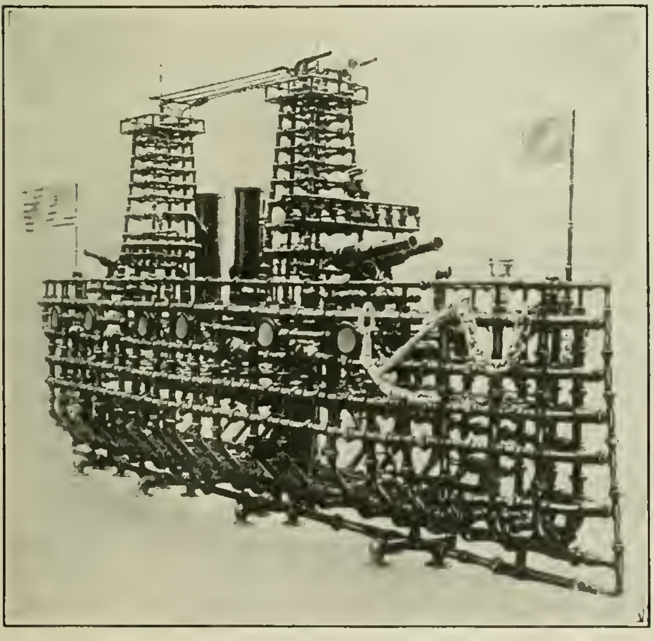
That there will be a scarcity of coal during the rest of the winter and well on into the spring is a foregone conclusion. What the situation will be after that is problematic. Conditions will doubtless change for the better to some extent, but it will be impossible to get coal in large quantities. That a repetition of present conditions shall not prevail next winter a number of changes in the handling of coal should be made.

The householders should order coal during the summer months. The coal operators should be made to sell clean coal, not adulterated with ash and bone. The unloading piers should be equipped with suitable means for thawing frozen coal in cars. The railroads should repair their locomotives and order new ones so that their motive power can handle the volume of freight that must reach the points of delivery. Empty cars should be moved to the mines as fast as they are emptied, and the fuel and railroad administrators should work together to bring such changes about.

New England should be taken care of by seeing to it that sufficient bottoms are available for transporting coal by water and thus avoid their present predicament.

Model of Superdreadnaught "New York"

The illustration gives a view of a model of the superdreadnaught "New York," made completely of Crane Co. products—fittings, valves, specialties, etc. According to the *Valve World*, the model was designed and its construction supervised by an employee of Crane Co. in the works of the company's Bridgeport division. It is now on exhibition in the Crane exhibit rooms, 23 West 44th St., New York.



MODEL MADE OF FITTINGS

The over-all dimensions of the model are: Length, 186 in.; breadth, 34 in.; molded depth, 42 in., total height from keel to topmast, 102 in. Its net weight is 3308 lb., and 6669 separate pieces were used in its construction. It is complete to the smallest detail, and the ordinary working parts of a battleship are movable. A small electric motor gives action to the propeller. The ship is electrically wired throughout, the wires running in conduit, and by the pressing of a button action may be seen everywhere—the propeller turns, the commander salutes, lights flash, guns roar, the wireless crackles, the searchlight throws a searching beam. The entire action is automatic and may be repeated indefinitely or until the pressing of another button stops it. A row of colored electric lights runs from bow to stern over the mast tops, and when in action the model makes an interesting exhibition.

Eleven Ohms the Resistance of a Circular-Mil-Foot

By T. A. Nash

The resistance of a circular-mil-foot of copper depends on the purity of the copper and on its temperature. The resistance of ordinary commercial soft-drawn copper wire at 70 deg. F. is almost exactly 10.6 ohms. However, the use of the value of 11 ohms in the formula for a two-wire circuit,

$$\text{cir. mils} = \text{amperes} \times 11 \times \text{total length of conductor in feet} \div \text{volts drop},$$

is justified. In computing wire sizes for interior-wiring circuits, it is folly to endeavor to figure too closely. The length of the circuit is probably not known within 10 per cent., the purity of the copper to be used is unknown, and finally, one must use conductors of one of the standard wire-gage sizes. Hence, it is common practice to use the 11-ohms value in practical calculations because the results obtained by using it will, on the average, be as accurate as those obtained by using 10.6 ohms, and it (11 ohms) is an easier figure to handle. Also the value 11 ohms can be remembered easily.

Inexperienced Draymen Damage Heavy Machinery

A recent purchaser of a large air compressor points out that irresponsible draying firms cost the purchaser of heavy machinery far more than is saved by patronizing inexperienced firms who will take a job "for less." The point is that serious damage can be easily done by inexperienced teamsters in delivering heavy machinery from railroad depot to plant and it may be that this damage will not be discovered until the plant is being tested in operation. In that case the blame may never be properly placed and is very likely to be charged up to the manufacturer as a defect in construction. The case in point occurred recently in a Western city. Some large-sized compressors were hauled across the town in such a position on the dray that the stress of shocks from the wheels was carried by bolts in the lining of the cylinder, which separated the water jacket from the compressor chamber, and these stresses so strained the bolts that a joint was opened and leakage resulted that caused much delay and inconvenience after the unit had been put in operation. In this instance a capable mechanical engineer saw the compressor in its strained position on the dray and at once entered a protest, predicting the possibility of the trouble which, in fact, later developed.

Mine Plant Saves Forty-Five Tons of Coal Per Day

Installation of a new boiler plant, utilization of exhaust steam by a low-pressure turbine and a change from steam and compressed air to electric drive for auxiliaries and mine pumps resulted in a reduction of fuel of from 90 to 45 tons per day. Besides, the mine capacity per day was increased 50 per cent.

ABOUT two years ago the Chicago & Carterville Coal Co. decided to improve its power plant at Mine A, at Herrin, Ill. The plant at that time consisted of eight horizontal-tubular boilers 72 in. diameter by 18 ft. long, one 250-hp. and one 350-hp. water-tube boilers, each being equipped with an independent steel stack. The equipment supplied by the boilers consisted of one 250-hp. and one 450-hp. air compressors and also one 170-kw. electric generating unit. Standard steam piping with screwed fittings was used.

All the auxiliaries around the mine, consisting of the coal washer, the centrifugal pump for the washer, the shaker engine, the engine for driving the shop, the main fan and various other small units, were steam-driven. The steam lines were run underground in many cases with no insulation. Most of the joints were leaking, and the entire plant was in a deplorable condition, being extremely wasteful in the use of steam. Under these conditions it required 90 tons of coal per day to operate the plant, nine firemen for the three shifts and three ash wheelers. No. 4 washed coal was burned under the boilers.

After a careful examination it was decided to install a new boiler plant, consisting of water-tube boilers equipped with chain-grate stokers, and a 500-kw. mixed-pressure turbine to utilize the exhaust steam from the present air compressors and fan engine. Provision was made also for using, at some future date, the steam from the main hoisting engine by the use of a regenerator. There was no need to draw on the hoisting engine for the time being, as the two compressors would furnish more than enough exhaust steam to operate the low-pressure turbine at full load.

STEAM DRIVE REPLACED BY ELECTRIC

All the steam-driven auxiliaries were to be replaced by electric-driven units with the exception of the engine driving the main fan. Distributed at various points about the mine were several pumps that had been operated by compressed air taken from the main air lines in the mine, supplying the punchers used for undercutting the coal. These pumps were extremely wasteful in the use of compressed air, and it was decided to replace them with direct-connected centrifugal pumps, and in a few cases where gathering pumps would be required of a portable type, with motor-driven reciprocating pumps.

On account of the scarcity of water for condensing purposes, it was decided to install a spray pond, the makeup water being drawn through a 4-in. line from a small pond about a quarter of a mile distant by a motor-driven pump. The plant had been operating on city water, as the water available close to the mine was too poor in quality to use in the boilers. The new arrangement provided for a vertical motor-driven submerged centrifugal pump placed at one corner of the spray pond, which delivers the water direct to the feed-water heater.

The new boiler plant consists of three 350-hp. water-tube boilers, two being new and the third a boiler from the old plant. All are provided with chain grates and are connected to a 7 x 210-ft. concrete stack, the stack and breeching being arranged for the installation of an additional boiler at some future time.

PUNCHERS USED TO UNDERCUT COAL

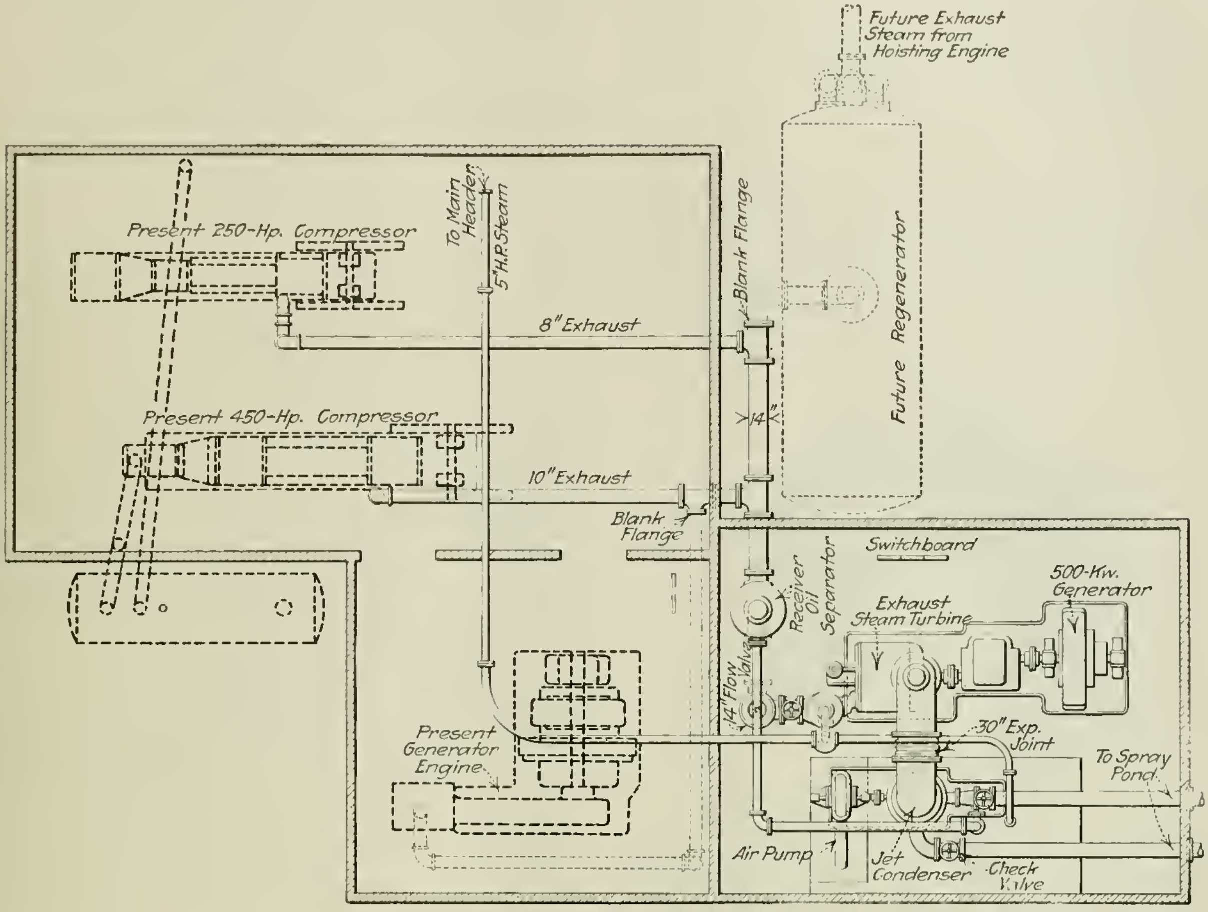
As previously stated, the present method of undercutting coal is by the use of punchers driven by air furnished by the two compressors now supplying exhaust steam to the low-pressure turbine. It is the intention, however, at some future time to do the undercutting with electrically operated machines. When this is done, the two compressors will be abandoned and steam for operating the low-pressure turbine will be obtained from the hoisting engine, the engine driving the 170-kw. generator and the mine fan engine. As the turbine is of the mixed-pressure type, it may be operated on live steam at periods when insufficient exhaust steam is available. The turbine drives a 500-kw. 250-volt direct-current compound-wound generator through reducing gears, the reduction being from 3600 to 720 revolutions per minute.

The condensing equipment consists of a Rees Returbo installation taking water from the spray pond and returning it through 60 nozzles. It is capable of producing 28 in. of vacuum, referred to a 30-in. barometer, the year around and a great part of the year produces a vacuum of 29 in. and better. The condenser is driven through gears by a steam turbine, and the exhaust steam is delivered to the 500-kw. low-pressure unit.

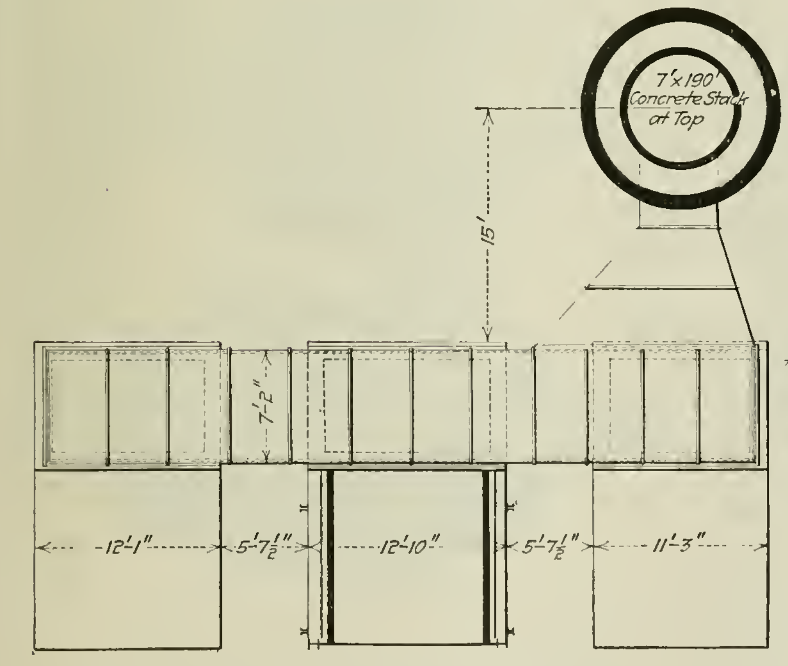
As shown in the layout drawing, steam from the two compressors passes through a vertical receiver oil separator and thence through a 14-in. flow valve to the low-pressure turbine. A 5-in. live-steam connection is made from the new steam header to the turbine to carry the load when sufficient exhaust steam is not available. At the top of the receiver oil separator a 14-in. relief valve allows any excess steam to pass to the atmosphere. The condenser is also provided with a 12-in. automatic relief valve.

NEW EQUIPMENT REDUCES LABOR COST

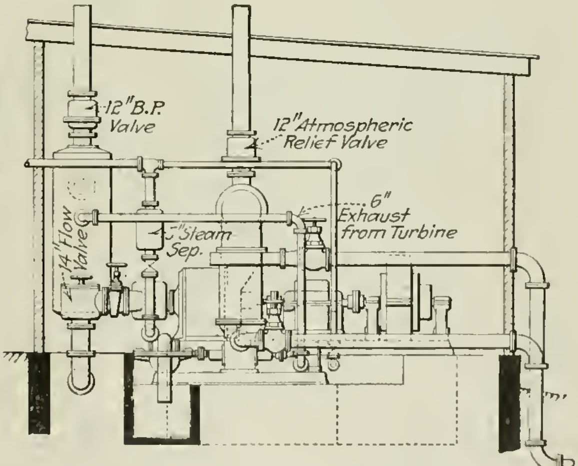
By the installation of this new equipment the number of firemen was reduced from nine to four and the ash wheelers to one, the latter reduction being due to the installation of a steam-jet ash conveyor. As the operating shifts at the mine are eight-hour periods and the day shift is the only period of heavy load, the ashes during the other two shifts are easily taken care of by the fireman operating the boilers. As a matter of fact there is sufficient ash storage under the boilers to allow accumulation for 16 hours.



PLAN OF ENGINE ROOM



PLAN OF BOILERS AND STACK



ELEVATION OF LOW-PRESSURE TURBINE

As a result of the improvements the coal consumption was reduced from 90 tons of No. 4 washed coal per day to 45 tons of No. 5 washed coal. At present prices this means a saving of approximately $135 per day.

The plant has been in operation for 21 months, and the owners claim that the improvements have already paid for themselves. Besides, by releasing the air compressors from supplying the mine pumps, the capacity of the mine has been increased from 2000 to 3000 tons of coal per day. This in itself is a great advantage at this time, when coal is in such urgent demand and the price is higher than it has been for years.

The Electrical Study Course—The Dynamo

Consideration is given to the generation of voltage in a two-pole machine having a ring armature, and the distribution of the current in the armature winding.

SO FAR we have only considered dynamos that have one coil of a single turn of wire on the armature. In the commercial type of machines the armature contains a number of coils. On the small-sized machines the armature is usually wound with a small number of coils having a considerable number of turns of small wire, whereas in the large-sized machines the armature is wound with a large number of coils of large wire having a small number of turns, usually one turn made from a copper bar. We have also learned that there are two types of armatures; namely, ring and drum.

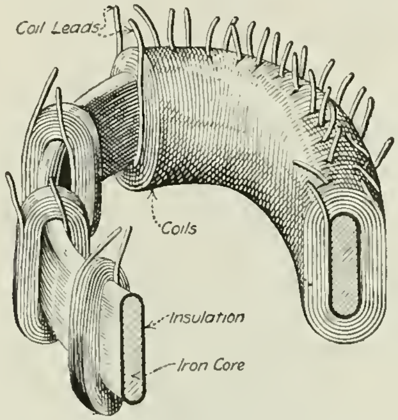


FIG. 1. RING ARMATURE IN SECTION

The ring armature consists of an iron ring with the coils wound around it as in Fig. 1, where the coils on a drum armature are placed on the surface of the core, or in slots in the surface of the core, as in Fig. 2. Fig. 2 shows three coils in place and how the coils fall over one another to form a complete winding, as in Fig. 3. In the drum-type armature the spread of the coils—that is, the number of slots spanned by a coil—is determined by the number of poles. For example, in Fig. 2 the coils span approximately one-quarter of the core, which would indicate that this armature is intended to operate in a four-pole field frame. In the ring armature the distribution of the winding on the core is the same, irrespective of the number of poles, where in the drum armature the coil spans approximately the distance between the centers of adjacent poles.

Although there is no difference in the two types of armatures so far as voltage generation is concerned, when it comes to a consideration of the various elements that take place in the windings, the ring type lends itself much more readily to a theoretical discussion, therefore will be used in our consideration of this subject.

In Fig. 4 is shown, diagrammatically, the complete layout of a dynamo-electric machine having an armature of the ring type. Coils of wire, designated field coils, are placed on the polepieces. The winding on the armature is shown, for simplicity's sake, to be continuous for the entire circumference of the core and closed on itself, with a tap taken out at each turn of the winding to a bar or segment in the commutator. This winding could have been shown grouped into coils, as in Fig. 5, with the leads of each coil coming out to two commutator bars, as shown, which is generally the way the job is done in practice, but for our purposes Fig. 4 is better suited. The winding in Fig. 5 has twice as many turns as that in Fig. 4, consequently, will generate twice the voltage under a given condition of speed and field strength.

In Fig. 4, if a current is caused to flow through the field coils in the direction shown, it will cause the top polepiece to become south and the bottom one north polarity, and the magnetic flux will flow in the direction indicated. Then, if the armature is revolved in the direction of the curved arrow, the conductors under the S pole will be cutting the lines of force in a left-hand direction, while those under the N pole will be cutting the flux in a right-hand direction. The lines of force are moving upward, from the N to the S pole, in each case, therefore, by applying the rule for determining the direction of electromotive force, it will be found that in the conductors under the S pole the voltage is down through the plane of the paper, while in the conductors under the N pole it is toward the reader, as indicated by the arrowhead. It will be seen that all the voltages generated in the various conductors under the S pole are in series assisting one another, likewise under the N pole. Therefore, the sum of the voltages generated in the conductors under one pole is the voltage that will appear at the brushes when the latter is in the position shown. It will also be seen that the voltage in the windings under the N pole opposes that generated in the conductors under the S pole. Since the voltages

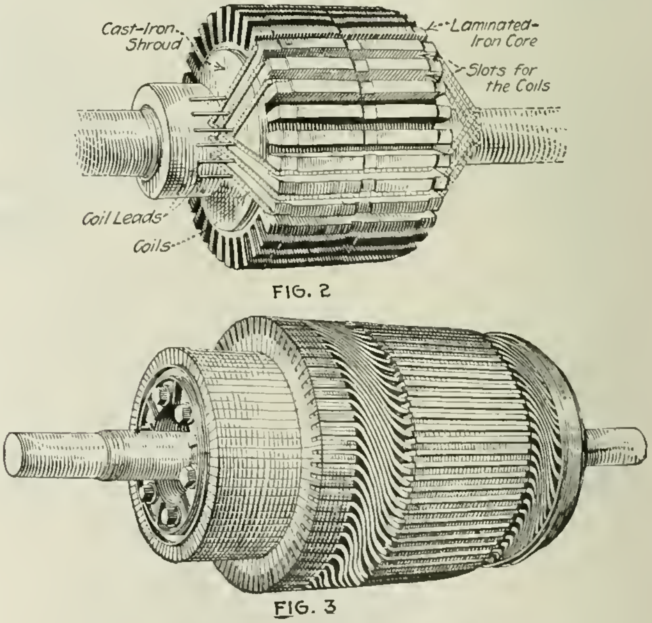


FIG. 2

FIG. 3

FIGS. 2 AND 3 DRUM-TYPE ARMATURE

in the two halves of the windings are equal, or at least should be, no current flows in the winding as long as the circuit is open between the two brushes.

The question of electromotive-force generation was discussed to considerable extent in some of the earlier lessons, and it was pointed out that the device which supplies the current to the circuit does not generate the current, but produces a voltage that causes the current to flow in a conductor when it is connected between the positive and negative terminals of the source of voltage. This is just the condition we have in Fig. 4. The conductor on each half of the armature cuts the line of force and generates a voltage; however, the arrangement of the winding is such that the voltage in one half opposes that in the other half, and no current can flow around in the winding until the brushes are connected to an external circuit *C*, as in Fig. 6. In the figure the external circuit is shown on the center of the commutator; however, this is for simplicity's sake only, as this circuit might be a motor or a group of lamps, or any device that requires an electric current for its operation, and might be located at a considerable distance from the machine.

The generator in an electric circuit is the same as a pump is in a circulating system. The pump does not generate the fluid that it causes to flow in the system, but creates a pressure that causes the fluid to flow in the pipe line. Likewise an electric generator only produces the pressure that causes the electric current to flow in the circuit.

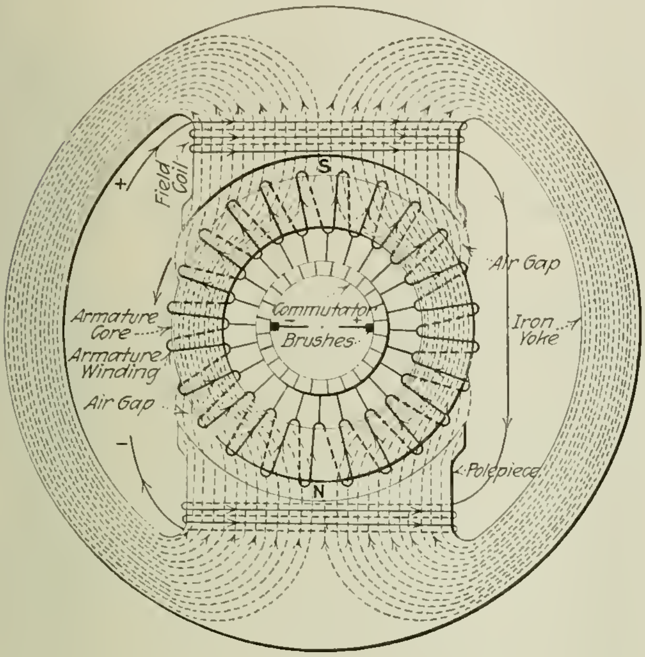


FIG. 4

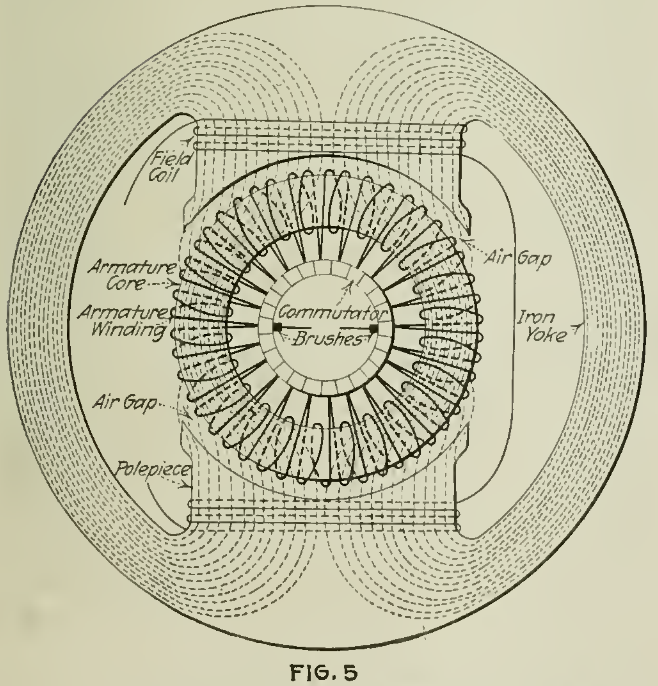


FIG. 5

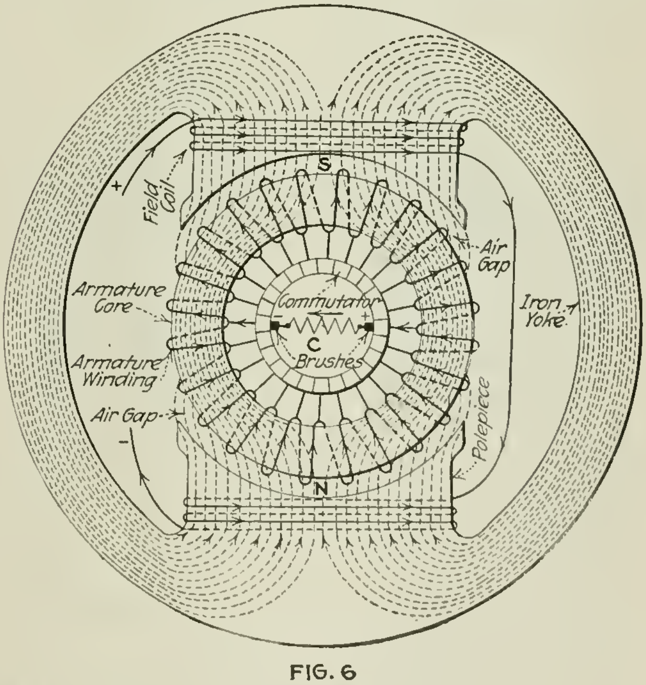


FIG. 6

FIGS. 4 TO 6. DIAGRAMMATIC REPRESENTATIONS OF A RING-ARMATURE TYPE GENERATOR

The two halves of the armature windings in Figs. 4, 5 and 6 are similar to two voltaic cells in parallel. In Fig. 6 it will be seen that the electric pressure generated in the conductors under the N pole causes a current to flow out from the positive brush through the external circuit *C* and into the negative brush, as indicated by the arrowhead; likewise, for the conductors under the S pole. Since the two halves of the windings are in parallel, the voltage appearing at the brushes will be that developed in one half of the winding, just as when two voltaic cells are connected in parallel—the voltage of the group is equal to that of a single cell. Also, each half of the winding will supply one-half of the current in the external circuit; that is, when the armature is supplying 30 amperes to the external circuit *C*, 15 amperes will be flowing in the conductors under the N pole and 15 amperes in the conductors under the S pole. This is again the same as when two voltaic cells are connected in parallel and supplying current to a circuit—one-half of the current is supplied by each cell.

All the foregoing discussion has been in reference to two-pole machines. The general principle applies to multipole machines, although the division of the current may be somewhat different in the winding, as will be seen in our discussion on this subject in future lessons.

Fig. 7 is a layout of problem 1 given in the last lesson. This circuit may look complicated, nevertheless it is the equivalent of three resistances in parallel. There are three circuits from A to B: One directly through $r_5 = 6$ ohms; another, which we will call R' through r_1 and r_2 in series $= 2.5 + 7.5 = 10$ ohms; and the third, which we will designate as R'' through r_3 and r_4 in series $= 6 + 9 = 15$ ohms; that is, three resistances R', r_5 and R'', in parallel, of 10, 6 and 15 ohms respectively. That there are three circuits parallel is indicated by the flow of the current shown by the arrows.

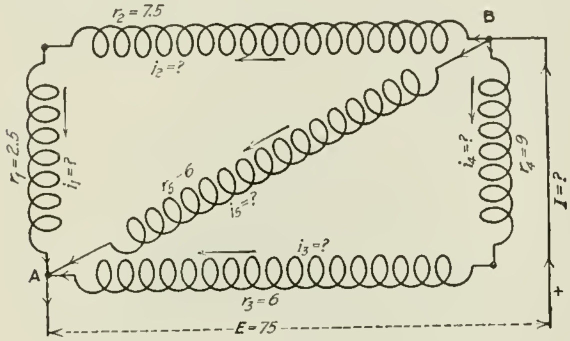


FIG. 7

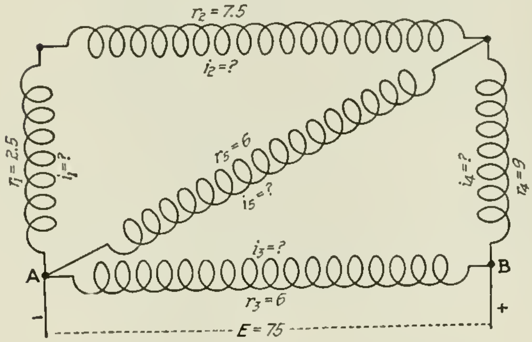


FIG. 8

FIGS. 7 AND 8. COMPLEX CIRCUITS

The joint resistance of the circuit is

$$R = \frac{1}{\frac{1}{R'} + \frac{1}{r_5} + \frac{1}{R''}} = \frac{1}{\frac{1}{10} + \frac{1}{6} + \frac{1}{15}} = \frac{1}{\frac{10}{30}} = \frac{30}{10} = 3 \textit{ ohms}$$

The total current flowing in the circuit equals total volts divided by the joint resistance of the circuit, or

$$I = \frac{E}{R} = \frac{75}{3} = 25 \text{ amperes.}$$

$$i_1 = i_2 = \frac{E}{r_1 + r_2} = \frac{75}{2.5 + 7.5} = 7.5 \textit{ amperes;}$$

$$i_5 = \frac{E}{r_5} = \frac{75}{6} = 12.5 \textit{ amperes;}$$

$$i_3 = i_4 = \frac{E}{r_3 + r_4} = \frac{75}{6 + 9} = 5 \textit{ amperes;}$$

and the total current equals the sum of the three, or 7.5 + 12.5 + 5 = 25 amperes, which checks the foregoing calculation.

In problem 2 of the last lesson the circuit took 15 hp. when 115 volts was applied to it. To find the current, first find the watts, which equal $W = \text{hp.} \times 746 = 15 \times 746 = 11{,}190$ watts. Then $I = \frac{W}{E} = \frac{11{,}190}{115} = 97.3$ amperes. This might have been expressed as $I = \frac{\text{hp.} \times 746}{E} = \frac{15 \times 746}{115} = 97.3$ amperes.

The total resistance $R = \frac{E}{I} = \frac{115}{97.3} = 1.18$ ohms. R also equals $\frac{E^2}{W} = \frac{115 \times 115}{11{,}190} = 1.18$ ohms.

In Fig. 8, in addition to determining the values indicated by the interrogation marks, find the joint resistance of the circuit.

Engine Troubles Due to Carelessness

By Charles W. Oakley

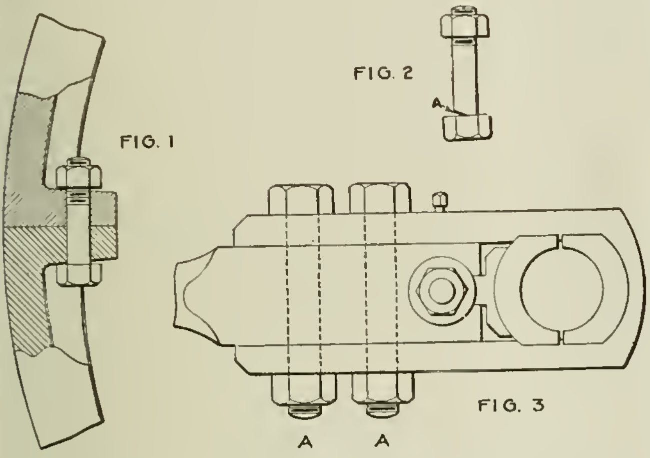
There is a weakness on the part of many engineers to consider the man sent out by the builder to erect an engine or turbine as almost infallible. While this man is usually a thorough mechanic, conscientious and painstaking in his work, occasionally one is met whose idea of his own importance either overcomes his judgment or else takes the place of the knowledge and experience which he is supposed to have. This is due in a large measure to the attitude of many superintendents and managers, who, because the erecting man is invested with considerable responsibility, defer to him and seek his opinion not only on questions pertaining to the machinery being installed, but on matters concerning the operation of the plant, with which the chief engineer is much better acquainted and probably has vastly more experience.

A case of carelessness on the part of an erecting man, which might have resulted in a disastrous accident, occurred in putting together a flywheel weighing about sixteen tons, made in halves and bolted through flanges at the rim and the hub. When the wheel was put on, the heads and nuts of the bolts had a bearing on the flanges at one side only, as shown in Fig. 1. The engineer protested to the erecting man, who explained that it was unnecessary to face off the flanges to secure a full bearing, as it was the custom of his firm to make the bolts and flanges several times as strong as required, and therefore no harm could ever occur. However, he suggested that copper washers be placed under the heads and nuts, explaining that the copper would allow the heads and nuts to bed themselves until a full bearing was obtained. This was done, the bolts being pulled down considerably tighter than would have been necessary had they had a full bearing on the flanges. The engineer was then instructed to tighten the bolts at intervals, after running a few days, and eventually they would have a uniform bearing.

The engineer obeyed his instructions; but one morning shortly after the engine had been put in service, when he started to tighten up one of the nuts, he was surprised to find that it turned quite easily. The bolt, on being removed, was found to be cracked about halfway through under the head, as at A, Fig. 2. Examination of the other bolts disclosed incipient fractures in three of them. It is hardly necessary to describe what would have happened to that wheel before many hours.

No time was lost in getting the engine builders on the job and having them face off the flanges until the new bolts which were secured had a proper bearing on the flanges.

One of the errors made by engineers, and sometimes by erecting men, is the improper fitting of bolts. Some engineers are of the opinion that so long as a bolt is amply large for the work it has to do, it is of little consequence whether it fits closely in the hole or not. They argue that the job is all right because the nuts are drawn up tight. Later on, evidence of shifting of the parts that are bolted together may be detected through the appearance of rusty oil at the joint or under the bolt head. Whenever an indication of this kind appears, the nut should not be tightened further, but the bolt should at once be removed and an examination made to ascertain whether there is any fracture of the bolt or the casting. The hole should be tested for alignment, to see whether a bolt the full size of the hole will go all the way through. If not, the parts should be held firmly together in their correct relative positions and the hole should be carefully reamed out. Then a bolt of proper size should be obtained and turned to fit the reamed hole snugly.



FIGS. 1 TO 3. EXAMPLES OF CARELESS FITTING

Figs. 1 and 2—Effect of poor bearing of flange bolts. Fig. 3—Design of connecting-rod end.

In making a flywheel or a large belt wheel in two or more sections, it is customary to plane off the joints and flanges of the wheel, and then bolt the sections together before turning and boring the wheel. It is rare, however, that a wheel is bolted together as firmly for this purpose as it is when placed in position for service; consequently, when the wheel is put in place on the shaft, some slight distortion frequently occurs at the bolt holes, especially when the arms are bolted between hub flanges. Great care should be taken to have the bolts well fitted to holes reamed out carefully, and no springing, prying or drifting should be allowed in making up these bolted joints. Not only must the head and nut of each bolt bear fully and squarely on the surfaces, thus insuring a straight pull on the bolt, but the shank of the bolt should present its full shearing area at all points in the joint.

Other parts of the engine besides the flywheel are susceptible to danger and trouble from ill-fitting bolts. To illustrate, the crosshead end of a large connecting-rod developed a very annoying pound shortly after it had been fitted with a new set of brasses. Upon taking down the connecting-rod at the crosshead end, which was of the design shown in Fig. 3, it was discovered that the bolts *A* were slightly loose in their holes and had necks cut into them by the strap, thus allowing some movement of the strap.

When this condition of affairs was pointed out to the engineer, he confessed that as the brasses had been found slightly large between the strap and the wedge, he had filed the bolts down so that they would pass through the holes in the rod end, thus avoiding the trouble of taking out the brasses again to plane them off. It was necessary to secure new bolts and ream out the holes in the strap and rod to fit. The pound then disappeared.

In erecting a large engine it is usual to locate the pillow block or pedestal on the sole plate by means of dowel pins, as shown at *A*, Fig. 4. The sole plate *B* is first lined up and leveled properly, and when the foundation has hardened sufficiently the pedestal is set in place over the dowel pins and held firmly by means of the anchor bolts *C*.

It is inadvisable to have the anchor bolts fit closely in the holes in the sole plate and pedestal, as shifting of the bolts while the foundation is being built would prevent the placing of the pedestal over the bolts. To allow for slight lateral movement, therefore, they are usually set in boxes *D*, with pockets *E* in the foundation at their lower ends, so that a wrench may be inserted to remove the lower nuts and allow the bolts to be drawn up and replaced in case injury or breakage requires their renewal.

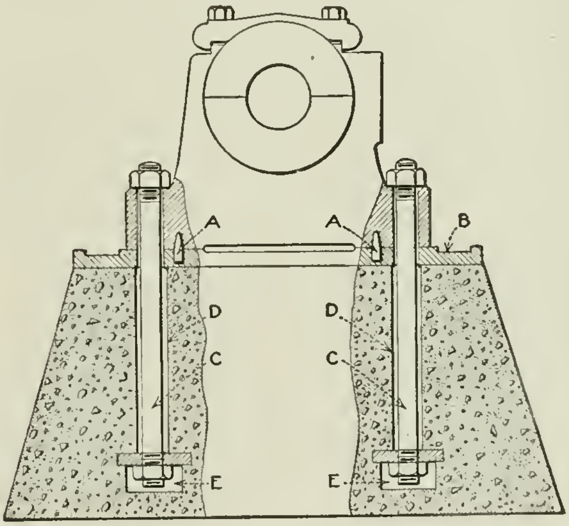


FIG. 4. DOWEL PINS TO PREVENT PILLOW BLOCK FROM SHIFTING

Allowing the anchor bolts to become loose permits the pedestal to work back and forth, slightly at first, but gradually increasing in movement until the dowel pins are sheared or broken off, leaving the position of the pedestal dependent entirely on the tension of the anchor bolts. A serious accident resulted from this cause some years ago. The movement of the engine frame caused such excessive vibration of the governor standard that it broke or sheared off the studs securing it to the engine frame. The breaking loose of the governing mechanism resulted in a runaway that wrecked the entire plant.

What of the Labor Situation?

WHAT of the labor situation? Let us face the facts. Labor is stronger today than ever before. It has tremendous power. It can for short periods stop industry. Within reason, it can force almost anything it will. If it goes to extremes, the rural communities and large groups in the cities will rise to check and thwart its demands. Nevertheless, if misguided, it can work serious hardship. What, then, is its purpose? How will it use its power? Is it bent on a rule-or-ruin policy? Or, seeing the good in the existing order and conscious of the sure control that lies in the mass of the people, is it desirous of compromise?

Emphatically the latter is true—speaking as to the majority of the acknowledged labor leaders. Their desires cannot be realized unless capital comes half way. If capital resists, if it is represented—or rather misrepresented—by those who take an autocratic stand, it will force millions into the radical wing of the labor party, it will add fuel to fires already burning.

These are not the days for sugar-coating the pill. The coward will cringe from facing the facts. He will roundly condemn those whose object is to save him—and with him the essential elements in the present social order. Charles M. Schwab said a few days ago that the worker was to dominate the world. A more temperate statement is that of former Supreme Court Justice Hughes, a student of industrial relations, accustomed to consider and weigh. Before the New York Bar Association last month he said:

"Individual privilege [in the future] will have to show cause before a public to which old traditions are no longer controlling—a public trained in sacrifice—which will enforce its own estimate of the common right." And again he said: "The present exercise of authority over the lives of men will hereafter find its counterpart in a more liberal exercise of power over the conduct, opportunities and possessions of men."

Mr. Schwab and Justice Hughes had the courage to recognize the changing order. Narrow minds, however, will rail and rant, urge that capital prepare to fight for its position, and declare that no man shall dictate how they shall run their plants. Such minds are not changed by dissertations on the reasonableness of the new order, which decrees that the public good shall take precedence over private gain, that the public cares for the individual and demands that he have a voice in determining the conditions under which he works.

It is a matter of indifference, in any event, what the individual thinks as to the soundness of the coming order. We are in a new era, in fact. Witness the fires raging socially in Russia and now kindling in Austria and even in Germany. Note the power which labor has in England.

We are in and of the world. The power drifting to the workers here is part of the world tide. Whither will it lead us?

Even as there are standpat autocrats as well as men of enlightenment among employers, so there are radicals and conservatives among labor. The autocrats on the one hand and the radicals on the other are the extremists. If they are left to lead us out of the difficulties, we shall have an arming for conflict and a great catastrophe. It is for those who see the light to compose the differences—the moderates among the employers, the conservatives among the workers.

These wings of the opposing parties can reach a working agreement. They must come together in order that the extremists may be disarmed—aye, that they, and the country with them, shall be saved from their own madness. The final result will work for the greater good of all. "Harsh changes are necessary," said Mr. Schwab, "but they will be more than repaid not only materially, but in happiness and contentment."

Practically, what is coming out of the present economic crisis? Detailed predictions are dangerous. This much is certain: (1) Labor will demand and get a larger share of the profits of industry, and (2) it will demand a voice in each industry in determining the conditions under which it shall work.

Is that a cure-all? Will all labor difficulties be then composed?

Not so. There is not an absolute unity of interest; there cannot be a permanent peace. All we can hope for is compromise under conditions that obtain today. When conditions change, there will be a new compromise, succeeded by another and another and still another. But the present compromise will be the greatest for many a day, for it will definitely establish labor's voice in the control of industry.

And what of the industries that pay a bare 4 or 5 per cent. on a fair or low valuation of investment? Bankruptcy or a reduction of overhead through increased production. These are the only alternatives.

And what of efficiency, now at a low mark in industrial plants? Education is the answer—education, through participation in management, regarding the factors which affect profits; education which will engender a sense of responsibility for the success of the industry, a realization that there can be no labor prosperity without industrial prosperity—a realization that will be turned into effective action by confidence that labor will get "its share" of the profits it helps to create. A long process, yes, but a necessary one.

And efficiency is a shoe that both parties can wear. Management inefficiency more than matches, count for count, labor inefficiency.

Radical talk this? Yes, if you will have it so, but read again the words of Charles Schwab and of Justice Hughes.

Shall we fear to face the facts? Shall we, by ignoring conditions that the merest numskull can appreciate, drift into anarchy? *Laissez faire* and "last-ditch resistance" both lead to that end.

Soon there will meet in Washington a Labor Policy Board. It will hold the balances for our industrial peace. There must be give and take—compromise. Both sides must surrender much that they value highly. Far-seeing employers are ready to make sacrifices. So, too, are the forward-looking labor leaders. The interests of the country demand that both sides look carefully to it that they be not misrepresented. And above all let both be prepared for large concessions. In that direction lie peace and the country's good.—*E. J. Mehren in "Engineering News-Record."*

Editorials

What Is Labor Unrest?

THE human mind is the most complex piece of mechanism in the world. It is the master mechanism. How it works nobody knows. What it will do individually and collectively under any given conditions nobody knows—not even its owner.

The man who digs your ditches has depths you cannot plumb. You see him come and go every day and his coming and going become a part of your daily habit of thought, like the coming of your morning newspaper. Some day he doesn't blend with the scenery as you are accustomed to viewing it. Unknown to you there has been some crisis in his life; his mental depths are in turmoil; age-old questions come to the surface. Placidity becomes turbulence and you are annoyed—unless you have become similarly turbulent yourself, in which event you are not annoyed. You understand.

Your ditch digger has thousands of years of his ancestors' life and thoughts and yearnings slumbering in his soul and speaking when he is roused. He has not always been a ditch digger. Some centuries past in Asia Minor, in Greece, in Italy, along the whole line of civilization's push upward, he has been oppressor and oppressed, just as you have been—mostly oppressed, for the oppressed have always been in the majority.

One life begins and ends; but the blood-flow is continuous from generation to generation. The thousands of years behind us speak in us and to us and through us every day. The greatest thinkers, ancient and modern, affirm this.

There has been more stirring of the human depths since August, 1914, than there had been in the whole period since our Civil War. All of our accustomed grooves have been upset. In our social bearings we lack a sureness of direction. The guide posts have become weather vanes. Our placid gray matter has been set seething. The former smooth surface of our minds which reflected the current weather, the passing clouds and the orderly seasons, is turbulent; the sediment of the centuries is bubbling to the surface from the depths.

We get into channels. Channels are comfortable. They fix direction. Where you are going doesn't worry you. It suffices that you are comfortably on your way. Then something happens and destroys the channel. You and your ditch digger face each other with the eternal question of your mutual relationship in your eyes. The thousands of years back of each of you is compacted in the look. *And you couldn't phrase the question in words if you tried.* You don't try, either of you. Instinctively you know it, but to save your souls neither of you could say it.

If you tried to say it, you would both use the words you used in the channel—wages, open shop, cost of living. Especially the ditch digger would. He couldn't phrase the concentrated protest of ten thousand years in a moment of crisis any more than he could think it logically in a year in the channel. It is too big, too overwhelming, too much a rising of his whole being. So when you ask him what he is turbulent about, don't quibble about the lack of a clear-cut answer. It can't be made; you couldn't make it yourself. But if you want his answer, get it in his reactions. Hear him give approval to war against the Kaiser; note the set of his features when the war profiteer is mentioned; watch him as he listens by the hour to the man you would call an agitator; catch his constant sanction to the opportunities open alike to everybody and his equally constant suspicion of opportunities not possible for *his* children. The public schools are never afraid to go direct to the people for money; the universities are.

Business based on the idea of maximum cash returns to the owner, at any cost to competitors, to labor, to the social order, to the Government, was bound to be a boomerang.

The labor unrest is the instinctive protest of ten thousand years against all this.

New Jersey Plants Closed from Lack of Coal

NOTWITHSTANDING the fact that suspension of heatless Mondays was announced on February Thirteenth, by Fuel Administrator Garfield, with the reservation, however, that the suspension order might be revoked before the ten-week period expired if a return of cold weather should bring another breakdown in railroad transportation, it strikes one as being somewhat premature when viewed from the state of local conditions and those prevailing in New England.

Although heatless Mondays have been abolished, a large number of industrial plants in northern New Jersey were forced to stop or curtail work the day prior to the Fuel Administration order, because of the cutting off of electric power by the Public Service Electric Co. of Newark and the Public Service Corporation of Jersey City, due to lack of coal.

Many of the plants affected have important war contracts, and about 50,000 employees were made idle. It was announced by officials of both companies that the shutdown would probably continue until February twentieth.

It is believed that the manufacturers in this district have cause for complaint because of the alleged failure of the Fuel Administrator to keep his promise, made about the middle of January last, to the effect that the Public Service Corporation would be supplied with enough coal to keep it going. It is understood that a delegation from Jersey City, Hoboken, the Bayonne Chamber of Commerce and the Newark Board of Trade visited the Washington fuel authorities and were told by them that arrangements would be made with War and Navy Departments whereby the coal would be shipped ostensibly to the army, but would be delivered in Jersey City to the corporation. The corporation officials declare that this plan was never carried out properly, that although for a time they got coal from what is known as the tidewater pool, a few days ago the pool refused to deliver coal.

It seems incredible that such a situation should have been allowed to come to a head as to compel the shutting down of a chain of large power plants, especially when so many companies are using their current for manufacturing war materials.

Improve Plant Efficiency

SHORTAGE of labor limits the output of the mines, and scarcity of cars hinders coal distribution. With the demand far in excess of production, there is one way that will help to relieve the shortage. Save coal at home and, more important still, save it in the power plant. Make nine pounds of coal do the work ten pounds did before, and then see if the economy cannot be bettered. There is many a plant in which this ten per cent. saving might readily be increased to thirty, and in some cases it would be possible to cut coal consumption in two without reducing the output.

It is not a question of installing new and more efficient machinery. Manufacturing and transportation facilities are not available, and if they were, the time element is too pressing. Relief is needed at once. The solution is to improve the plant as it stands. The worse the condition the greater the saving possible. The opportunity exists and all that is needed is intelligent attention by every power-plant owner and engineer in the country.

A real engineer well knows what is needed. He will look to air leaks in the boiler setting and stop steam and water leaks in the piping. He will adopt proper firing methods for the coal he is burning, see that the draft is right and keep the heating surface free from soot and scale. All equipment in the engine and pump rooms will be kept in good order. The valves will be properly set, and the bearings will be kept cool by sufficient lubrication. In a word, the plant will be maintained in the "pink" of condition.

All this necessitates a competent engineer, a good fireman, a system of records showing accurately what is being done and the necessary instruments with which to obtain the operating data. And here is the owner's opportunity. He must choose his man wisely and then provide him with every facility possible that will help to produce the most efficient results.

In those plants not containing mechanical stokers the fireman is the biggest single factor to be considered. Good men of this trade are scarce, and it is a question of educating the material at hand. Higher-priced fuel has helped to eradicate the idea that the fireman is a common laborer subject to the treatment of a roustabout. As fuel prices go up the margin between good and indifferent work means more and more of the firm's money. It will be found cheaper to educate the fireman than to pay for coal, and the laborer will be raised to the plane of a skilled workman. In this process valuable information may be obtained from the Bureau of Mines, various schools and engineering associations will contribute to the cause, and *Power* stands ready to supply all information at its command.

Prompt action by every power plant in the country would easily increase the average economy ten per cent. It would mean millions of tons of coal for war purposes, resulting in more rapid mobilization of men and supplies at the front by our own country and our allies. It would contribute toward shortening the war and at the same time mean a saving to the power-plant owner. This is no sacrifice. Like buying a Liberty Bond with interest and principal returnable, it is the duty of every patriotic engineer and power-plant owner to contribute to the cause.

Names! Names! Names!

THE following appeared in the New York *Sun* o February 15. Why is it that "The names have not been made public"?

> COAL MEN INDICTED
>
> *Tennessee Operators and Dealers Held for Food Law Violations*
>
> Knoxville, Tenn., Feb. 14.—The Federal Grand Jury here today returned twenty-three indictments against forty-seven defendants, including coal operators, coal dealers and coal brokers of the east Tennessee field, charging violation of the food-control bill. The names have not been made public.
>
> The indictments include 163 counts. The cases will be called for trial here at the May term. The indictments resulted from investigations made during the last two months by the Department of Justice, which developed charges of violations of Government fixed prices and Fuel Administration order.

Give us their names.

Coal Piracy Under Ban

> Sale of rock and slate masquerading as coal is going to be discouraged, C. E. Robertson, deputy state fuel administrator, said today.
>
> "Within the past few days," he added, "this office has had rejected two cargoes of which an analysis showed 69 per cent. of rock and slate and only 31 per cent. of coal. The railroad companies carrying this coal notified the producers in Pennsylvania that no more cars would be furnished to them. If this stuff had been accepted by the consignee, it would have cost him $26 per ton for the coal in it."—*N. Y. Globe, Feb. 14.*

And even at that he could not have burned it.

There is nothing to be gained by holding meetings, writing papers and editorials to argue that the Monday closing orders of the Fuel Administration have saved little, if any, coal. Their object was not to save coal, but to relieve the bunged-up conditions of the railways. It is a pity that some of these intellectual giants cannot see how absurd some of their advice and comments appear in the light by which those who have great responsibilities are doing big things.

The *Engineering and Mining Journal* will say the following, editorially:

> The days of suspended industry in February may or may not be costly, but it is certain that they were not so expensive as the New York dailies represented last Sunday, on the authority of the *Black Diamond*. They put the loss for eight days at $4,344,000,000, which would be $543,000,000 per day, or at the rate of $162,900,000,000 per annum, reckoning 300 days. Inasmuch as the gross volume of business in the United States in 1917 is estimated at about $50,000,000,000, there is manifestly something wrong in estimating the loss of about eight per cent. of that sum in eight days.

Correspondence

Why Hot-Water Pipes Pit

On page 824 in the issue of Dec. 18, 1917, a description was given of the pitting of steel pipes used for steam and hot-water lines. Two instances were given, and the question was asked, "What is the reason?"

There is a possibility, as mentioned in the article, that there was originally in the steam pipe a pin-hole through which the steam escaped, gradually wearing the hole larger and larger and that it was, therefore, not a case of corrosion but of erosion. The other case, however, is typical of corrosion in hot-water lines, which is one of the everyday troubles of power-plant engineers and is satisfactorily explained by the electrolytic theory of corrosion. According to this theory corrosion is caused by electric currents emanating either from outside sources or in the material itself. In the latter case the elements necessary for corrosion to occur are as follows: (1) Impurities or other conditions in the metal, causing different electrical potential in adjoining areas thereof; (2) an electrolyte—commonly water; (3) a depolarizer—air or oxygen. With these conditions prevailing, a current is set up which dissolves the metal at the electropositive pole, resulting in oxidation and precipitating of rust at this point, where the pit will subsequently be observed.

It will be seen that if oxygen can be excluded from a water line, corrosion will not take place; likewise that corrosion will to some extent be accelerated or retarded according to the amount of free oxygen contained in the water. From the oxygen content of the water viewpoint one may reason out the relative corrosive effects of water, steam and moisture in various forms, and it will be seen from the following that the corrosion in hot-water lines is, in the light of the electrolytic theory, calculated to be very severe, agreeing with actual experience. Hot water, under certain conditions, as will be explained, is very destructive to the life of ferrous metals.

The experiments of Heyn and Bauer in 1910 indicate that the corrosion of iron in hot water increases with the temperature, reaching its maximum at about 140 deg. F., where the effect is about four times as great as at normal temperatures. Above 140 deg. the corrosion decreases with increase of temperature, and above 176 deg. the falling off is rapid and the corrosion should be very slight at the boiling point (212 deg.) because of the expulsion of oxygen from the water.

When iron is immersed in hot water, there are opposing forces to be considered:

1. Corrosion should be increased because: (a) The conductivity of the water as an electrolyte becomes progressively greater with increase of temperature to the boiling point. At this point it may be several times as great as at normal temperatures, and thus there may be several times the current density with its equivalent solution of iron for the same potential difference set up between the iron and any electronegative substance. (b) With rise of temperature there should be increased speed of reaction between the iron and oxygen in the formation of the rust.

2. Corrosion should be decreased because: The solubility of oxygen in water decreases with rise of temperature, becoming nil at the boiling point.

The amount of corrosion at any temperature will depend on the balance of these forces. As indicated previously, the observed effect is an increase to a maximum with subsequent decrease from this temperature to the boiling point of water.

In hot-water supply and heating systems the corrosive action will depend largely upon conditions of design, installation and operation. At best there is a tendency for marked acceleration of corrosion because of the increased electrical conductivity of the water up to a certain temperature; also because of the evaporation of the water—as in all closed circulating systems—which will result in increased concentration of salts in solution as compared with the natural supply. If an open system is used, where the water is brought to the boiling point and the greater part of the liberated oxygen is allowed to escape before entering the pipe system, corrosion may be very much reduced in spite of other influences in its favor. But with the customary closed system conditions could hardly be more favorable for maximum effect, owing to the accelerating influence of high temperature and probable concentration of salts in solution, coupled with a maximum content of oxygen, since the latter cannot escape from the closed system and is forcibly kept in solution by the relatively high working pressure.

The electrolytic theory of corrosion, or the difference of electrical potential in adjoining areas of a metal, may, as mentioned, be caused by impurities contained in the metal. On this theory it might be thought that high purity of metal would prevent, or at least greatly reduce corrosion. But the high-purity commercial irons apparently do rust just as quickly as ordinary steel, and metallurgists were therefore forced to look for other causes besides high purity. They then discovered that different polarity, causing electrolytic action, may also be due to: (1) Distortion or unevenly strained parts in the metal (caused in pipe by applying a wrench in tightening a joint, bending the pipe or the like); (2) lodgment of foreign matter or mill scale on the metal surface.

In addition it has been found that rust is of a different electrical potential from that of iron or steel and, when once formed on the surface, becomes the cause of further rusting or pitting. In other words, rust breeds rust, becoming such an important factor in the progress of corrosion that original purity of metal and the other causes mentioned assume comparatively little importance. While the electrolytic theory of corrosion, when properly interpreted, is a valuable guide to the understanding of the subject, it cannot be used for the purpose of reasoning out how any metal of a given composition will behave in actual service. Experience with the metal under service conditions is the best guide. The metal may, for instance, be very impure, like cast iron, and yet be fairly rust-resistant. This is assumed to be due to the barrier action afforded by these very impurities, principally the graphitic carbon, which in itself is highly rust-resistant and protects the underlying iron from corrosion by preventing penetration of the water or oxygen. In respect to the nature of other forms of iron considerable confusion exists, and the following may therefore be in order:

By commercially "pure iron" we understand certain products of the openhearth processes which should more properly be called pure steel, for they lack both the graphite contained in cast iron and the slag contained in genuine wrought iron. We know that wrought iron is a very durable product in spite of the large proportion of slag which is incorporated in the pure iron, but we should not be misled into construing this as a contradiction of the electrolytic theory, for it is apparent that the slag, like the graphite in cast iron, being in itself a practically noncorrodible substance, must on account of its fine distribution, protect the underlying iron from corrosion.

N. Bowland,
A. M. Byers Co.
Pittsburgh, Penn.

Water for Air Pump

I would like to add the following to what the readers of *Power* have contributed to the subject of the source of water supply for the air pump of Mr. Forseille, as told by him in *Power*, Nov. 20.

The first change to make is to lower the strainers and then connect up the new proposed line to the intake of the strainers, with a gate valve in the line so as to cut out the new line when the slush ice disappears. This will melt the slush ice by mixing the water, and a temperature from 60 to 70 deg. F. can be held in the air pump intake water. The temperature of the intake should be below 70 deg. The pump gets more or less vapor or steam from the condenser, but as long as the temperature is kept below 70 deg. F. the efficiency of the pump will not be appreciably reduced. Cold water is two-thirds of the battle in condenser operation.

North Kansas City, Mo. P. B. Williamson.

Providing Stand-by Service

In an industrial power plant where only one generator was provided, on which the maximum load never exceeded 75 per cent. of the unit's rated capacity, it was getting to be quite a problem to find sufficient time to make the necessary repairs and adjustments. Somebody always requires light and power, and although the load was small on nights and Sundays, it nevertheless caused considerable inconvenience if the engine was shut down for any length of time. The management did not feel inclined to buy another engine as long as this one was not loaded up to capacity. The figures offered by a central station for stand-by service were such that they could not be even considered. The central staton offered to take the entire load at a reasonable rate, but as all the exhaust steam was used in the different heating and cooking processes in the plant, the engineer soon convinced the management that the central-station figures, no matter how attractive, would be an expensive proposition. It was now up to the engineer to provide, if possible, some sort of stand-by service, and he solved the problem as follows:

In the room adjoining the engine room, mounted on the wall between the two rooms, was a 15-hp. motor belted to a lineshaft. This machine was never run at night or on Sunday and was idle part of the time during nearly every day in the week. The motor had originally been used for a generator and had been driven by a small engine, which had been taken out and stored in the boiler room. The old engine was resurrected, cleaned up, adjusted, tried out and found to be in good condition. Holes were cut in the wall in line with the pulley on the motor, and the engine was placed on a concrete foundation built on the engine-room floor in such a position that the engine pulley was in line with that of the motor.

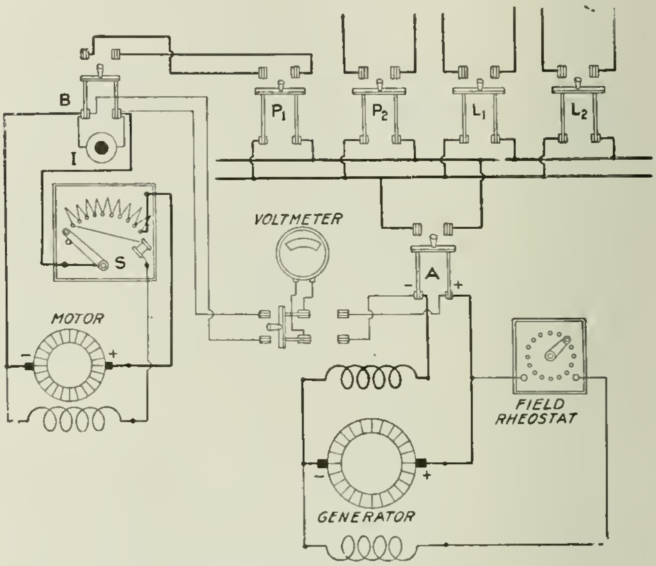


DIAGRAM OF GENERATOR AND MOTOR CONNECTIONS

The governor of the engine was adjusted so that, according to the pulley proportions, it should about run the motor at normal speed. A lamp *I*, as shown in the figure, was connected across the motor's switch to approximately determine the voltage of the motor while running as a generator.

When everything was ready, the engine was started and brought up to speed. The arm on the starting box *S* was placed in the running position, and soon the lamp *I* began to glow and came up to full brilliancy.

The switchboard was arranged with four switches, as shown. The two switches marked P_1 and P_2 supplied the power circuits; L_1 and L_2 the lighting circuits of the plant. There was only one other motor on the circuit P_1 besides the one being used as a generator, and the switch to this and the switch P_2 on the switchboard were blocked open so that no one could close them and throw excessive load on the emergency generating unit.

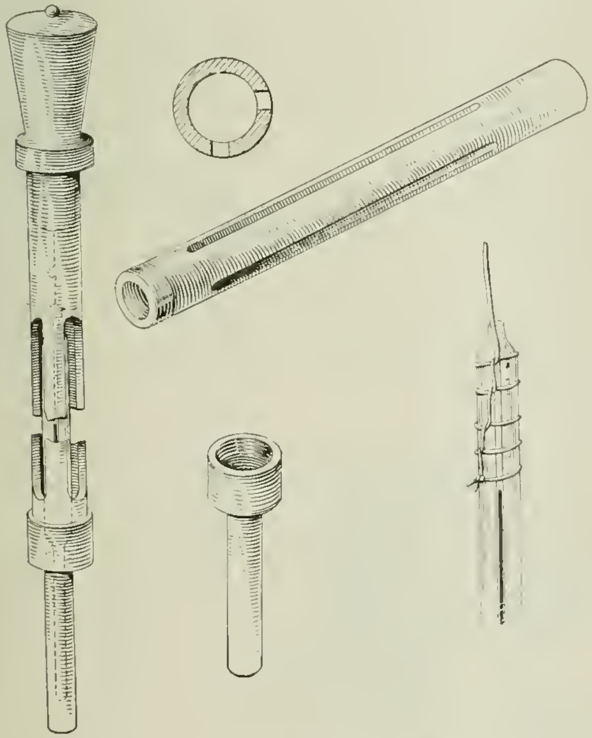
When everything was ready for the change-over, the motor switch *B* was closed, after which the generator switch *A* was opened and switch P_1 closed. The light grew a little dimmer, but this was soon remedied by adjusting the governor to increase speed of engine.

This stand-by unit was used several nights a week and nearly every Sunday for almost two years, when the load became so heavy on the main unit that a larger one had to be installed. The night engineer made another improvement by connecting the voltmeter to a double-throw switch, as shown, so that it could be switched from the main to the emergency unit when it was in operation, and the change-over was then made by paralleling the units, and therefore without interrupting the service. E. W. MILLER.

Minneapolis, Minn.

A Thermometer Guard

The illustration shows a serviceable thermometer guard which is simple to make and easily removed when not in use. Its essential parts are a piece of $\frac{3}{8}$-in. pipe 14 in. long and a wooden cap, the latter shaped to give oily fingers a secure hold and having a hole lengthwise through it for a wire or cord by which to support or move the thermometer. The pipe is threaded at one end and is attached to the ordinary thermometer cup by tapping the cup as shown. The other end is preferably reamed out smooth. Two $\frac{3}{16}$-in. slots are machined in the pipe 90 deg. apart. Then, with the pipe loosely screwed into the cup, one slot can always be turned to face the light. With a hole through the cap, the length of the wire or cord connecting with the thermometer is more readily adjusted than with a screw-eye or a transverse hole in the inner end of the cap.



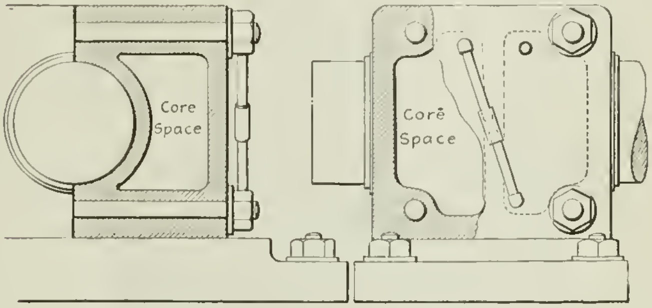
GUARD TO PROTECT A THERMOMETER TUBE

If the eye is broken off the thermometer, tie a soft string around it, followed by a succession of half-hitches. Where excessive vibration endangers the thermometer, a turn of lampwick around its upper end or a small rubber band looped around a few turns will safeguard it. R. MATTHEWS.

Ithaca, N. Y.

Water-Jacketed Pillow-Block Cap

The pillow block of a 30 x 42-in. rolling-mill engine was in the habit of working hot; in fact, it required close attention and a lot of oil, and occasionally some cylinder oil, to keep it from smoking and throwing babbitt. It was cured by circulating water in the cored-out space in the bearing cap through a $\frac{1}{2}$-in. pipe. The bolt holes were in solid metal, and there was a vertical cast-iron partition in the middle, but the core was nearly the size of the babbitt area so that there was plenty of cooling surface. The rough core holes were stopped with wooden plugs into which small iron wedges were driven, on the principle of securing a hammer handle. Four holes for $\frac{1}{2}$-in. pipe were drilled and tapped and piped so that the water entered at the bottom of the space next to the flywheel, discharging from the top to the bottom of the crank side, as shown, and out at the top, after which the bearing was the least of the engineer's troubles. J. LEWIS.



PILLOW-BLOCK CAP COOLED BY CIRCULATING WATER

New York City.

Induction Motor Would Not Operate on Direct Current

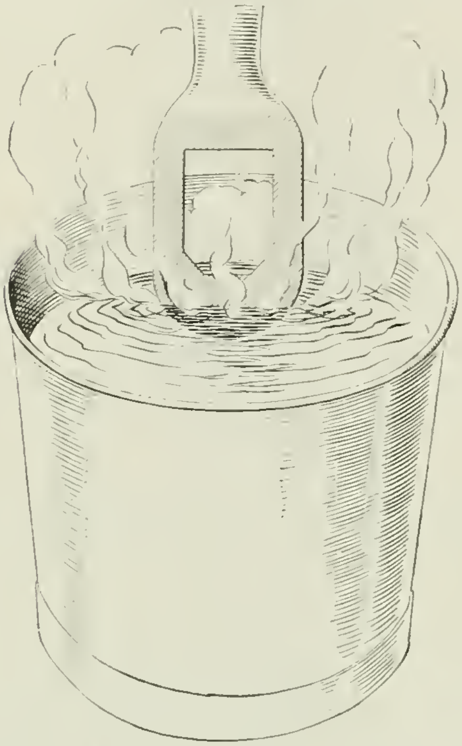
When it is considered that the counter-electromotive force in the armature conductors of a direct-current motor is generated by the conductors being moved across the magnetic field from the field poles, where in an induction motor, the counter-electromotive force is developed by the stator winding cutting the lines of force set up by the current in this winding, it is evident that the alternating-current motor will not operate on a direct-current circuit.

Some time ago, after making some repairs on a small alternating-current motor, I started to give it a running test from a double-pole, double-throw switch connected to a direct-current circuit on one side and an alternating-current circuit on the other. By mistake I threw the switch to the direct-current side instead of the alternating-current side, with the result that the fuses were immediately blown. After trying to make this test two or three times and failing, the motor was opened up and inspected for trouble, but everything was found in good condition. About this time it was discovered that the switch had been thrown to the direct-current side instead of the alternating. Upon assembling the motor and connecting it to the alternating-current circuit, it operated satisfactorily without any further trouble. C. R. BEHRINGER.

Schenectady, N. Y.

Shrinking the "Eye" of a Rod

I have received a great deal of useful information from *Power* and will, in turn, endeavor to supply something myself. I am a machinist and was called out on a job on a Corliss engine (18 x 42 in.) that had developed a bad pound, and I discovered that the brasses were loose in the rod.



EYE CONTRACTED BY HEATING AND COOLING

To save the customer buying a set of new brasses, I removed the old ones, took the rod to the shop and heated and shrunk it in the manner illustrated. When cooled, I found I had to remove nearly $\frac{1}{32}$ in. to refit the brasses.

B. Harrison.

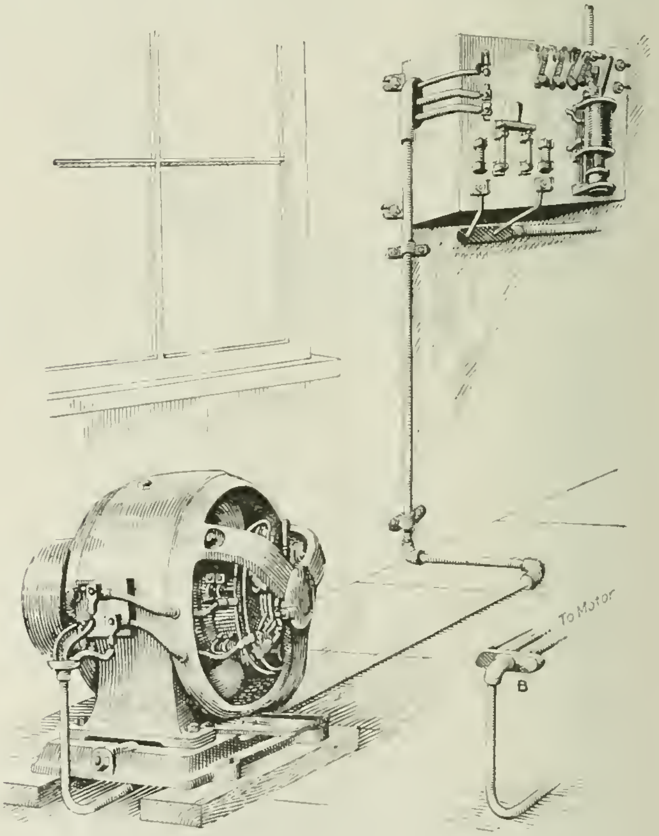
Rochester, N. Y.

An Elusive Ground

A direct-current motor, controlled by an automatic starter, as in the figure, caused trouble by blowing its fuses. The wires from the controller to the motor were run in conduit, and a magneto test showed one of these wires to be grounded. A burned spot showed on the conduit near the control panel, about three inches from the end fitting. As this was believed to be the location of the ground, the wires were disconnected from the motor, and pulled about six inches out of the conduit at the control-board end, and were all found to be in perfect condition. Closer inspection showed the burned spot on the conduit to be on the outside only, evidently having been caused by a live wire coming in contact with the conduit at some previous time. With the wires in this position the magneto was again applied and all rang clear.

Next, the motor and control board were tested for grounds and found to be clear. Inasmuch as everything was now apparently in good order, the wires were again connected to the motor and upon starting all went well for a few hours, then the same trouble again occurred. The next thing done was to test each and every connection on the controller, all of which showed a ground that could not be located. After losing considerable time in this manner, the wires in the conduit were disconnected at each end and again tested, this time showing a ground on one of them.

The wires were then pulled entirely out of the conduit and found to be badly water-soaked, while the insulation was burned from one of them for a length of about four inches where the current had been arcing from the conductor to the conduit. A hole had been burned entirely through the conduit at this point, which was directly under the motor and could not be seen until the conduit was removed from the floor. When the lines were moved during the first inspection as mentioned, it so happened that the bare part of the grounded wire was moved away from the conduit, which accounted for the mysterious way the trouble was cleared at the first trial. It is supposed that after staying in that position for a few hours, it had again moved by jarring caused by the slight vibration of the motor. Upon inspecting the conduit, it was found that water occasionally splashed over from the open jackets of a small vertical compressor near-by and had found its way into the conduit through the end fitting near the motor, which was so located as to allow of that happening. This trouble was overcome by placing an elbow on the conduit so as to point the end fitting horizontally, as shown at *B*. When testing for grounds in conduits, both ends of wires should be disconnected and tests made before moving wires.



MOTOR AND CONTROLLER INSTALLATION

I. S. Chamberlain.

Jersey City, N. J.

Inquiries of General Interest

Equalizing Cutoff of Single-Valve Engine—How can the cutoff of a single-valve automatic engine be made the same for each end of the cylinder? J. C.

The cutoff can be equalized for any particular load by adjusting the length of the valve rod, and for most valve gears thus adjusted, the cutoff will be practically equal for all loads.

Exhaust Lap—What is meant by "exhaust lap"? A. C.

The "lap" of a valve is the distance the valve overlaps its port when the valve is in the middle of its travel. Exhaust lap is the lap of an exhaust valve. In a "D" slide valve "exhaust lap" is sometimes defined as the distance between the exhaust edge of the valve and the near edge of the steam port when the valve is in its mid-position.

Chattering of Spring-Loaded Safety Valve—What causes a spring-loaded safety valve to chatter or rumble on its seat, and how can it be remedied? H. H.

Chattering or rumbling occurs when the pressure is just enough to balance the valve, but not enough to hold the valve clear of the seat. The chattering or rumbling will be of duration for less time by adjusting the blow-down ring for greater blow-down.

Greatest Expansion at Temperature of Freezing—When water pipes are burst by freezing, at what temperature does the rupture occur? T. P. M.

Rupture usually occurs while the water is passing to the solid state or when the temperature has been returned to the freezing point, which for quiet water at atmospheric pressure is 32 deg. F. and for higher pressures is about 0.0135 deg. F. higher for each additional atmosphere of pressure. During the freezing process the volume becomes about 8½ per cent. greater than water at the same temperature, or the volume may increase a slightly less amount when the original water has been freed from air by boiling. After ice has formed, a reduction of its temperature causes contraction, and reheating to the freezing temperature causes expansion back to the initial ice volume, and the latter may cause rupture of a pipe from local accumulation of the expansion of volume.

Best Thickness of Fire for Forcing Boiler—Can a boiler be forced hardest by carrying a thick fire or a thin one? L. B. R.

The thickness of fire with which a boiler can be forced hardest depends on the denseness of the fuel bed and the draft available. The greatest heat will result from the thickest fuel bed for which the draft is sufficient to supply air necessary for complete combustion, and the greatest absorption of heat or forcing of the boiler will occur when the air supply is not in excess of 1½ to 2 times the theoretical requirement for perfect combustion. More air becomes a vehicle of heat wasted in the chimney gases. Hence the thickness of fire that is most advantageous for forcing a boiler with a given draft cannot be predicted without recourse to trial or analysis of results obtained with given sets of conditions. Under ordinary conditions of draft, fuel and grate area, the greatest forcing can be accomplished with fires carried 3 to 6 in. in thickness.

Pump Fails To Empty Receiver—The feed pump of a pump and receiver apparently in good working order fails to operate at sufficient speed to keep down the water level in the receiver. How can the pump be made to run faster? N. S.

If the pump is in good working order, it may be that it is prevented from operating at a higher speed by excessive back pressure on the discharge or on the exhaust. To ascertain whether the trouble is with the discharge pipe it should be disconnected, and if the pump then runs at a good speed, the trouble comes from back pressure that may be caused by stoppage, excessive pipe friction or attempting to discharge against excessive head pressure. Putting a bleeder connection in the foot of the steam exhaust pipe will show whether the trouble is not due to back pressure of the exhaust. Such a drip always should be employed and left open so there will be no accumulation of condensation to cause back pressure. If the pump and connections are suitable for obtaining normal speed when the float-operated valve is held open, then if it will not work fast enough when operated by the float-controlled valve it may be assumed that the float is set too high or is otherwise prevented from opening the float-controlled steam-supply valve.

Size of Conductors for a Direct-Current Motor—How can the size of the conductors be determined for a 25-hp. 220-volt motor, full-load current 92 amp.? The motor is located 325 ft. from the generator. J. S.

The size of conductors for a two-wire circuit may be found by the formula,

$$\textit{Circular mils} = \frac{21.4ID}{E_d}$$

where I = the current in amperes, D = the length of the circuit one way in feet, and E_d = the volts drop in the line. The volts drop should not be allowed to exceed 5 per cent. For distances under 500 ft. 3 per cent. is a better practice. As 3 per cent. of 220 volts is 6.6, then,

$$\textit{Circular mils} = \frac{21.4 \times 92 \times 325}{6.6} = 97{,}000$$

The nearest larger standard size is a No. 0, B. & S. conductor. This is also the smallest size that can be used in this case, since the National Board of Fire Underwriters' Code specifies that for direct-current motors the circuit capacity must exceed the normal rating of the motor in amperes by 25 per cent. A No. 0 rubber-covered conductor is rated at 125 amp., therefore it has ample capacity to meet the code requirements for a motor rated normally at 92 amperes.

Boiler Horsepower and Coal Required to Heat Water—With evaporative economy under actual conditions of 7 lb. of water per pound of coal and steam at 90 lb. boiler pressure, what quantity of steam and of coal would be required to heat 22,000 gal. of water from 40 deg. F. to 160 deg. F. and what boiler horsepower would be required to heat the water in 10 hours? H. S.

Each pound of water would receive 160 — 40 = 120 B.t.u., and as 22,000 gal. of water would weigh 22,000 × 8⅓ = 183,333 lb., the water would receive 183,333 × 120 = 21,999,960 B.t.u. A pound of steam at 90 lb. boiler pressure contains 1187.2 B.t.u. above 32 deg. F., and when condensed and cooled to 160 deg. F., or 128 deg. above 32 deg. F., each pound would part with 1187.2 — 128 = 1059.2 B.t.u. and under the conditions raising the temperature of the water would require 21,999,960 ÷ 1059.2 = 20,770 lb. of steam. With a boiler economy of 7 lb. of water evaporated per pound of coal, this would require 2967 lb. of coal. A boiler horsepower is equivalent to the evaporation of 34½ lb. of water from and at 212 deg. or 33,479 B.t.u. per hour, and as the heat transmitted to the water would amount to 21,999,960 ÷ 10 = 2,199,996 B.t.u. per hour, the expenditure of steam for heating the water would be at the rate of 65.71 boiler horsepower. The estimates given do not include any allowances for heat lost by radiation from the surfaces of the water heater or the steam-supply pipe.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

How Fuel May Be Saved

Two papers presented before the Providence Engineering Society, one by Prof. William H. Kenerson, of Brown University, and the other by Henry W. Ballou, of Jencks & Ballou, consulting engineers, discuss means for the alleviation of the present serious fuel situation and the prevention of waste in the use of steam.

THE Providence Engineering Society held one of its most successful fuel-conservation meetings, Wednesday, Feb. 13, at its headquarters, 29 Waterman St. The meeting was under the direction of the Power Section and was presided over by Warren B. Lewis, of Providence. The first paper, "The Fuel Situation as It Confronts New England," by Prof. William H. Kenerson, of Brown University, Providence, and a paper on "The Abuse of Steam," by four local engineers, read by Henry W. Ballou, follow:

THE FUEL SITUATION AS IT CONFRONTS NEW ENGLAND

Two-thirds of the coal mined in this country is used for generating steam, and of this it is probable that 10 per cent., at least, can be saved. Instead of a shortage of 50,000,000 tons of coal this year, it is likely that there might have been an actual excess over requirements if the preventable wastes had been eliminated. The large public utilities and some of the more progressive manufactures have long since carefully studied and met the situation, but to many users fuel has been such a relatively small item in the total cost of production that the desirability of saving in this direction has not occurred to them. So long as the wheels go round and the plant is comfortably heated, and coal can be easily obtained when wanted, there are too many things of greater immediate importance to claim attention. Now it is not only a desirable economy but a patriotic duty to conserve coal. It has been my good fortune to know a considerable number of the men who immediately control the coal pile, and I know that many are well informed and desirous of getting the most out of fuel. For example, the National Association of Stationary Engineers conducts educational lectures by experts. The burning of coal is a complex chemical problem, and it is no more reasonable to equip a man with a nicked shovel and a woolen cap, which he can use as a pad to hold a hot slice bar, and then expect him to get the best results out of the fireroom, than it would be to turn a chemist loose in a dye works, without balance and graduate, and expect him to get uniform and satisfactory results. And so you see that it is very necessary that we educate the man who hires the man who shovels the coal. He must know what is involved in the burning of coal and that the knowledge of his fireman cannot be utilized unless he is given some facilities which will help him to determine the conditions of his plant and some expert advice from time to time in solving problems as they arise.

In principle, however, the burning of coal is a simple matter. All that is necessary is to thoroughly mix the proper proportions of fuel and air and maintain the whole, including the gases evolved, at such a temperature that the chemical action resulting will be accompanied by the maximum evolution of heat. Then all that remains is to transfer as much of the heat as possible into the water in the boiler. The manufacture of pig iron is just as simple. All that is necessary is to mix the right proportion of iron ore, coke and limestone together, maintain a proper temperature by supplying air to the burning coke and draw off the iron, slag and gases from the blast furnace. But in the latter case the ingredients are carefully weighed and the resulting product is analyzed, all under the eye of an expert chemist, while in the boiler room reliance is often placed on more or less shrewd guessing and no fault is found unless the steam pressure drops. If the guess is wrong and too much air is used, a lot of heat is lost. If the guess is wrong and too little air is used, still more heat is lost. In either case the loss can be made up by simply shoveling in more coal, and nobody knows the difference and nobody cares. Every steam plant needs certain facilities for the determination of facts, together with intelligent supervision. Please do not understand by this that I advocate elaborate plant tests or analyses of fuel at this time. At present we will not question a lump of coal regarding its pedigree if it chances to come our way nor condemn it if it does not contain 14,500 B.t.u. per pound. We are overjoyed to get any kind of coal. Certainly in many cases a complete plant test would be a waste of time and of money. But to deprive the boiler room of measuring devices which show what is going on is as absurd as it would be to deprive the merchant and manufacturer of the yard stick, quart measure or set of scales. The boiler room should at least be provided with means for measuring water and weighing coal, and in addition it would usually be well to provide means for analyzing flue gases. Large sums of money are spent in the boiler and engine rooms and it is as essential that some system of accounting be installed as in any other part of the plant. Incidentally, this makes possible a bonus system based on fuel saved, which in many cases has worked out well. Entirely apart from such a system, however, the men who run steam plants will, in nearly all cases, welcome the opportunity to know the facts that they may better the conditions. Although I have studied many steam plants, I have yet to meet a man in charge who was in any way antagonistic. In most cases they are eager to help in improving conditions. It remains for the manufacturers to capitalize that interest by assisting them with measuring appliances, competent advice and supervision. The return in dollars and cents would be well worth while, and at the same time the present coal crisis would be relieved in the most sensible and logical way.

There is one other way in which many plants could save fuel. Power can be produced in the large central stations far more cheaply than in some small isolated plants. Where there is relatively little use for exhaust steam either for heating purposes or in the processes, coal can be saved by purchasing the power.

THE ABUSE OF STEAM

The aim of this paper is to contribute to the current public discussion on the conservation of coal. It is an endeavor to combine and set forth some of the views of four local engineers who have had experience with the more popular methods of wasting steam in Rhode Island.

There is today within fifty miles of Providence an industry employing 5000 people, which is the last word in systematic scientific management. Its prime movers consist of no less than six small noncondensing engines. For half of the year nearly all the exhaust steam belches to the atmosphere; for the other half a large part is used for heating. The hot drip from the heating system, instead of being returned to the boiler, flows to the sewer, while the annual bill for the feed water amounts to several thousand dollars. There are literally hundreds of similarly flagrant cases.

What the typical Rhode Island manufacturer needs to help him conserve coal is not information about the refinements of the economic use of steam, but ceaseless reiteration of the simplest platitudes about steam. Platitudes as simple as this:

If steam can be seen anywhere out of doors, coal is being wasted.

Another platitude would be:

Are your steam traps and valves leaking coal all of the time? Do you have periodic inspection and reports as to their condition?

These platitudes are ridiculously elementary, but it is doubtful if one plant out of fifty in Rhode Island has any periodic inspection and reports on these vital matters. For illustration, about a year ago the owner of a new plant using central-station electric power complained that his heating system took too much steam and that his boiler plant was not of sufficient capacity. On investigation it was found that the otherwise frozen ground was soft and moist for a considerable distance around a certain cistern. The bypass on a steam trap serving the sprinkler tank had been carelessly left open, and live steam to the tune of several tons of coal per day had been wasting through the trap into the cistern for several months. This is typical Rhode Island cause of deficient boiler capacity.

Steam Traps—Hundreds of cases come under observation where steam traps are either leaking or are bypassed and where the leakage is a source of direct waste. The discharge from traps is frequently connected directly to the sewer or to mill trenches where leakage is invisible, and waste may go on for months and even years undetected. This subject of leaky traps is a long story, but therein lies a great possibility. Nearly every steam plant has steam traps, and sometimes there are hundreds of steam traps in a single manufactory. Yet it is probable that not one plant in ten has its traps so equipped and connected that they can be readily tested for leakage. It is the opinion of a number of engineers that of all the steam traps in Rhode Island today, probably over 75 per cent. are either leaking, are bypassed or are in some way failing to serve their purpose purely for want of regular supervision.

Lax Operating Conditions—There is a large finishing plant in which, a few years ago, an engineer was "turned loose." Within a few months the load on the boilers was reduced fully 1000 boiler horsepower with practically no expense for new equipment, but simply by stopping gross leakage and waste. The most obviously needful changes were often secured with difficulty or secured only in part. In one department there were three sets of large can driers, each set being served by a 2-in. live-steam pipe and a 6-in. exhaust-steam pipe. Steam was kept turned on in both pipes at the same time, despite repeated protests to the manager, the master mechanic and the chief engineer. Of course the live steam was immediately reduced to exhaust-steam pressure, to the end that large quantities of steam went to waste through the back-pressure valve in a remote part of the low-pressure piping system without the slightest advantage to the driers. This is an excellent illustration of the objections to having high- and low-pressure connections to any one piece of apparatus.

This same plant had a large air compressor driven by a cross-compound Corliss engine. It was desired to carry a nearly constant pressure in the compressed-air receivers, and to accomplish this the engine was throttled by hand, running probably 95 per cent. of the time at a speed below which the valves would cut off automatically; in other words, taking steam the full stroke. This engine was equipped with a surface condenser which was not in operation, the engine exhausting directly to the atmosphere. A test was made of the engine as found running, and again when operating condensing and with the valves cutting off properly. It was found that the saving due to operating the outfit as intended by the makers was in excess of 125 boiler horsepower.

Blowoff Valves—Probably not one steam boiler out of a hundred in Rhode Island has the boiler blowoff valves so arranged that they may be readily tested for leaks. Moreover, it is fashionable to submerge the end of the blowoff pipe in some river or brook so that no offensive steam cloud caused by leakage will be perceptible. The blowoff platitude would be as follows:

Are the blowoff valves so connected that they may be readily tested every day?

Pipe Covering—Pipe covering is almost an axiom of steam economy, yet there is no systematic periodic inspection and recorded report on the condition of this most thrifty means of saving coal. It is a popular custom not to cover the flanges because of the inconvenience when a joint leaks.

Excessive Back Pressure on Engines—Where steam is used for heating and drying purposes, it is often economical to operate engines and other prime movers against back pressures. Under these conditions every effort should be made to have this back pressure as low as possible. In one instance, where a single back-pressure gage was in use, it was stated that 1 lb. back pressure was all that was required. But the gage in use and which indicated a pressure of 1 lb. was found to be nearly 4 lb. in error due to faulty piping, and the back pressure was in consequence nearly 5 lb. The platitude in this case would be:

Test the pressures periodically.

In many cases the back pressure has been reduced owing to a more efficient circulation of steam by vacuum heating systems or other means. Plants running condensing can frequently obtain a better vacuum by eliminating air leaks, etc. It is not unusual to find a poor vacuum caused by insufficient condensing water which latter is caused by obstructions in the piping such as leaves and accumulations of foreign matter.

Back Pressure and Reducing Valves—At least four cases have been observed by one engineer where live steam was blowing directly to the atmosphere in large quantities through the low-pressure steam system. These were in the case of a supposedly insufficient supply of exhaust steam, where live steam was being admitted to make up the supposed deficiency. At the time the live steam was being admitted through a reducing-pressure valve or by hand control, the back-pressure valve was partly open, allowing the escape of steam direct to the atmosphere. The remedy is to install properly sensitive back-pressure and reducing-pressure valves so arranged and set as to pressures that it will be impossible for such waste to occur.

Heating Systems—As a general statement it can be said that little or no attention is paid to securing economical operation of heating systems for buildings. Many plants operating noncondensing engines have a surplus of exhaust steam available for heating at all times when the prime movers are running. Under these conditions this steam is likely to be carelessly used, there being a feeling that because it is exhaust steam and there appears to be no other use for it, it is not necessary to use it economically, the result oftentimes being that radiation is not properly trapped and that various drains and bleeders discharge directly to the sewer. Under these circumstances waste of live steam occurs at night and on holidays, at such times as the heating system must be operated with live steam, which in this climate in an ordinary manufacturing plant is a considerable number of hours yearly. Obviously, all open ends become sources of waste when live steam is in use.

Exhaust steam, where available, can frequently be substituted for live steam in heating coils with slight changes in the equipment.

In some cases it has been found possible to extract a certain amount of steam from a compound condensing engine or turbine, such steam first performing a certain amount of mechanical work and then giving up its latent heat (amounting to 90 per cent. of the total heat) to the heating system. A specific instance may be noted where in a cotton-mill plant, the steam which passes through one of the turbines is used in the heating system during the winter months, the unit being operated condensing in the summer months. This is a change made during the present winter which has resulted in a reduction of the load on the boiler plant amounting to more than 200 horsepower.

Hotel-heating systems are as a rule very wasteful, because there is a great tendency toward overheating. Many mills, office buildings, etc., are overheated during most of the winter months. Automatic temperature regulation is in many cases a desirable and profitable adjunct to a heating system, for it prevents overheating.

Some of the older vacuum heating systems are wasteful in that considerable quantities of water are required at the vacuum pump to assist in maintaining a vacuum. This condition is frequently caused by improper automatic expansion valves on the return ends of radiators, in many cases it having been found that the interiors of the valves have been entirely removed, allowing the steam to be pulled through into the return line. Several cases have been observed where large quantities of water were being injected into the vacuum pump and delivered by the pump to an open heater or receiver, and from there overflowing (in the form of hot water) to the sewer.

Leaks—Leaks in pipe joints and flanges are a source of waste larger than is sometimes supposed. The cumulative effect of a wee jet of steam moving perhaps a mile a minute during 24 hours a day is considerable.

Most plants keep their piping systems fairly tight where the pipes are in plain view; but leaky joints on hidden pipes, leaky valves on connections between live and exhaust systems and on drains, etc., are common. It has been found helpful in large plants having many piping connections, to go through the plant late at night when everything is quiet (both out of doors and inside), at which time it is easier to detect the sound of escaping or leaking steam.

Large plants should be equipped with valve reseating tools and should use them whenever necessary to maintain all steam valves in proper condition. This is another matter that should have systematic attention.

Heating of Water—It is quite common in plants using large quantities of hot water to find this water being heated by live steam, while at the same time exhaust steam is being wasted to the atmosphere. This matter needs little comment as it is obvious that great economies can be effected by using exhaust steam for this purpose.

Boiling with Live Steam—In cloth-finishing plants and dyehouses there are many processes, the nature of which makes it necessary to boil large tubs of water with direct steam and maintain them at the boiling point sometimes for hours. Large wastes can occur in this operation, because the amount of steam that can be turned into apparatus of this sort is limited only by the sizes of pipe connections thereto. It is evident that the temperature cannot be increased after the liquid reaches the boiling point. This is a difficult matter to control, as the men handling such apparatus are usually not in the least interested in where the steam comes from or in what it costs.

Automatic temperature regulation can be applied to some work of this character under some conditions, but the sovereign remedy is systematic, skilled oversight and eternal vigilance.

Insufficient Boiler Capacity—Another instance of the typical Rhode Island cause of insufficient boiler capacity may not be irrelevant. The management of a thriving manufactory suddenly concluded that its steam supply was inadequate. It was immediately realized that two new boilers and a new chimney and appurtenances were needed, *and in a hurry*. (Intense hurry is apt to be one of the most distressing symptoms of this disease.) It is the usual custom in such cases to ask the gentlemen who sell boilers and other things to supply the engineering. They do engineering free of charge. But in this instance the management called in an engineer. Instead of installing two new boilers, he shut down one of the old ones. At the end of the next year, during which the business had increased by some millions of yards of cloth, the cost of coal consumed had decreased $8000. This saving was attained by stopping the waste of steam in the dyehouse and by using exhaust steam.

Exhaust steam was used to preheat large quantities of water, instead of putting cold water into dye tubs and bringing it to a boil with live steam as was done previously.

Exhaust Steam—There is, on the part of owners and managers, a universal prejudice against exhaust steam. This prejudice also extends to superintendents and foremen, and it becomes virulent with the workmen. They all know that high-pressure steam will make more commotion and racket than exhaust steam. They know that high-pressure steam will make water boil harder. Most manufacturers are confident that there is some magic property in live steam that is lacking in exhaust steam, even at the same pressure; their head dyers tell them so.

A large part of the failure of some exhaust-steam systems is attributable to a feeling that exhaust steam is cheap—doesn't cost anything—and may therefore be wasted with impunity.

A perpetual campaign of education, remonstrance and expostulation is necessary to prevent the waste of both live and exhaust steam in dyehouses and finishing plants. In the previously mentioned plant where the coal bill was reduced $8000 in a year of increasing business, it is safe to say that the gain would have all been lost in the following year if previous conditions of oversight and management had been resumed.

Platitudes for exhaust steam should be about as follows:

Nine-tenths of the coal used in making steam goes into latent heat.

In making steam nine-tenths of the coal is used before we get an ounce of steam pressure.

When you waste exhaust steam, you waste nine-tenths of the coal used in making live steam.

There are many processes where, with slight changes in the method of drainage, etc., exhaust steam may be used in place of live steam. This is particularly true in cloth-finishing plants, paper mills, rubber works and similar industries, where large quantities of materials have to be dried.

One of the most prolific sources of waste is in the throwing away of the condensed steam in the form of hot or warm water. It should be the aim of every manager to see that no heat is lost to the air or to the sewer which may be recovered.

Enemies Within

It is unfortunate that there can be no powerful government or great industry without its traitors. Often such enemies are fanatics who believe they are right while all others are wrong. The anarchist who plants a bomb to correct a seeming injustice risks his neck and is an honest gentleman compared to that Judas in the coal industry who today is allowing the shipment of dirty coal, and accepting record prices for a product he couldn't possibly sell in normal times.

"That's strong language," you say; and I reply, "It isn't strong enough to fit the case." Furthermore, let it be understood I wouldn't make such an accusation if I hadn't seen with my own eyes many times in many places instances of such a reprehensible practice. Yesterday I saw 60 tons of coal that cost a lot of money that couldn't even be burned without being mixed with real coal of decent quality.

The dishonest clerk who short-changes his customer is a thief, but he hurts only a few people and harms himself most. Here is what the dishonest coal shipper does today:

He is damning an industry that has developed through the exercise of greater individual courage and the endurance of more personal hardship than any other important business.

He is causing the finger of public condemnation to be pointed at honest, conscientious coal operators who have spent a lifetime in the organization and development of reputable mining companies.

He is wilfully and certainly bringing about a situation that can have no other outcome than to deprive efficient mining men of control of their own business, and to hasten government direction of mining, if not Federal ownership.

However, these are only a few of the little things. Here is something more serious:

The very existence of this United States depends on our overthrowing German autocracy. The weak link in our entire war program is transportation. This deficiency in the last three weeks has caused our nation a billion-dollar loss through suspended effort.

Here is what the dishonest coal shipper accomplishes.

The railroads of the United States haul about 1800 million tons of freight yearly; approximately 35 per cent. of this freight is coal. Some coal is sold locally and considerable is used at the mines. Assuming that 630 million tons will be shipped over the railroads this year, it will require 12,600,000 fifty-ton cars to move this output.

Nine per cent. of ash is a normal quantity for American coal. If numerous recent investigations are at all accurate, there is at least 9 per cent. additional adulteration in the coal now being shipped in America. Coal carrying 18 per cent. refuse has but 63 per cent. of the fuel value of coal carrying 6 per cent. ash and requires the transportation of 37 per cent. more coal than is necessary. In certain localities the transportation facilities, due to dirty coal, are being taxed as much as 35 per cent. above normal requirements.

With coal carrying 6 per cent. ash, eight boilers are required to generate 300,000 lb. of steam per hour. With 20 per cent. ash, 19 boilers are required. A certain tonnage of coal running 6 per cent. in ash requires 11 cars to transport it; coal having the same fuel value, but running 20 per cent. ash, requires 17 cars to move it.

For every additional 1 per cent. of impurities in the nation's annual coal production the railroads must haul more than five million tons of useless waste. Coal adulteration means more boilers, more firemen, increased fuel demand and more ash handlers. It is further true that as the percentage of ash in coal increases, the percentage of combustible matter lost in the ashes increases.

It is physically impossible to mine and market coal that contains no noncombustible matter, but when the impurities in our total production average more than 10 per cent., a despicable crime is being perpetrated. The coal industry must rid itself of the pirates that would destroy it, and it is urgent that effective action be taken at once.—*Floyd W. Parsons in Coal Age.*

Why Support the A. A. E.?

The following is from a circular issued by the Committee on Ethics and Coöperation, American Association of Engineers, Isham Randolph, chairman, consulting engineer; W. H. Finley, chief engineer, C. & N. W. Ry.; F. H. Newell, head of School of Civil Engineering, University of Illinois.

A question often asked when the A. A. E. is under discussion is "What is the need of another national society of engineers?" The answer is it is because we are awakening to the fact that the engineers are not occupying their full position of usefulness. The curious anomaly exists that although the victories of war and peace are those of the engineer, yet in most of these the engineer is occupying a secondary place; because of this fact he is unable individually or collectively to utilize his ability to the largest good of mankind. For the last ten years this has been discussed in a more or less abstract manner. Morris L. Cooke in 1908 called attention to the fact that while other professions and lines of business have awakened to the need of definite action, the engineers have been singularly conservative. Dr. Talcott Williams has called attention to the fact that the profession which gives "this age in the various works and achievements of engineers its crowning difference from other ages has less weight in public affairs and on public opinion from any other." "Modern life pays little attention to the word of the engineer." "The engineer will never stand where he should in the state until he discharges his duty at this point (of coöperation and information)."

These quotations taken from among scores that might be used, indicate a condition which, while widely appreciated, has not yet been definitely entered upon by any engineering organization in the same way in which the A. A. E. is acting. Unlike other societies its main object is not mainly that of meeting to discuss technical papers, but rather, not neglecting these, to concentrate on the human matters—the things which affect the engineer as a man and citizen as well as an engineer. It goes into employment because it is the foundation for the success of the individual. Other societies have neglected this fundamental point or at least have given it merely perfunctory attention. The American Association believes in doing what other professional and business organizations are doing for the mutual advancement and protection of the highly trained man from the undermining influence by the unskilled or incompetent. It goes into publicity, advertising if you please, not for the benefit of the individual but of all engineers, because it believes that engineers as a whole will be benefited to the extent that the public knows about the work already performed or of the position to be achieved, which can be realized when the public really understands what can be gained in greater health, comfort and prosperity.

It goes into politics, not the partisan kind, but into the science or practice of the original meaning of the word, that of helping to direct affairs of public policy, of the greatest good to the greatest number. It believes that every intelligent, educated man or engineer educated largely at public expense, should individually and collectively devote a part of his time to the affairs of the community, especially those which touch the practice of engineering. Ours is a political government and every citizen is vitally interested in politics and every engineer who does not take an intelligent interest in public questions and array himself in the cause that appeals to his reason and sense of right, fails in duty to himself, to his community and to his country. Engineers have fallen far short of their duties and privileges in this respect.

Why is it that engineers have done so little in this direction? It is because the older societies established precedents that have hampered growth in public affairs. They were early impressed with the danger of being considered unprofessional or falling into the category of commercialism. They have prided themselves on keeping away from the very subjects that are most vital to the majority of members of the engineering societies. There is no class of educated people more bound to traditions in this regard than the engineer, nor none who have made slower progress toward efficiency in their own organizations.

Illuminating Engineers Hold Special Meeting

On Thursday evening, Feb. 14, 1918, in the Engineering Societies Building, New York City, the Illuminating Engineers held a special meeting for the purpose of discussing the saving of coal by lighting curtailment. The meeting was formally opened with a short address by G. H. Stickney, president of the society, after which Preston S. Millar, chairman of the Committee on War Service of the Illuminating Engineers, presented his paper on "Lighting Curtailment." An abstract of this paper will appear in an early issue of *Power.*

The discussion was opened by J. W. Lieb, chairman of the National Committee on Gas and Electric Service, of the Council of National Defense. During Mr. Lieb's address he read a resolution, filed with Dr. Harry A. Garfield, National Fuel Administrator, setting forth what his committee believes to be the attitude of the electric-light and power companies of the country on the question of sign lighting in its relation to national fuel conservation. The resolution minus the whereases read as follows:

Resolved, that the public-utility companies throughout the United States through their organization, the National Committee on Gas and Electric Service, of the Council of National Defense, representing the gas companies—manufactured and artificial—the electric-light and power companies, the water-works companies and the central steam-heating companies throughout the country, pledge their hearty support and coöperation to the national authorities in carrying out any plan or regulation for the saving of fuel, gas, oil or electricity which the national authorities in the public interest may consider it necessary to adopt as a war measure.

Morton G. Lloyd, of the National Bureau of Standards, Washington, D. C., called attention to the tremendous waste of fuel due to overheating our buildings, residences being the most uneconomical and industrial plants almost as bad in their methods of burning coal. Mr. Lloyd took the opportunity to criticize the coal operators of the country for the poor quality of coal that they have been supplying, pointing out that there might be some excuse for doing this if the mines could not produce sufficient quantity, but if the operators' claim, that the coal shortage is due entirely to lack of transportation, is true, then there is no excuse for shipping the extremely low grades about the country.

Many others took part in the discussion, and the general opinion expressed was that every effort possible should be made to save coal by the curtailment of all unnecessary lighting, but that the amount of fuel that could be saved by the elimination of waste in other directions was so great that the possible saving by the curtailment of light becomes almost insignificant in comparison.

Probably one of the most disappointing features to many who attended the meeting was the absence of representatives from the national, state and municipal fuel administrations. Representatvies from each of these bodies had been invited to take part in the discussion, but for some reason failed to avail themselves of this opportunity.

The address of C. M. Griffin should be 114 First St., Newburgh, N. Y., instead of 114 Spruce St., as given in the article on page 183 of *Power* for Feb. 5, descriptive of his condenser-tube cleaner.

Electricity To Solve the Fuel and Transportation Problems

By E. W. Rice, Jr.

President, General Electric Co. and the A. I. E. E.

An address delivered at the opening session of the midwinter convention of the American Institute of Electrical Engineers, held in New York City, Feb. 15 and 16, 1918. The speaker sets forth the tremendous saving in fuel that can be accomplished by a universal electrification of our steam railways, also that at least 50 per cent. increase in available capacity of existing tracks can be obtained by substituting electricity for steam in the operation of the railroads in this country.

MEMBERS of the electrical profession and industry have reason to be pleased with the contributions which they have made for the benefit of the world. While we are glad to think that our science and our industry are fundamentally devoted to the products and conditions of peace, we realize that in the electric light, searchlights, the X ray, telephones, telegraph, wireless apparatus, electric motors, etc., electricity plays an important part in the grim business of war.

We are in the midst of an extraordinary coal famine, due to causes which it is perhaps undesirable for us to attempt to outline. However, I would like to point out how much worse the situation might have been were it not for the contributions of the electrical engineers; and also how much better our condition might have been if our contributions had been more extensively utilized.

Electricity Increased Coal Production

Suppose we assume that the present serious situation is due to a lack of production of coal. It is comforting to consider to what extent conditions surrounding such production have been improved and how the output of our coal mines had already been increased by the use of electrical devices in connection with coal mining—such for example as the electric light, electric coal cutters, electric drills and electric mining and hauling locomotives. I have no figures before me, but I think it is a fair assumption that the output of coal mines should have been increased at least 25 per cent. on the average by the employment of such electrical devices. If this estimate were cut down to 10 per cent., it would still leave a possible increase in the coal produced of something like 50,000,000 tons during the past year.

If, on the other hand, our situation is not due to a shortage in the production of coal, but rather to the failure of the distributive agencies of the country, which is more probable, it is interesting to see how this difficulty would have been largely removed if the railroads of the country were operated by electricity instead of steam.

Where electricity has been substituted for steam in the operation of railroads, fully 50 per cent. increase in available capacity of existing tracks and other facilities has been demonstrated. This increased capacity has been due to a variety of causes, but largely to the increased reliability and capacity, under all conditions of service, of electric locomotives, thus permitting a speeding up of train schedules by some 25 per cent., under average conditions. Of course, under the paralyzing conditions which prevail in extremely cold weather, when the steam locomotives practically go out of business, the electric locomotives make an even better showing. It is well known that extreme cold (aside from the physical condition of the traffic rail) does not hinder the operation of the electric locomotive, but actually increases its hauling capacity. At a time when the steam locomotive is using up all its energy by radiation from its boiler and engine into the atmosphere, with the result that practically no useful power is available to move the train, the electric locomotive is operating under its most efficient conditions and may even work at a greater load than in warm weather. It may therefore be said that cold weather offers no terrors to an electrified road, but on the contrary it is a stimulant to better performance instead of a cause of prostration and paralysis.

But this is not all. It is estimated that something like 150,000,000 tons of coal was consumed by the railroads in 1917. Now we know from the results obtained from such electrical operation of railroads as we already have in this country that it would be possible to save at least two-thirds of this coal if electric locomotives were substituted for the present steam locomotives. On this basis there would be a saving of over 100,000,000 tons of coal in one year. This is an amount three times as large as the total coal exported from the United States during 1917.

Coal Restricts Capacity of Railroads

The carrying capacity of our steam roads is also seriously restricted by the movement of coal required for haulage of the trains themselves. It is estimated that fully 10 per cent. of the total ton-mileage movement behind the engine drawbar is made up of company coal and coal cars, including in this connection the steam-engine tender and its contents. In other words, the useful or revenue-carrying capacity of our steam roads could be increased about 10 per cent. with existing track facilities by eliminating the entire company coal movement.

I have not mentioned the consumption of oil by the railroads, which we are told amounted in 1915 to something like 40,000,000 bbl., nearly 15 per cent. of the total oil produced. This fuel is entirely too valuable to be used in a wasteful manner. It is important for many reasons that such a wonderful fuel as oil should be most economically used, if for no other reason than that it will be needed for the ships of our forthcoming merchant marine, for the tractors that till our fields, and for the motor trucks that serve as feeders to our railways.

The possible use of water power should also be considered in this connection. It is estimated that there is not less than 25,000,000 hp. of water power available in the United States, and if this were developed and could be used in driving our railroads, each horsepower so used would save at least 6 lb. of coal per horsepower-hour now burned under the boilers of our steam locomotives. It is true that this water power is not uniformly distributed in the districts where the railroad requirements are greatest, but the possibilities indicated by the figures are so impressive as to justify careful examination as to the extent to which water power could be so employed and the amount of coal that could be saved by its use. There is no doubt that a very considerable portion of the coal now wastefully used by the railroads could be released to the great and lasting advantage of the country.

Water Power Allowed To Run to Waste

The terrors of these "heatless days" will not have been without benefit if they direct the attention of the people and of our law makers to the frightful waste of two of our country's most valuable assets—our potential water power and our wonderful coal reserves. The first, potential water power, is being largely lost because most of it is allowed to run to waste, undeveloped, unused. The second asset, coal, is wasted for exactly the opposite reason. It is being used but in an extravagant and inefficient manner.

Our waterfalls constitute potential wealth which can be truly conserved only by development and use. Millions of horsepower run to waste every day, which, once harnessed for the benefit of mankind, become a perpetual source of wealth and prosperity.

The amount of coal in our country is enormous, but it is definitely limited. While Providence has blessed us with a princely amount of potential riches in our coal beds, it is known that there is a finite limit to the amount of coal so stored and when this coal is once exhausted, it is gone forever. It is really terrifying to realize that 25 per cent. of the coal that we are digging from the earth each year is burned to operate our railroads under such inefficient conditions that an average of at least 6 lb. of coal is required per horsepower-hour of work performed.

The same quantity of coal burned in a modern central power station would produce an equivalent of three times that amount of power in the motors of an electric locomotive, even including all the losses of generation and transmission from the source of power to the locomotive. Where water power may be utilized, as in our mountainous districts in the West, all the coal used for steam locomotives can be saved. In the Middle and Eastern States, however, water powers are not sufficient and it will be necessary in a universal scheme of electrification that the locomotives be operated from steam-turbine stations; but as I have already stated, the operation of the electrified railroads from steam-turbine stations will result in the saving of two-thirds of the coal now employed for equivalent tonnage movement by steam locomotives.

Electrification Not an Inventor's Dream

It is, therefore, not too much to say that if the roads of the country were now electrified, no breakdown of our coal supply, due to failure of distribution, would exist. What this would mean for the comfort of the people and the vigorous prosecution of the war, I will leave for you to imagine.

Of course this picture, which I have briefly and inadequately sketched, of the great benefits which our country would have received if the roads had been electrified, does not improve our present situation and it may be claimed that any discussion of such a subject at this time is of an academic nature. This point of view is in a sense true, but I think that we can properly take time to consider it because of the effect which it may have upon our future efforts. This picture is not merely an inventor's dream, but is based upon the solid foundation of actual achievement. We have had enough experience upon which to base a fairly accurate determination of the stupendous advantages and savings which will surely follow the general electrification of the railroads; in fact, I think we can demonstrate that there is no other way known to us by which the railroad problem facing the country can be as quickly and as cheaply solved as by electrification.

The solution of the railroad problem would also "kill two birds with one stone" by solving the fuel problem at the same time.

If it is a fact, as has been stated, that the steam railroads of the country have failed to keep pace with the country's productive capacity—the increased output of manufacturing industries, the extension of agriculture and other demands for transportation—it is obvious that if the country is to go ahead, the railroad-transportation problem must be solved and it must be solved at the earliest possible date. It becomes a matter of national importance that the best solution should be reached in the shortest possible time. That solution is best which will give the greatest amount of transportation over existing tracks, in the most reliable manner and, if possible, at the lowest operating cost.

Every Element of Electrification Solved

We electrical engineers would not be justified in being so confident of the benefits of electrification of railroads if every element in the problem had not been solved in a thoroughly practical manner. The electric-generating-power stations, operated either by water or by steam turbines, have reached the highest degree of perfection, efficiency and reliability, while the transmission of electricity over long distances, with reliability, has become a commonplace. Electric locomotives capable of hauling the heaviest trains at the highest speeds, up and down the heaviest grades, have been built and found in practical operation to meet every requirement of an exacting service.

There is, therefore, no element of uncertainty, nothing experimental or problematical, which should cause us to hesitate in pressing our claims upon the attention of the country.

I realize that the task of electrifying all the steam railroads of the country is one of tremendous proportions. It would require under the best of conditions many years to complete, and demand the expenditure of billions of dollars.

The country, however, has clearly outgrown its railway facilities, and it would require, in any event, the expenditure of billions of dollars and many years of time to bring the transportation facilities up to the country's requirements.

It is not necessary that electrification should be universal in order to obtain much of its benefits. It is probable that one of the most serious limitations of our transportation system, at least in so far as the supply of coal is concerned, is to be found in the mountainous districts, and it is precisely in such situations that electrification has demonstrated its greatest value. Electrification of a railroad in a mountainous district will in the worst cases enable double the traffic to be moved over existing tracks and grades.

If a general scheme of electrification were decided upon, the natural procedure would be, therefore, to electrify those portions of the steam railroads which will show the greatest results and give the greatest relief from existing congestion. Electrification of such sections of the steam railroads would have an immediate and beneficial effect upon the entire transportation system of the country, and it is our belief that electrification offers the quickest, best and most efficient solution that is to be obtained.

It may be said that the present is not a propitious time in which to deflect any of the country's money into railroad electrification. I think that in spite of the enormous advantages of which I have spoken, we would be inclined to agree with such a point of view if it were not for the recent unpleasant demonstration of the failure of our railroad-transportation systems to meet the demands placed upon them by the industries, aggravated it is true by the war conditions and also by the unkindness of the weather.

After all, the question for the country to decide is whether we dare to limp along with the present conditions of restricted production, due to limited transportation, at a time when the world demands and expects from us the greatest possible increase in our efficiency and production.

What assurance have we that the present conditions are temporary? And even if they improve, as they will with the coming of warm weather, what are we going to do next winter? Of course, even if we should start electrification at once, we could not have all our railroads electrified by next winter, but we could have a good start, and as Sherman said about the resumption of specie payments, "The way to resume is to resume," so "The way to electrify is to electrify."

College of the City of New York Giving Boiler-Room Course

The College of the City of New York has offered a course in boiler and fuel economy, under Harry Baum, an engineering expert. The course is given at the college on Thursday evenings from 7:30 to 9:18. The first lecture was given Feb. 21, 1918.

The course is intended for such men as building managers and superintendents, operating engineers, firemen, public-school janitors, engineers, library janitors and others who have not had technical training, but who are interested in the subject.

The prerequisites for this course are a knowledge of simple arithmetic, common sense and an interest in the subject. The fee is $7.50, and for city employees $5. The course is under the direction of Frederick B. Robinson, City College, Convent Ave. and 139th St., New York City.

A. I. E. E. Midwinter Convention

The American Institute of Electrical Engineers held its sixth annual midwinter convention in the Engineering Societies Building, New York City, Feb. 15 and 16, 1918. On account of conditions due to the war, the Meetings and Papers Committee with the approval of the board of directors made this convention purely a business meeting, eliminating all entertainment features and excursions, so that instead of the convention occupying three days as in previous years, this season's sessions were curtailed to one and a half days. Four technical sessions were held at which nine papers were presented and discussed. Although, as would be expected, the attendance was smaller at this season's convention than in previous years (280 members and guests registering), it is doubtful if more enthusiasm and interest was ever shown in the meetings.

The first session, Friday morning, was devoted to the subject of "Circuit-Breaker Ratings," President E. W. Rice, Jr., occupying the chair. Mr. Rice addressed the meeting on the solution of the country's fuel and transportation problem by the electrification of our railways. This address appears in this issue, beginning on page 310.

One paper, "Rating and Selection of Oil Circuit-Breakers," by E. M. Hewlett, J. M. Mahoney and G. A. Burnham, was presented at this session. It was read by Mr. Burnham and discussed by Messrs. Hewlett and Mahoney. In this paper the authors discuss the interpretations of the A. I. E. E. Standardization Rules covering the rating of oil circuit-breakers and consider the variable factors involved in the selection of circuit-breakers for various systems. A method is suggested whereby short-circuit characteristics of various systems can be used for determining the proper selection of oil circuit-breakers for average systems. The method does not apply to very large systems or unusual conditions.

In the open discussion on the paper it was made evident that there was a need of some standard for the selection of electrical protective equipment. It was also brought out that, although oil circuit-breakers had been constructed that had ruptured as high as 500,000 kv.-a, there are so many variable conditions in systems on which circuit-breakers are used that it is impossible to give a simple rule covering the selection of circuit-breakers for all cases.

The Friday afternoon session was presided over by Vice-President L. T. Robinson. This session was devoted to the subject of "Meters and Measurements." Four papers were presented. The first, "A New Standard of Current and Potential," by Chester T. Allcutt, was given in abstract by the author. This paper describes a new secondary standard which is proposed as a substitute for the standard cell in certain classes of direct-current measurements. The device consists of a Wheatstone bridge which will balance for but one value of current. Various factors affecting the accuracy and permanence of the device are discussed and a number of curves are given showing the characteristics which have been obtained.

The second paper, "The Thermoelectric Standard Cell," by C. A. Hoxie, was also presented in abstract by the author. It considers a means of obtaining a secondary standard electromotive force by utilizing the voltage of a thermocouple. The standard thermo cell is fundamentally a standard of current, in that it requires a definite value of current to function properly. The operation of the cell consists in balancing the potential across a resistance against the thermoelectric em.f. of the thermocouple. This requires a definite value of current through a filament which is a source of heat for the thermocouple.

"The Character of the Thermal-Storage Demand Meter," by P. M. Lincoln, was read by the author. Following a detailed description of the principle and construction of the thermal-storage demand meter, the author shows wherein it always indicates what may be called "logarithmic average" rather than "arithmetic average" of power consumption, heretofore indicated by practically all demand meters. The inherent faults of the "arithmetic average," or "block interval" meter, are described and examples given demonstrating that the thermal-storage meter alone recognizes the true heating effect that fixes size of equipment and therefore cost that should be assessed against the customer. This paper will be published in abstract in an early issue of *Power*.

During the discussion of this paper the question was raised as to the justification of basing rates upon the maximum demand of the customer, the opinion being expressed that the diversity factor of the load on the system should be taken into consideration. In answer to this question Mr. Lincoln said that the cost of the equipment at the customer's load end of the line justified basing a rate upon the maximum demand of that customer, because the equipment to render service cost practically the same whether the customer used it continuously or for a short period only.

The last paper given at this session, "Measurement of Power Losses in Dielectrics of Three-Conductor High-Tension Cables," by F. M Farmer, was presented in abstract by the author. This paper describes the method used at the Electrical-Testing Laboratories for measuring the dielectric-power losses in 10-ft. samples of three-conductor cables with three-phase potential applied to the cable. The difficulties encountered and the methods employed to overcome them are discussed in considerable detail. Typical results are given in the form of data for two specimens of cable, one having a low power loss in the dielectric and one having a high power loss in the dielectric. The data are also presented in the form of curves.

The interest taken in this session was evidenced by the large attendance and the length of the session, which lasted from 2:30 until after 6 p.m.

Between the Friday afternoon and evening sessions an informal dinner was served at the Cafe Boulevard, Broadway and 41st St., 225 members and their guests attending. The dinner was followed by an inspiring address by President E. W. Rice, Jr., on what this country has accomplished so far toward the prosecution of the war, and the problems that lie ahead of us to win this great conflict. This lecture will appear in an early issue of *Power*.

The Friday evening session was presided over by President E. W. Rice, Jr., and was devoted to a lecture by Dr. A. C. Crehore, on "Some Applications of Electromagnetic Theory to Matter." Dr. Crehore during his address showed how a number of the conclusions were arrived at mathematically as regards the electron theory.

The Saturday morning and last session was called to order by Vice-President B. A. Behrends. This session was devoted to a discussion of "Alternating-Current Commutator Motors." Three papers were presented. "The Polyphase Shunt Motor," by W. C. K. Altes, was read in abstract by the author. "Commutation in Alternating-Current Machinery," by Marius A. C. Latour, the noted French electrical engineer, in the absence of the author was presented by C. O. Mailloux. These two papers are very largely a mathematical discussion on alternating-current commutator motors.

The third paper, "The Secomor—A Kinematic Device Which Imitates the Performance of a Series-Wound Alternating-Current Commutating Motor," by V. Karapetoff, was presented by the author. Mr. Karapetoff had one of his instruments present on which he gave a demonstration of its operation and use. No small amount of attention was taken in this new device to assist in the designing of series-wound polyphase commutating motors, which are beginning to come into quite extensive use at the present time.

Workers for the Shipyards

Because ships are the primary factor in the winning of this war, and because the construction of these ships depends, and will always depend, upon labor, there has been created an organization of workmen known as the United States Shipyard Volunteers, enrolled under the Public Service Reserve. This organization is composed of workmen who are willing to give a good day's work for a good day's pay; workmen who will stand ready, when called upon, to do a particular job for a particular wage in a particular place, and who have enrolled themselves in this organization so that when needed they may be readily reached.

The need of the nation is great. The Shipping Board has the money, the housing of men is being arranged for, the yards are being completed and the materials provided. All that now is lacking is the knowledge of the need that will inspire loyal and efficient mechanics to enroll for service in the yards, though not in a fashion to disrupt the business of the country through the robbing of present industries.

It is urged that mechanics go at once to the nearest enrollment agent of the United States Public Service Reserve of the Labor Department, or to the local enrollment agent of their State Council of Defense, and register themselves as willing to work in the shipyards if needed; then to retain their present positions until called personally for service.

Through the Council of National Defense an appeal has been made to governors, mayors and other prominent officials, to stimulate interest in their communities.

In addition to the card which the volunteer fills out for the Public Service Reserve, he signs the following franked postcard, addressed to Chairman Hurley at Washington:

> Appreciating the Nation's imperative need for skilled workmen to build merchant ships with which to overcome the submarine menace, I request to be enrolled as a member of the United States Shipyard Volunteers of the Public Service Reserve. I realize that the World War will be won or lost in the American shipyards. Every rivet driven is a blow at the Kaiser. Every ship turned out brings America nearer to victory.
>
> It is understood that if I am asked to enter shipyard employment, my compensation shall be at the rate of wage prevailing in such yards.

The button which the workmen receive after enrolling bears this inscription: "U. S. Shipyard Volunteers." A service certificate will be given to all who enroll.

The list following shows the kind of trades most needed in shipbuilding, and a particular appeal is addressed to men in those occupations to enroll in the Reserve: Acetylene and electrical welders; asbestos workers; blacksmiths, anglesmiths, drop-forge men, flange turners, furnace men; boilermakers, riveters, reamers; carpenters, ship carpenters, dock builders; chippers and calkers; electrical workers, electricians, wiremen, crane operators; foundry workers; laborers, all kinds; loftsmen, templet makers, machinists and machine hands, all sorts, helpers; painters, plumbers and pipefitters; sheet-metal workers and coppersmiths; shipfitters; structural iron workers, riveters, erectors, bolters up; other trades, cementers, crane men.

Mobilizing the Educational Institutions

It is estimated that within the next six months 75,000 to 100,000 men will be given intensive training in schools and colleges. With a view to mobilizing the educational institutions of the country and their facilities for such special training, there has been created in the War Department a "Committee on Education and Special Training," associated with which committee will be five civilian educators: Dr. Charles R. Mann, of the Carnegie Foundation for the Advancement of Teaching and the Massachusetts Institute of Technology; Dr. James R. Angell, of Chicago, Dean of the Faculties of the University of Chicago; J. W. Dietz, of Chicago, Director of Education, Western Electric Co., President of the National Association of Corporation Schools; James P. Munroe, of Boston, a member of the Federal Board for Vocational Education (which appointment will include the interests of the trade schools and schools of secondary grade), and Dr. Samuel P. Capen, of Washington, specialist in higher education.

Manhole Heads for Heating Mains

Manholes surrounding fittings in the heating mains, particularly high-pressure steam mains, are one of the greatest sources of heat loss. This heat loss is concentrated in the manhole head which is in direct contact with the pavement.

The damage to pavement, particularly asphalt pavement, is a continual cause of complaint from city highway departments and property owners and a continual source of damage claims and expense. The Underground Construction Committee of the National District Heating Association desires to arrive at a solution of these troubles and has sent out the following questionnaire. Replies should be addressed to H. A. Austin, Chairman, 280 Madison Ave., New York.

A. What class of mains do you operate? High pressure steam? Low pressure steam? Hot water? (Give operating pressure.)

B. What type of manhole do you use? Concrete? Brick? Cast iron sectional?

C. How do you insulate the fittings in your manholes? (Give details.)

D. Do you have trouble with pavement around manhole heads? What kind of pavement? Describe trouble and state inside temperature manhole when closed.

E. What valves, traps, fittings, expansion joints, or specials in manhole?

F. Do you pave around manhole head in special manner? (Give details and sketch.)

G. What have you done to overcome heat losses at manholes?

H. What suggestions have you to offer regarding construction of manholes, such as insulating sidewalks, etc.? (Give details and sketch.)

I. What suggestions have you to offer regarding special insulation of fittings in manhole? (Give details.)

Five Powerless Days Saved Coal

The W. S. Barstow & Co., in their weekly news letter No. 59 give some comparative figures of coal saved as a result of the Fuel Administration order for the closing down of industries from Jan. 18-22 inclusive. The following figures are from seven plants operated by the company:

COMPARATIVE FIGURES ON COAL SAVED FROM JAN. 18 TO 22 INCLUSIVE

Company	Average Coal Consumption for a Like Five-Day Period, Tons	Coal Consumption for the Five-Day Period in Question, Tons	Coal Saved During the Five-Day Period in Question Jan. 18-22 Tons
Binghamton Light, Heat and Power Co	303.40	246.80	56.60
Metropolitan Edison Co	1,240.00	935.00	305.00
New Jersey Power and Light Co	179.90	148.10	31.80
Northwestern Ohio Railway and Power Co	190.42	*207.91	−17.49
Pennsylvania Utilities Co	1,490.00	850.00	640.00
Sandusky Gas and Electric Co	236.50	152.50	84.00
Sayre Electric Co	103.52	97.52	6.00
Totals	3,743.74 —	2,637.83 =	1,105.91

Figures given are in long tons—2,240 lb. * Coal in excess of ordinary consumption used on account of severe storms.

President Wilson Signs Garabed Bill

On Feb. 9 President Wilson signed the so-called Garabed bill. This measure, as explained in the issue of *Power* for Feb. 5, assures to the inventor of the Garabed, or free-energy motor, protection of his rights in the invention for a period of seventeen years, and gives the Government the free use of the device. It also provides for the appointment of a committee of five eminent scientists, before whom the invention is to be demonstrated, to determine whether it is practicable. The inventor, Garabed T. K. Giragossian, of Boston, is now arranging with Secretary Lane for the selection of the committee of scientists. The opinion prevails that these men will be taken from the faculties of such well-known technical institutions as Massachusetts Institute of Technology, Harvard and Tufts. Engineers will await the report of the committee with a considerable degree of expectancy.

In recent discussion of the subject of electrolytic corrosion of steel before the Iron and Steel Institute, it was brought out that, "Water containing carbonic dioxide is electrolytic at adjacent anodic and cathodic areas in a steel surface. These areas may be revealed by use of an indicator of phenolphthalein and potassium ferricyanide. Where iron dissolves, a blue, and at cathodic spots, a pink, reaction is obtained." The quotation is from a letter in London *Engineering*.

Waste of Fuel and the Remedies

At a meeting open to the public, held by N. A. S. E. No. 1, in Fullerton Hall, Art Institute, Chicago, Joseph Harrington, chairman of the Committee on Technical Publicity of the United States Fuel Administration for Illinois, delivered an interesting talk on the "Waste of Fuels and the Remedies."

In his discussion Mr. Harrington had two objects in mind: First, a brief outline for the benefit of nontechnical members present, showing the causes of waste of fuel and the remedies that could be applied thereto in a practical manner; and second, an endeavor to bring out the fact that the stationary engineer, through his control of both steam production and consumption, was handling a necessity of life, and as such should be rated as one of the important cogs in every industrial establishment using power. The technical end of the discussion was intended to show that if the engineer is given adequate assistance in the way of the proper instruments and the necessary moral support, it is possible to save substantial amounts of coal.

Without the aid of certain instruments, Mr. Harrington claimed that it is not feasible to apply measures of economy. In the electrical department switchboard instruments are considered an absolute essential without which a generator would not be started. Voltage can be regulated approximately by the brightness of the lamps, but the method is not to be considered for a moment. It is no more possible, and should no more be countenanced in the boiler room, that the fireman should operate his boiler and judge of the efficiency of the combustion by merely inspecting the fire by eye. While an experienced fireman can approximate the conditions by looking into the furnace, it is impossible for the average man to do so. Instruments are therefore a necessity, and they should be backed up by adequate records.

A record system that does not show the effect of each and every change made by the engineer is useless. Mr. Harrington brought out the point that in undertaking an efficient examination a test should be conducted under operating conditions to show wherein the losses are greatest and division should be made of furnace and boiler losses. With the heat-balance test before him the engineer would then be in a position to locate the loss and apply the remedy. After this the records should show the effect on the plant efficiency of any changes made, and if they fail to do this they are valueless.

Changes should be made one by one in such manner that close records may be kept and the proper credit be given to each change. These records must go to the chief engineer and from him to the plant manager or owner. As the owner is usually nontechnical, the details would neither interest nor enlighten him. The result that the fuel administration is after in this campaign is to reduce the quantity of coal burned to produce a given amount of steam, and unless the changes actually accomplish this, they have not been beneficial. The plant owner, therefore, should be given a data sheet in which this one main significant figure predominates. To get this, two instruments are essential—a coal-weighing device and a water or steam meter. In the larger plants one more step can be taken and that is a regular coal analysis that will permit the engineer to report the number of B.t.u. consumed per thousand pounds of steam from and at 212 deg. This is the ultimate criterion and is the one on which a just comparison can be based.

When the records have been arranged, there is one other matter that must be given attention by the owner. He must consider that the engineer and the engineering department constitute a link in his manufacturing chain that is all-important and without which manufacturing processes cannot be carried on. Instead of considering the power plant in the light of a necessary expense, it must be considered one of the prime factors and be given every support. The engineer himself must be assisted in every possible way in acquiring information about his business; he must be given the tools necessary to efficiently carry on his work, and he must be encouraged in the reporting of results in an intelligent manner so that both he and the owner may profit by the experiences of the past. The plant itself should be put in such shape that operatives can work comfortably and use all the intelligence with which they are endowed. Very high temperatures in the boiler room, dark and dirty surroundings, lack of washing facilities and lack of office space for the engineer, all conduce to indifference and neglect on the part of the men, which in turn results directly in increased fuel costs. One of the most prolific sources of economical combustion is a general toning up and dignifying of the work of handling the power department.

Why a Fire Policy Was Avoided

An application form filled out as a basis for issuing a policy insuring an industrial plant against fire contained the question, "Is steam power, water power, or what other power is used?" This was answered, "Water." The next question was left unanswered, "If gasoline power is used, then describe the location of the engine, gasoline storage tank, spark igniter," etc. Applicants also remitted in payment of a premium based on use of water power only, although a gasoline engine was in auxiliary use in its plant and it was known that this called for a higher rate. The insurance company's representative knew that the engine had been used about three months before and drew attention to the fact that this was not disclosed in the application. The mill, the subject of insurance, burned one night just after the gasoline engine had been shut down. Under these circumstances the Pennsylvania Supreme Court holds in the case of Corbin et al. vs. Millers' Mutual Fire Insurance Co. of Harrisburg, 102 Atlantic Reporter, 425, that the insurance company was not liable for the loss; the statements in the application amounting to a warranty of facts material to the risk, and it being found that notwithstanding the company's representative's previous knowledge concerning the use of a gasoline engine, the company was entitled to assume that such use had been discontinued.

Dog as Power-Plant Adjunct

Where a factory employee was sent on an errand to the basement of a building and was injured by a dog that the engineer of the plant had been permitted by the common employer to keep there, it was decided by the Appellate Term of the New York Supreme Court in the recent case of Barone vs. Brambach Piano Co., 167 New York Supplement, 933, that the accident must be deemed to have been one sustained in the "course of employment," within the purview of the New York Workmen's Compensation Act. The court said:

> There is no doubt that the plaintiff was engaged in performing the duties of his employment at the time he was bitten. The presence of the dog, with the employer's implied knowledge and consent, was one of the physical conditions of the plant under which the defendant required the plaintiff to perform his duties. The mere fact that the direct cause of the injury was animate, rather than inanimate, does not alter the result; nor in this view can I see any force in the suggestion that the dog was not especially kept as a watch dog, or for some similar purpose (though I think the proof showed that it was so employed). The right of the plaintiff to a recovery does not, on any theory of which I am aware, depend upon the comparative usefulness to the employer's business of the immediate cause of the injury.

War-Savings and Thrift Stamps

The sale of War-Savings and Thrift Stamps has been made much easier and missionary work much more effective by the use of the blue return post card, Form WS-138. This card is an order for War-Savings and Thrift Stamps to be delivered at your door C. O. D. The blue card provides the simplest, easiest, safest and least objectionable way of obtaining a pledge to buy stamps and the utilization of the card permits a vast amount of better patriotic campaigning. It is also convenient for agents when ordering supplies.

The card explains its utility to all who can read. It does away with uncertainty, difficulty and delay in securing stamps, for Uncle Sam's letter carriers will fill all blue post card orders in the earliest mail, thus eliminating both bother and risk. The cards can be obtained free in large quantities at almost any post office or bank and from the letter carriers.

New Publications

METHODS FOR INCREASING THE RECOVERY OF OIL SANDS. By J. O. Lewis. Bureau of Mines, Bulletin No. 148. Petroleum Technology 37.

In its efforts to reduce waste and increase efficiency in oil production, the Bureau of Mines is investigating methods of increasing the recovering from the underground sources of supply which are the foundation of the petroleum industry and the allied industries wholly or partly dependent on it. In the face of a demand that is increasing faster than the production, and that in the consensus of opinion of well-informed authorities is soon likely to outstrip the productive commodity, it is well to consider whether it is not possible to extract more oil from the known sources of supply. It is universally acknowledged that by the usual production methods much oil is left underground, the general opinion being that at least 50 per cent. of the oil in the field remains unrecovered when the field is abandoned as exhausted. The writer believes from his investigations that the average recovery is even less, and if any considerable portion of this oil being left underground could be made available, it would have a tremendously favorable influence on the petroleum industry.

This publication considers the principles involved in increasing recovery and methods of extracting more oil from the oil-bearing formations than by the usual way of producing. These methods are: The use of gas or vacuum pumps in forcing compressed air or gas through the oil-bearing formations, displacing the oil by water, and further utilization of the natural pressures in the oil-bearing formations. Special attention is being given to a process commonly known as the Smith-Dunn for forcing compressed air through oil-bearing formations because it is believed to hold the most promise for the future.

The article is of interest to power-plant men for the reason that it shows that the Bureau is active in attempting to recover the maximum of oils in the oil field. These oils, of course, are not only used for fuel purposes but for lubrication.

SAFE PRACTICES

Bulletins No. 8, 9 and 10, issued by the National Safety Council, Continental and Commercial Bank Building, Chicago, Ill., are just off the press, "being an orderly presentation in loose-leaf form of accident hazards and the best practices for their elimination." No. 8 (pages 85 to 92 inclusive of the series) pertains to "shafting, couplings, pulleys, gearing, etc. (transmission machinery)." No. 9 (pages 93 to 108), is on "engine guarding and engine stops," and No. 10 (pages 109 to 116), treats of "oiling devices and oilers." These pamphlets may be obtained for 10c. each by addressing the society or Edwin R. Wright, Editor, at Chicago.

They are accepted not only by the 4000 members of the council, but generally, as standard safe practices to protect the lives and limbs of workers. Accident prevention is now recognized as of supreme importance if for no other reason than to keep every man on the job producing materials to help Uncle Sam win the war.

Obituary

James Stackhouse, for many years superintendent of buildings for the John Hancock Mutual Life Insurance Co., of Boston, Mass., died at his home in West Roxbury, Feb. 8. He was in the sixtieth year of his life, and had spent 28 years in the service of the John Hancock Co. Mr. Stackhouse was born in St. John, N. B., and most of his early life was spent at sea as a marine engineer, having made several trips around the world. Entering the employ of the Hancock Steamboat Co., he later became chief engineer of one of the passenger steamers. He was afterward in the employ of the Suburban Electric Co as chief engineer, followed by a similar position at the Mason Building, on Kilbey St., Boston, which position he resigned to become chief engineer of the building at 178 Devonshire St., now known as the Old John Hancock Building. Mr. Stackhouse was one of the oldest members of Massachusetts No. 1, M. A. S. E., of Boston, and always took an active interest in the welfare of that organization. Edward H. Kearney, who for many years served as chief engineer of the John Hancock Building, under Mr. Stackhouse, succeeds the latter in the position of superintendent of buildings for the company.

Personals

James A. Campbell has resigned his position with the Renfrew Manufacturing Co., Adams, Mass., to take a position as mechanical superintendent with Lever Bros., Cambridge, Mass.

H. W. Fuller has been appointed vice president in charge of operation of the Northern States Power Co., with headquarters at Minneapolis. H. M. Byllesby & Co. announce the creation of this position to relieve R. F. Pack, vice president and general manager, of operating responsibilities which have increased greatly due to the rapid growth of the Northern States organization. Mr. Fuller has been associated with Byllesby & Co. for seven years, devoting a large part of his time to the solution of special operating problems.

H. H. Harrison, of the Merchants Heat and Light Co., Indianapolis, Ind., has a vigorous policy as to patriotic, civic and public matters. His theory is that any institution that works industriously for the good of a city, county, state or nation will in turn be treated generously by the community. In short, in serving the public you are serving the company. Last fall he inaugurated a campaign to send useful Christmas gifts to the French tots who had been crying for a Santa Claus for three long years. The effort put forth resulted in 18,000 gifts sent to the little French children. His company has vigorously pushed Liberty Loans, and is now pushing Food Conservation, Thrift Stamps and Comic Valentines made by celebrated Hoosier caricaturists and authors. These valentines are sold for the benefit of the French Relief.

Engineering Affairs

The Southwestern Electrical and Gas Association will hold its annual convention on Apr. 15 at Galveston, Tex.

The American Institute of Steam Boiler Inspectors of New York City held its regular meeting in the Engineering Societies Building, 29 West 39th St., on Thursday, Jan. 31. The officers of the past year were reëlected as follows: T. T. Parker, president; J. G. Shaw, vice president; M Fogarty, treasurer; J. H. Pollard, secretary. The annual dinner will not be held because of the conditions caused by the war.

The New York Section of the American Society of Refrigerating Engineers, at its next meeting, Tuesday, Mar. 15, will hear a paper by Charles H. Bromley, associate editor of "Power," on "Some Specific Fuel Wastes and Their Reduction." The paper will be illustrated with lantern slides. The meeting, to be held at Machinery Club, 50 Church St., New York City, will be preceded by a dinner, also in the club. Van R. H. Greene, consulting engineer, 50 Church St., New York City, is secretary of the New York Section and has charge of the arrangements.

The Boston Section of the A. S. M. E., combined with the American Institute of Electrical Engineers on the evening of Tuesday, Feb. 5, at the Massachusetts Institute of Technology to listen to a paper by Prof. Walter I. Schlieter, of Columbia University, on "The Modern Trend of Education." The paper was discussed by Professor Franklin, of Lehigh, Professor Brozel, of Yale, Professor Clifford, of M. I. T., and several other prominent educators. Representatives of the American Society of Mechanical Engineers were Parker H Kemble, of the U. S. Shipping Board; Captain Foster Veitenheimer; Dr. Ira N. Hollis, president of Worcester Polytechnic Institute; A. L. Williston, of Wentworth Institute; Director Russell, of Franklin Union, and Mr. Hall, of the General Electric Co., Lynn, Mass. These speakers covered the special problems in training for the Army and Navy, as well as for the mercantile marine, munition factories and other industries directly concerned in the prosecution of the war, and particularly in reference to the utilization of existing technical schools in New England for the training of large numbers of men for such service

Miscellaneous News

A. Newlands, Engineering Chief of the Highland Ry., in the course of a paper on "Water Power in Great Britain," before the Royal Society of Art, said that turbines for a head of 25 ft. cost £4 per horsepower as against £1 per horsepower for a head of 500 feet.

A Boiler Exploded at the plant of the Republic Iron and Steel Co., East Chicago, Ind., on Feb. 18. Two employees were instantly killed and two others died later in a hospital. Of the 29 injured, two are not expected to live. The plant was partly wrecked, with an estimated loss of $500,000.

Radio Engineering at Lafayette—Prof. James T. Rood has started a course in radio engineering in connection with the prescribed course of electrical engineering at Lafayette College. This course was designed and approved by the Signal Corps of the United States Army in order that the engineering students, subject to the selective draft, might enter this course and receive thereby the deferred classification which would enable them to continue in their engineering courses at the college for the balance of the year.

Western States Petroleum Administrator—Prof. D. M. Folsom, head of the School of Mines at Stanford University, Calif., on Feb. 6 was appointed petroleum administrator for the Western States by Mark L. Requa, national oil administrator. Professor Folsom has been serving as chairman of the petroleum committee of the state fuel administrator in California and is one of the leading oil experts of the West. In his new capacity he will have supervision over the production and distribution of petroleum in California, Washington, Oregon, Idaho, Utah, Nevada, Arizona, Alaska and Hawaii. This appointment is taken to mean the abolition of the petroleum committee which consisted of Professor Folsom and two members of the Railroad Commission of California. Professor Folsom has announced that there will be no compulsory licensing of oil producers at present, as this would require the fuel administration to become immediately responsible for operation and production. A system of friendly coöperation rather will be practiced. "It will be necessary, however," he stated, "for all companies to pool their cars and tank ships to prevent shortages and embarrassment in deliveries." No limit is to be placed on fuel-oil consumption so long as storage conditions remain as they are at present."

Business Items

The Plant and Business of the Schutte & Koerting Co., of Philadelphia, has been taken over by the Government as a German-owned concern. Adalbert K. Fischer, its former president, is interned at Fort du Pont, Del., as a dangerous alien.

The Esterline Co., of Indianapolis, Ind., has appointed the Northern Electric Co., of Montreal, as exclusive distributor of Esterline products for the entire Dominion of Canada, and complete information and service may be had at its offices at Montreal, Halifax, Ottawa, Toronto, London, Winnipeg, Regina, Calgary and Vancouver.

The Marion, Indiana, Machine, Foundry and Supply Co. has taken over the entire business, good will, etc., of the Planet Steam Specialty Co., which has specialized in the manufacture of soot blowers for all types of water-tube boilers. Gordon C. Bennett, who was secretary of the latter company, has taken charge of the engineering department to develop the manufacture of a complete line of soot blowers for all types of boilers.

Wright-Austin Co. — After twenty-five years of producing the highest grade of steam specialties in close association, the Wright Manufacturing Co. of Detroit, Mich., the Austin Separator Co. and the Murray Specialty Manufacturing Co. have combined their interests under the name of Wright-Austin Co. The high standards of manufacture and service which have been jealously guarded by the older concerns will be maintained. The business will be continued at the present address and under the direction of the same officials as heretofore

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market

	F.o.b. Mines*		Alongside Boston†	
	Feb 21, 1918	One Year Ago	Feb 21, 1918	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.25—7.50
Buckwheat ..	4.30—5.00	2.75	5.50—5.80	6.25—6.50
Barley	3.25—3.50	1.95	4.00—4.25	3.50—3.75
Rice	3.75—3.95	2.20	4.50—4.80	4.50—5.00
Boiler	3.50—3.75	220	....	3.25—3.50

Bituminous smithing coal, $4.50—5.25 f.o.b.

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)...............	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt Olive and Staunton		Standard	
	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago	Feb. 21, 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.50-2.75
2-in. lump..	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Steam egg ...	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Mine-run ...	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Goverment figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Calif., Red Bluff—City is having plans prepared by E. A. Rollison, Arch., Redding, for the erection of an electric lighting plant.

D. C., Wash.—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at various Navy Yards, under Schedule No. 1697, steam and water brass, air, bibb, hose, pet, cutout oil, and stop cocks; Schedule No. 1698, steam and water composition bends, Y-branches, caps, couplings, crosses nipples, plugs, tees and unions, steam and water screwed reducing bushings, elbows and locknuts.

Iowa, Bloomfield—City plans to improve its electric-lighting plant and install new equipment including 2 electric generators, one 225 kw. and one 75 kw. alternating current, and two 150 hp. boilers.

Ky., Walton—The Walton Electric Light Co. is in the market for a 25 kw., 250 volt, 220 r.p.m. D. C. generator for direct connection through flexible couplings, a 10,000 gallon horizontal oil storage tank, 6-8 ft. in diameter, 3-16 in. shell and ¼ in. heads.

Mass., Everett—The J. Duncan Co., 7 Fulton Place, Boston, is in the market for machine lathes, blacksmith power punches, cutters, bolt drivers and all machinery used in small structural iron work.

Mass., Everett—The Town plans to install equipment in its incinerator to include a 3½ x 40 ft. conveyor belt, baling presses and binds with appurtenances. About $7,000 is available. A. Varney, Town Engr.

Miss., Clinton—City plans to build a brick addition to its electric lighting plant and install a 50 hp. engine. Estimated cost, $8850. A. Latimer, Mayor.

Mo., Kahoka—City plans to extend its electric transmission line from here to Luray, Williamstown, Clark City and Medill, about 16 mi. L. R. Sherrill, Supt.

Mo., Ozark—The Finley Light Co. plans to build an electric-lighting plant. Estimated cost, $15,000. G. T. Breazeale, Mgr.

Neb., Sidney—The Town will receive bids until March 12 for furnishing and installing one 250 hp. steam engine, two 200 hp steam boilers, one 200 kv.-a. 60 cycles, 2300 volt, A. C. generator, 1 steel smoke stack, feed-water pumps and automatic stokers, two 150 hp. internal-combustion oil engines and one 10,000 gallon fuel tank. R. D. Salisbury, 1415 East Colfax Ave., Denver, Colo., Engr.

N. J., Camden—City plans to build an electric-lighting plant. L. E. Farnham, City Engr.

N. Y., Chenango Forks—The Binghamton Bridge Co., Press Bldg., Binghamton, plans to build a concrete dam, 150 ft. long, a brick and steel power house and steel penstocks and install two 250 kw. water turbine-driven generators. Noted Nov. 27.

N. Y., Jamestown—The Crescent Tool Co., 200 Harrison St., plans to build a power station and concrete coal storage binds. New machinery, including a 1000 kw. steam turbine generator set and boilers will be installed. C. R. Swisshelm, Sales Mgr.

N. D., Maddock—City is having plans prepared by W. E. Skinner, Engr., 714 Plymouth Bldg., Minneapolis, Minn., for the erection of an electric-lighting system. Estimated cost, $7000. Noted Oct. 23.

Ohio, Youngstown—The Mahoning and Shenango Ry. and Light Co. plans to build a transmission line from here into the Mosier District. R. T. Sullivan, Mgr.

Okla., Chandler—The Washita Electric Power Co. plans to build a 50 x 75 ft. brick and concrete power house and improve and extend its distribution system. R. K. Johnston, Pauls Valley, Secy.

Penn., Philadelphia—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, Philadelphia, under Schedule No. 1698, steam and water brass joints.

Penn., Philadelphia (Kensington)—L. S. Leberman is having plans prepared by A. J. Sauer & Co., Arch., 908 Chestnut St., for the erection of a 1-story, brick and concrete power plant, including the installation of pumps. Estimated cost, $10,000.

S. D., Mitchell—City is having plans prepared by Burns & McDonnell, Engr., Interstate Bldg., Kansas City, Mo., for improvements to the electric lighting system.

Tenn., Hampton—J. H. Edens plans to rebuild his electric-lighting plant which was recently destroyed by fire.

Tex., Canyon—The Canyon Power Co. plans to rebuild its plant which was recently destroyed by fire. J. K. Boring, Ch. Engr.

Tex., Del Rio—C. A. Lindsey, Wichita, Kan., and associates, plan to build 1 or 2 hydro-electric plants in connection with a large irrigation project.

Wash., Puget Sound—(Bremerton P. O.—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, Puget Sound, under Schedule No. 1698, steam and water brass joints.

B. C., Vancouver—The Ontario Power Co. plans to issue $1,000,000 bonds; the proceeds will be used to build additions to its plant.

POWER

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On Being a Good Loser

Contributed by H. S. Knowlton, Cambridge, Mass.

IT IS not given to every engineer to advance steadily in his profession without setbacks which at times wear a discouraging aspect. The power to take the long look forward, to be a good loser if one is temporarily held back, and to learn the utmost possible from apparent failures is almost invaluable. Take the matter of promotions. Sometimes a plant chief resigns or passes away, leaving a second in command who feels himself the logical successor, and along comes the plant owner with a new man for the post of command, or, harder than this, he appoints a younger man from below in the organization in place of the former chief. Experiences like these put upon the "heir apparent" to the chief engineership a strain which sometimes causes him to offer his resignation at once in the belief that he is no longer appreciated and that the future in this particular station holds nothing for him.

THE GOOD loser in a situation of this kind conceals his feelings at least for the time being and never makes the mistake of jumping too rapidly to conclusions. His disappointment at being blocked in his logical progress may be taken for granted; but instead of losing his temper and acting hastily, he immediately begins a personal stock-taking. The problem is to find the reason why someone else was called to "go up higher," and the man who can analyze a situation of this kind regardless of how hard it may hit himself is at least fortunate in being able to look facts in the face. Now there may be a hundred reasons why he was not selected to command the installation. Some of them haven't the slightest relation to his personal efficiency. Cases are not unknown where an unfair choice is made through favoritism, family connections, misunderstanding of the inside situation, or some other cause beyond the control of the engineer. What concerns *him* is his own record in the plant, his own fitness for larger responsibilities.

NOTE the course of the good loser. He subjects his work to a severity of scrutiny which is bound to bring out every weakness of performance and, in most cases, every important lack in qualifications. Rigid self-examination helps mightily to establish the true inwardness of the new appointment. Then the engineer begins to study the ways and knowledge of his new chief and seeks to learn what he can from him to improve his own efficiency. His loyal service continues. Time passes, and ultimately the truth comes home to him. If the superiority of the new chief is established in his mind—and it takes pluck to realize it—the good loser may decide to continue in his present post, striving constantly to do better work and attain a broader mastery of his profession. On the other hand, he may become convinced that better opportunities lie elsewhere, and quietly but deliberately may begin to lay his plans to become established in another installation. Whatever the decision, it is not hasty, and it is the outcome of mature study which not seldom points the way toward more efficient service. Personal "preparedness" often grows out of difficult and trying situations in connection with the organization and direction of power-plant personnel. And it should not be forgotten that sometimes the new chief proves less adapted to command than the good loser, whose fitness is demonstrated thereby and who may come into his own by refraining from rash generalizations while sticking harder than ever to his job.

Walnut Plant, Columbus Railway, Power and Light Co.

This plant is ten miles from the center of the city and will have a capacity of 31,250 kv.-a. The boilers are arranged on the unit system, each unit consisting of two boilers, one economizer, two stokers, one induced- and one forced-draft fan. No bypasses are provided for the economizers. Each unit is to operate continuously or shut down as a whole when necessary. With three exceptions auxiliaries are electrically operated. All equipment requiring attention is on the main-floor level. The circulating and condensate pumps are of the vertical motor-driven type.

THE Columbus Railway, Power and Light Co. operates the street cars and supplies light and power for the City of Columbus, Ohio, its surrounding suburbs and near-by villages. This company has a number of old power stations, some of which are becoming inoperative due to one reason or another. The company still owns the site and buildings that were used for the first commercial generating station built in Columbus, and the first Edison station, started nearly thirty years ago, is still in operating shape and used considerably at times. For a number of years the company has had plans under consideration for new power-plant equipment, and in the last two years this problem became extremely active owing to the large increase in the industrial load and to the necessity of securing more economical operation.

Because of the scarcity and quality of water for condensing purposes and the lack of space for coal storage, it was considered desirable to find a site for a new power station outside of the city. The location chosen is ten miles southeast of the center of the city at a point where the Hocking Valley Ry. crosses Big Walnut Creek. The site consists of 25 acres of rolling ground on the east bank of Walnut Creek, with the railroad running through about the center of the property. The map of the property, Fig. 15, shows the location of the plant and the railroad tracks for coal-storage purposes and proposed operators' houses. Big Walnut Creek is formed by three small streams that come together about a mile above the site of this plant. There are approximately 500 square miles in the watershed of Big Walnut above the plant site, and there is a natural pool in the creek at the station varying in depth at low water from 15 to 20 feet.

The plant, Fig. 1, is located on the north half of the property, the low ground of this part being used for coal storage and the other part for houses for the operators and for coal storage. It will be the policy of the company to carry sufficient coal in storage, when it can be obtained, to run the plant for three or four months at a time.

The site for the Walnut Station was purchased in January, 1917. Active work was started in April, and the station began regular operation Nov. 18, 1917. This was accomplished in spite of delays in nearly all shipments of equipment and in the midst of a difficult labor market.

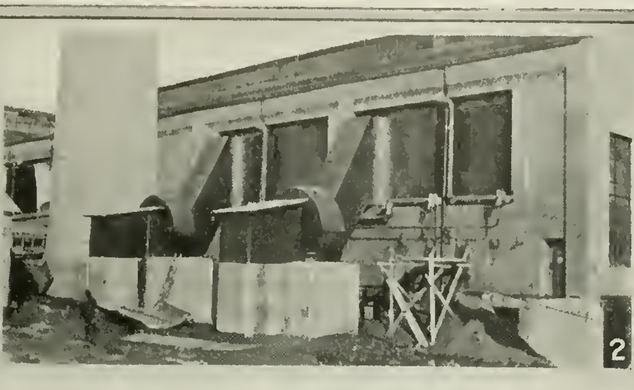
That part of the station now in operation consists principally of one 18,750-kv.-a. 60-cycle turbine, Fig. 5, and eight 440-hp. boilers provided with underfeed stokers. The plans include a second turbine, capacity 12,500 kv.-a. and eight additional boilers. This equipment is under order, and it is expected that it will be ready for installation in the early part of 1918. Fig. 9 is a plan view of the completed plant.

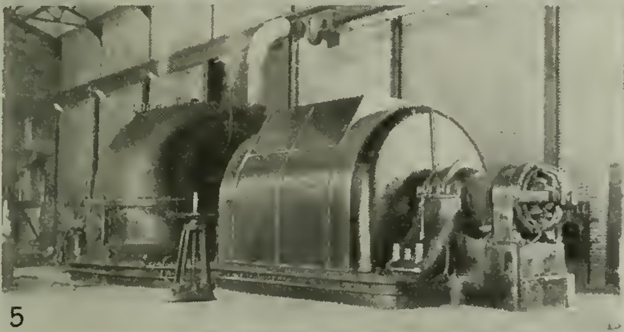
The boiler plant will consist of 16 cross-drum water-tube boilers, each having a heating surface of 4440 sq.ft. The present boiler and turbine installation gives 1.9 kw. turbine capacity per square foot of boiler-heating surface. With the second turbine and eight additional boilers there will be a ratio of 1 sq.ft. of boiler-heating surface to 2.27 kw. of turbine capacity. Each boiler has 21 sections of tubes, each section consisting of 10 tubes 18 ft. long and 4 in. diameter. Single-loop superheaters are also provided, each having 855 sq.ft. of heating surface, which will give about 150 deg. superheat under average conditions. This gives a ratio of 5.19 sq.ft. of boiler-heating surface to 1 sq.ft. of superheater surface. These boilers are designed for 250 lb. steam pressure and are provided with mechanical soot blowers, feed-water regulators, balanced-draft regulators for opening the outlet dampers and with furnace meters which record the steam flow, air flow through boilers and the temperature of the exhaust gases and also indicate the draft under the stokers.

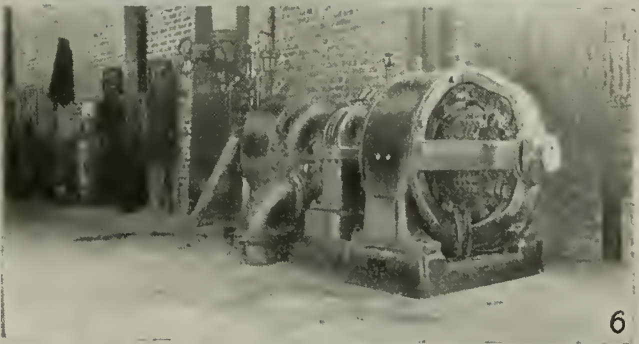
The boilers are set two in a battery, and each boiler is provided with one 8-retort underfeed stoker. The gases from each battery of boilers pass through one economizer having 6300 sq.ft. of heating surface, or 1.4 sq.ft. of boiler-heating surface per square foot of economizer surface. Each economizer has 32 sections, each section consisting of 12 tubes, 12 ft. long and 4⅝ in. outside diameter. The gases are conveyed from the boiler to the economizer by means of $\frac{5}{16}$-in. steel-plate flues covered with 1½ in. of asbestos. The gases from each economizer are in turn conveyed from the economizer by uncovered steel breechings to one 60,000-cu.ft. per min. induced-draft fan, Figs. 2 and 9. These fans are direct-connected to 75-hp. variable-speed motors. The fans discharge downward into a concrete flue, located below grade, which connects into the base of a tapered concrete chimney having a height of 150 ft. and an inside diameter at the top of 14 ft. 6 in. There will be two of these chimneys, one chimney accommodating four fans and eight boilers. The economizers are provided with the usual scraper mechanism, and one 5-hp. 720-r.p.m. motor drives the scrapers on two economizers.

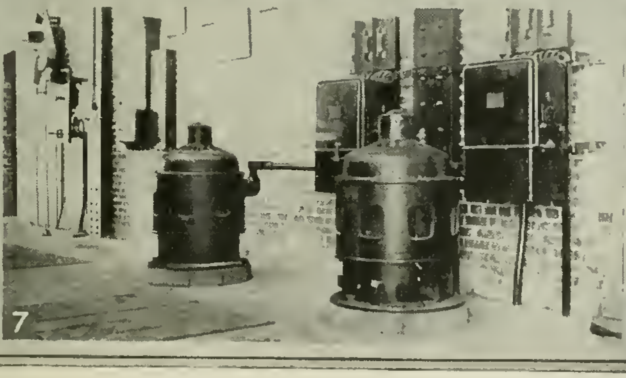
It should be noted that the boilers are arranged in units of two boilers, one economizer, two stokers, one induced-draft fan, one forced-draft fan, and that no bypasses are provided for the economizer. It is expected to operate this unit continuously and when necessary to make extensive repairs, to shut down the entire unit. Of course either one of the boilers may be shut down for cleaning without disturbing the operation of the other. The stoker, forced- and induced-draft fans are all driven by motors, the controllers for which are located convenient to the boilers and are under the control of the boiler-room operators.

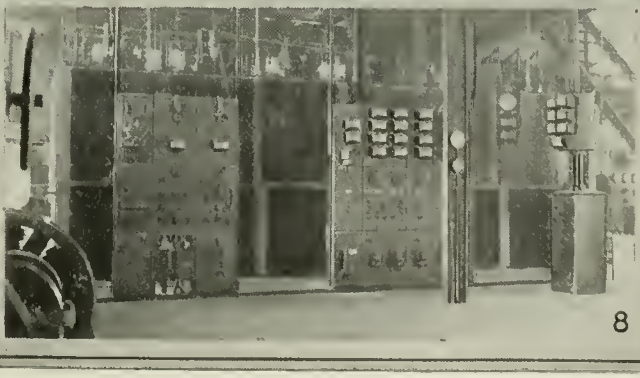
The balanced-draft equipment will provide the close regulation of the induced draft, and the large steps in the adjustment of this draft are obtained by the variable-speed motors, which are hand-controlled. The forced draft is also hand-regulated by varying the speed of the motors and by the movement of the dampers in the air ducts.











FIGS. 1 TO 8. GENERAL VIEWS IN AND ABOUT THE NEW POWER PLANT

Fig. 1—View of turbine room from river side, showing intake- and discharge-water tunnels, feed-water purifying plant and a portion of outdoor 39,400-volt bus structure. Fig. 2—Showing induced-draft fans for boilers 1 and 4 and openings in walls for economizers. Fig. 3—General view of plant from boiler room, showing coal- and ash-handling equipment, induced-draft fans and concrete stack. Fig. 4—Coal-storage track. This track showing elevated steel support track mounted on concrete piers. Fig. 5—The 18,750-kv.-a. turbine, showing generator end at the right with direct-connected exciter and main steam pipe for turbine. Fig. 6—The 100-kw. turbo-exciter set. Fig. 7—Two 35-hp. 220-volt, three-phase, alternating-current vertical constant-speed motors with controllers for driving condensate pumps. Fig. 8—General view of switchboard panels and bus structure; the panels at the left are for control of exciter, panels in the center are for control of outgoing lines and pedestal at the right controls turbine.

The economizers are operated in parallel and feed direct into the feed-water header, and to avoid unequal feeding from the economizers there are monel-metal orifices in the feed-water header between the connections to the economizers, the feed-water branch pipe to each boiler connecting to the header at a point between the orifices. As for the fine adjustment of the feed to the economizers, it is expected to obtain this by regulating the opening of the valves in the connections between the economizers and the header, determining the adjustment of these valves by the temperature of the feed water leaving the economizers, as shown by recording thermometers. In addition to the recording furnace meters, there are recording thermometers for the gases leaving the economizers and for the water entering and leaving the economizers and also for the water entering the feed-water heater. Fig. 11 is a cross-section of the boiler room.

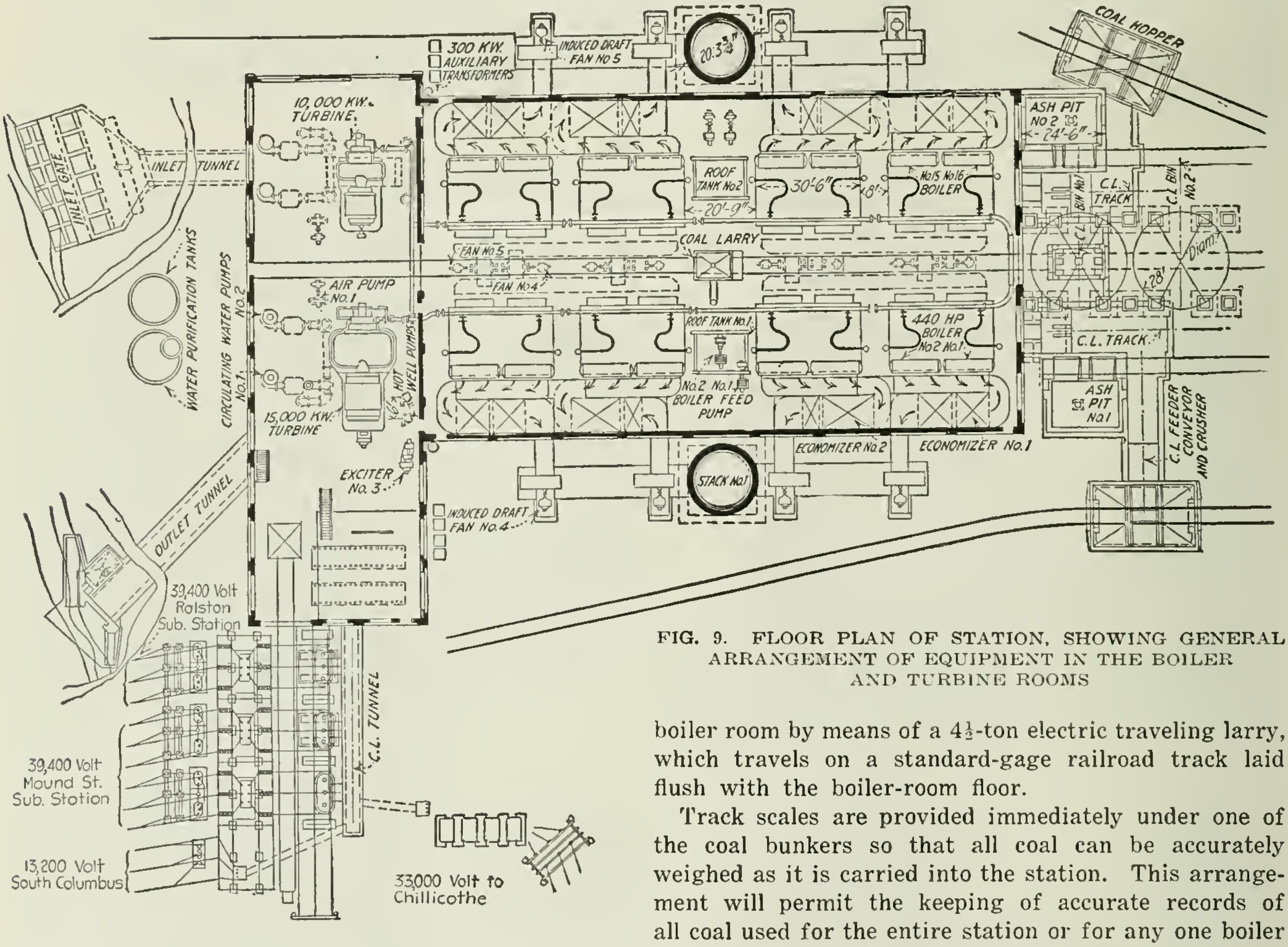


FIG. 9. FLOOR PLAN OF STATION, SHOWING GENERAL ARRANGEMENT OF EQUIPMENT IN THE BOILER AND TURBINE ROOMS

For supplying the makeup water for the boilers, that is, water over and above that secured from the surface condensers, a lime and soda-ash feed-water purifying plant is installed. It is placed outside of the building, as shown in Fig. 1. This plant consists principally of two 20,000-gal. wood-stave tanks with stirring mechanism, and an elevated dosing tank. The river water is of fairly good quality except during high water, when it may be quite roily.

Four 4-stage centrifugal pumps supply the boilers with water. Three are motor- and the other one is turbine-driven. The water rate of the turbine at full load is 49 lb. per brake-horsepower.

The steam from the boilers will be carried through 6-in. steam lines to a main 12-in. steam header. Each row of eight boilers will be provided with a 12-in. steam header, the two headers being connected together at each end so as to form a ring. In the same way the feed water will be supplied to the boilers from a 6-in. feed-water header for each row of boilers, and the feed-water headers will be connected across so as to form a loop.

The equipment for handling the coal and ash is very complete. The station will be provided, when completed, with two 400-ton coal bunkers located just outside of the boiler room at the end of the station, Figs. 3 and 13. Coal will be supplied to these bunkers from two track hoppers, the coal passing from the track hoppers by means of a flight conveyor through a coal crusher and thence by bucket elevator to the top of the coal bunkers. The coal from the bunkers will be carried into the boiler room by means of a 4½-ton electric traveling larry, which travels on a standard-gage railroad track laid flush with the boiler-room floor.

Track scales are provided immediately under one of the coal bunkers so that all coal can be accurately weighed as it is carried into the station. This arrangement will permit the keeping of accurate records of all coal used for the entire station or for any one boiler over any particular period. The larry is electrically operated, has a revolving bin which works like a turret, and is provided with a screw conveyor which supplies the boilers on either side of the firing aisle. The larry requires only one man for its operation, is simple in construction, and all wearing parts are accessible for repairs.

The foundations for the boilers are of concrete and form the ashpits. Two drag-chain conveyors pass under each row of eight boilers, conveying the ash out to the end of the station and discharging into a clinker crusher, which in turn discharges into the boot of a bucket elevator. This elevator may discharge either into a concrete ashpit, shown at the right of Fig. 9, or into railroad car or wagon. The ash can be disposed of for a long time by grading around the property. Each drag-chain conveyor has sufficient capacity for carrying out the ash, and duplicate conveyors are furnished so as to allow repairs and changes to be made without inconvenience to operation, as arrangements are made so that either one can be isolated for repairs without interfering with the other.

The coal will be distributed over the ground and reloaded into cars for moving into the station by means of a 15-ton steam-driven locomotive crane provided with a 2-yd. grab-bucket.

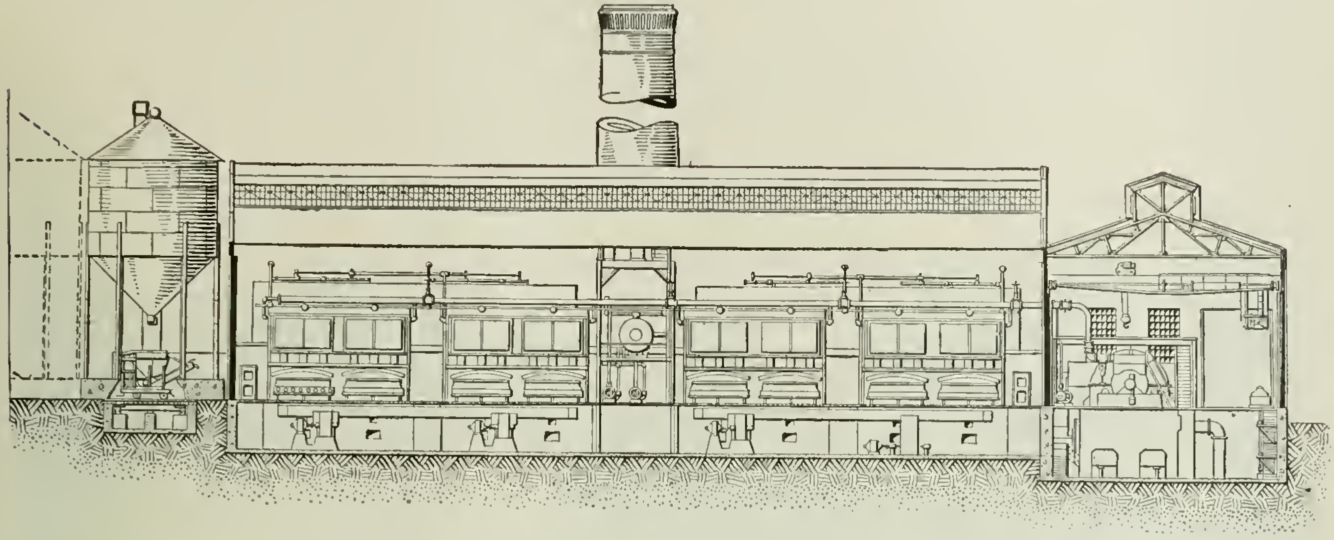


FIG. 10. LONGITUDINAL SECTION OF BOILER ROOM AND A CROSS-SECTION OF TURBINE ROOM

The coal bunkers have capacity sufficient for one to two days' operation of the station. To provide against car shortage and irregularity of shipments, an elevated storage track is provided, a track 480 ft. in length being elevated approximately 15 ft. over low ground, Fig. 4. Since practically all the coal received is in hopper-bottomed cars of one type or another, no labor will be required for unloading them. This track is supported by reinforced-concrete piers, 14-ft. centers, and supported between piers by steel I-beams with steel cross-members on 5-ft. centers to prevent spreading.

The generators are connected to the 13,200-volt bus through oil switches, and a transfer bus is provided with a transfer switch so that any 13,200-volt switch with its instrument transformers may be cut out of service and worked on when necessary without interrupting service. All feeders and other circuits are provided with the same type of oil switch, and all of them are remote-controlled from the switchboard. All the turbine controls are also located at the switchboard.

The auxiliaries in the station will be electrically operated with the exception of one boiler-feed pump

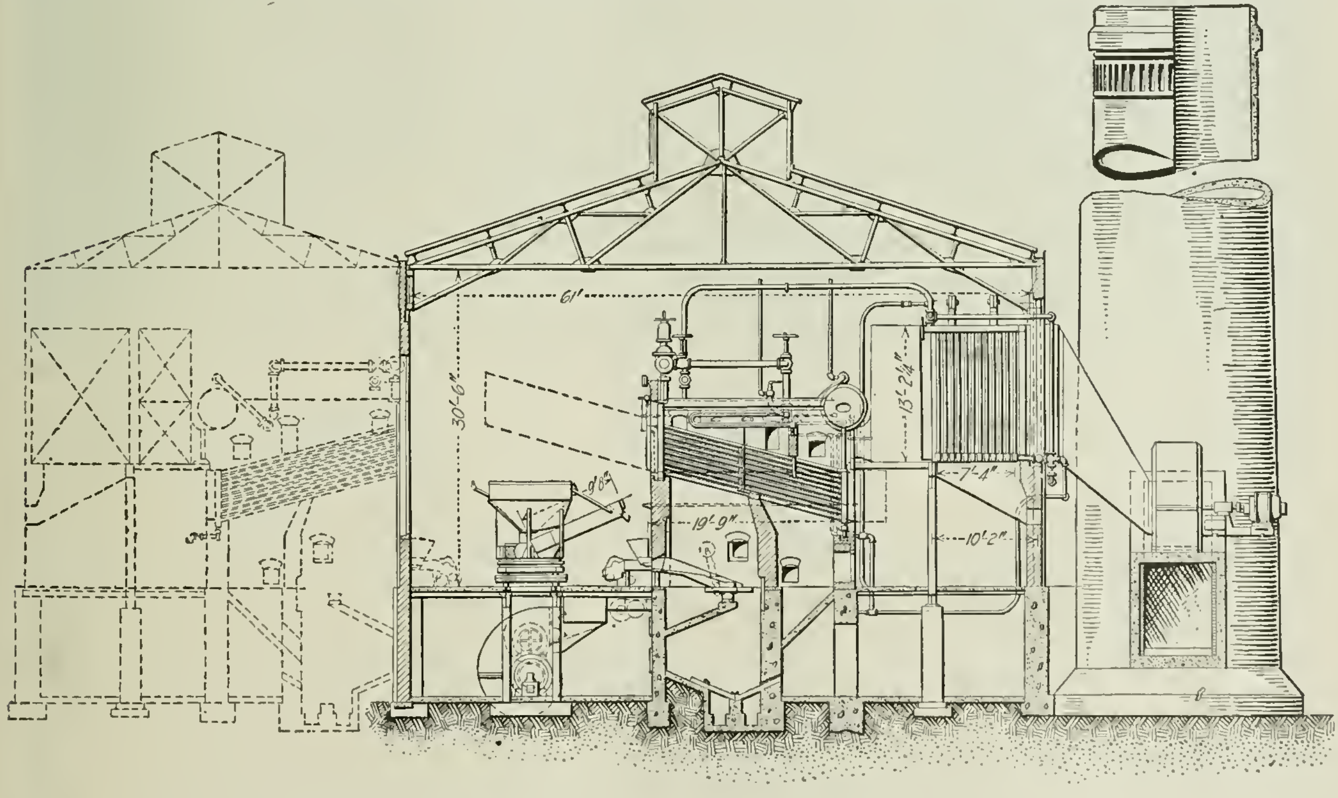


FIG. 11. CROSS-SECTION OF BOILER HOUSE, SHOWING PRESENT AND FUTURE BOILER ROOM AND ARRANGEMENT OF FORCED DRAFT, STOKERS, FLUES, ECONOMIZERS, ETC.

and two dry-vacuum pumps. The current for supplying these motor-driven auxiliaries will be supplied by two duplicate banks of three 300-kv.-a. single-phase 13,200-volt to 220-volt outdoor type self-cooled transformers. The total connected load of motors for auxiliaries in the station will amount to 2533 hp.

Each turbine is provided with a direct-connected 100-kw. 250-volt exciter, and a 100-kw. 3600-r.p.m. geared turbo-exciter set is provided for spare service, Fig. 6.

The plant is laid out with the idea of having all equipment that requires attention on the main-floor level, or elevation 740, this applying to the switchboard, turbines, motors for driving circulating water pumps and hotwell pumps, controllers for all forced-draft, induced-draft and stoker drives, battery-charging set, etc. Therefore there will be as small occasion as possible for the operators leaving the main floor.

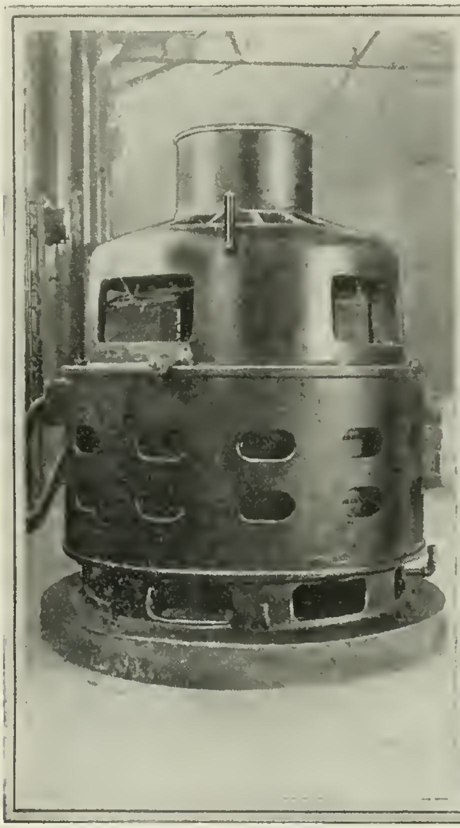


FIG. 12. A 120-HP. VERTICAL VARIABLE-SPEED, 220-VOLT, THREE-PHASE, ALTERNATING-CURRENT MOTOR FOR DRIVING ONE OF THE CIRCULATING WATER PUMPS

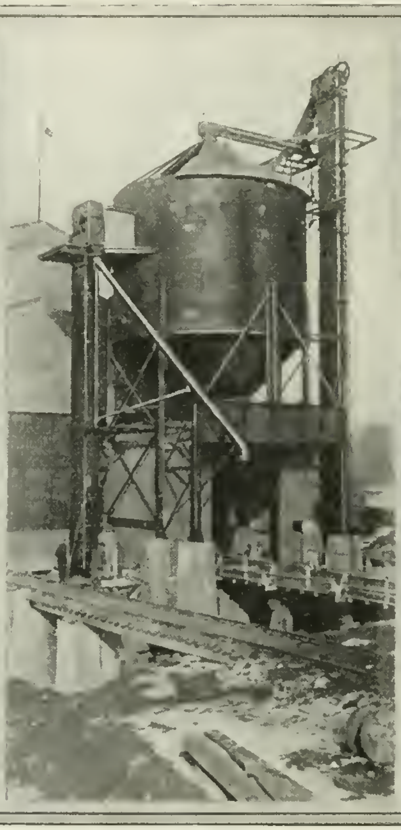


FIG. 13. VIEW OF COAL BUNKER AND ASH ELEVATOR. THE ELEVATOR AT THE LEFT WITH THE LONG CHUTE HANDLES THE ASH

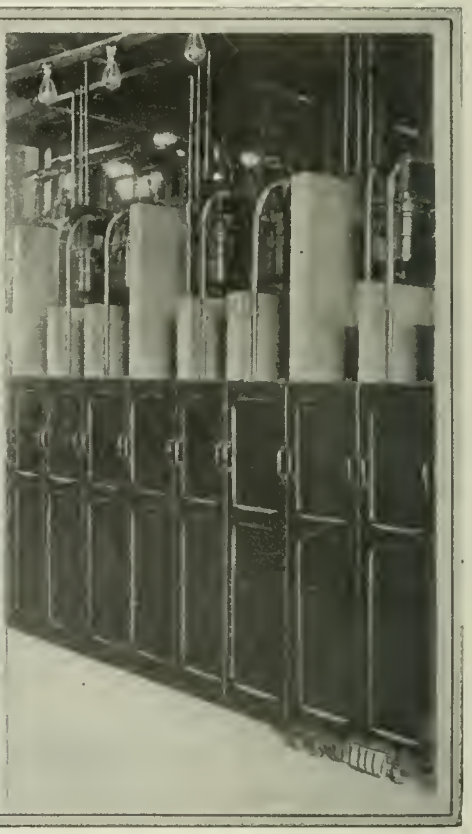


FIG. 14. A PORTION OF 13,200-VOLT SWITCH CELLS, SHOWING LOCATION OF POTENTIAL TRANSFORMERS. DISCONNECTING SWITCHES ARE BACK OF THE REMOVABLE DOORS

Each turbine is provided with a surface condenser, and each condenser will be supplied with circulating water by duplicate vertical variable-speed motor-driven circulating-water pumps. These pumps, Fig. 12, receive water from a gravity tunnel which runs under the length of the turbine room, and the water from the condensers discharges into another separate gravity tunnel, which also runs the full length of the turbine room and carries the water out into the river at a point about 160 ft. below the intake. Each condenser is also provided with duplicate vertical motor-driven single-stage centrifugal condensate water pumps, Fig. 7. Therefore, by the supplying of these duplicate sets of circulating water and hotwell pumps it is possible to avoid many reasons for shutdown.

The circulating water being carried into the station by a concrete tunnel and in turn being carried out by the same means, eliminates the usual large amount of piping required for circulating water and also supplies the water at a convenient point with minimum waste of power. The water in the tunnel will have a velocity of about 2 ft. per sec. with two turbines carrying full load and about 3.1 ft. per sec. with 40,000-kw. turbine capacity in operation. The discharge-water lines from the condensers are sealed in the discharge tunnel so that advantage is taken of the siphon action obtained thereby.

The intake end of the tunnel is enlarged and provided with a large area of racks (velocity through racks 0.5 ft. per sec. first two units and 0.8 ft. per sec. for 40,000 kw. of turbines in operation) for the water to flow through. There are also provided six large removable wire baskets (1-in. mesh) which should catch nearly all the leaves, twigs, etc., that may come downstream during high water. Each basket is in a separate compartment provided with a gate for shutting off the flow of water when the basket is raised for cleaning. A traveling hoist is provided for operating the gates and baskets. Such particles of leaves, twigs, etc., as pass through these baskets and racks can be removed before reaching the condenser by means of twin strainers (⅜-in. holes) which are located between the circulating-water pumps and the condensers. The circulating-water pumps are immediately on top of the intake tunnel so that a minimum suction lift of about 11 ft. is secured.

A battery of four 200-gal. per min. motor-driven centrifugal pumps is located in the basement of the turbine room for furnishing water to the feed-water purification plant, for the cooling of bearings and for the 15,000-kv.-a. transformers.

The condenser of the 18,750-kv.-a. unit is bolted direct to the exhaust flange of the turbine without any expansion joint, Fig. 16. Car springs are placed below the condenser and so compressed as to balance the weight of the empty condenser. These springs will allow the condenser to expand when heated, and the turbine is capable of taking the additional weight of the water which may be in the condenser during regular operation.

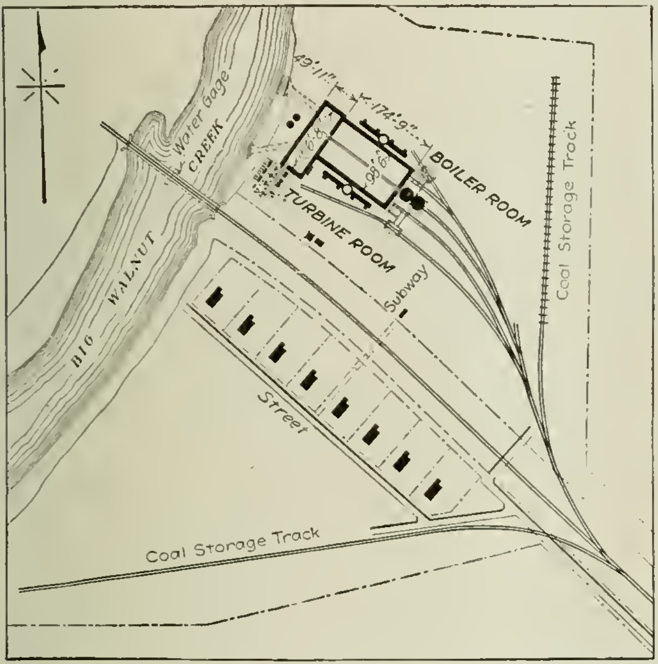


FIG. 15. PROPERTY MAP SHOWING GENERAL ARRANGEMENT OF TRACKS AND LOCATION OF PLANT, COAL STORAGE AND OPERATORS' HOUSES

The condensate from the condenser is forced by the centrifugal pumps to the top of the boiler room, where the water will flow through water meters into an open storage tank. This tank is divided into two compartments, one compartment with a capacity of 6000 gal. for condensate and one compartment with a capacity of 3000 gal. for makeup water. The water from this storage tank will flow through an open feed-water heater having 1300 sq.ft. of heating surface. The feed-water heater is divided into two parts; the condensate will pass over one-third and the makeup water over two-thirds of the heating surface. From the heater the water will pass through a battery of four 400-gal. per min. four-stage centrifugal boiler-feed pumps, three of these pumps being driven by 100-hp. three-phase 60-cycle 220-volt 1740-r.p.m. motors, and the fourth by a steam turbine, 1850 r.p.m. The pumps will discharge direct into headers supplying the economizers, the economizers carrying full boiler pressure plus the additional pressure required for forcing the water through the economizer to the boilers.

As the station is situated about ten miles from the center of distribution of the current in Columbus, it was thought desirable to transmit at a higher voltage than that generated. Therefore the current will be carried into the city over three transmission-line circuits at 39,400 volts, and one 13,200-volt circuit, the latter being the generating voltage, which will feed an industrial section at the extreme south end of the city. The electrical energy will be received at 39,400 volts at one point in the city at the present time and at second and third points later on. Current will be distributed in the city between substations and to large power customers at 13,200 volts; the primary voltage for all other light and power customers is 4150 volts four-wire distribution. The tie-lines between the principal substations of the city will operate at 13,200 volts and consist of triple-conductor lead-incased cables laid in vitrified-clay duct subways. Figs. 8 and 14 show the switchboard panels and a portion of the 13,200-volt switch cells respectively.

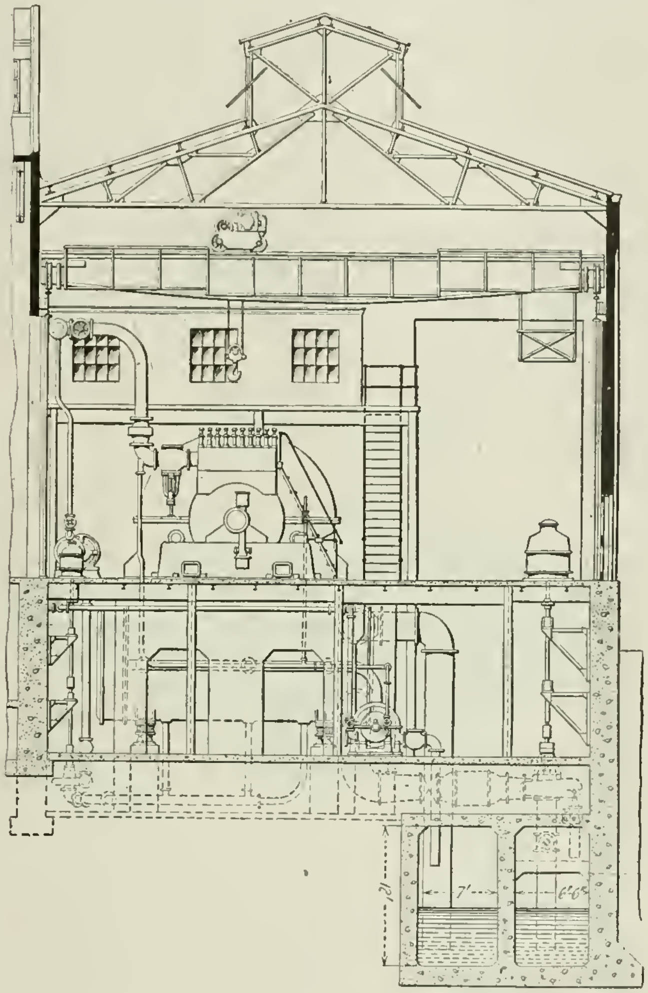


FIG. 16. CROSS-SECTION OF TURBINE ROOM, SHOWING SOME OF THE DETAILED ARRANGEMENT OF CONDENSING EQUIPMENT FOR THE TURBINE. ALSO SECTION OF WATER TUNNELS FOR CIRCULATING WATER

The current will be transformed from 13,200 to 39,400 volts at the power station by means of 15,000-kv.-a. three-phase 60-cycle water-cooled outdoor-type transformers. Two units will be installed this year and a third transformer at a later date. All switches for the 13,200-volt transformers and main generators will be located within the station, but all the 39,400-volt switches, lightning arresters and connections will be outside of the station. Provision is made for taking the transformers in the station on a truck so that they can be placed under the electrical traveling crane for disassembly for repairs and also for the original erection.

Very little space is required within the station for the electrical equipment. The control part is compact and only the 13,200-volt switches are within the station. All transformers, high-voltage bus structure, main-line switches and lightning arresters are located outdoors. Any of this equipment can be cut out of service and moved into the station for inspection and repairs, thus securing all the advantages of the outdoor-type of electrical equipment with minimum disadvantages.

The main building is a steel-frame structure supported on a reinforced-concrete foundation. The turbine room now completed for two turbines is 156 ft. 6 in. in length and 44 ft. 1 in. in width, is provided with a 35-ton electric traveling crane having a rail height of 25 ft. above the main floor. The turbine-room basement is 15 ft. high from floor to floor excepting under the condensers, where the height is 20 ft. The boiler room now completed is 174 ft. in length and 60 ft. in width and will be 174 ft. in length and 96 ft. 2 in. wide when completed for 16 boilers. The height under the lower chord of roof trusses is 30 ft. 6 in. The basement under the boiler room is 10 ft. 6 in. floor to floor.

The outside walls are built of hard-burned red brick, and the partition and temporary end walls of the turbine room are built of interlocking tile. Fenestra steel sash glazed with factory-ribbed glass are used throughout the building. Steel rolling doors are used for large doorways and steel paneled doors on all small doorways.

The roofs are supported by Fink trusses, ⅙ pitch, provided with monitors, ventilation being secured by opening sections of the steel sash by means of suitable window-operating mechanism. The roof for the boiler room consists of a concrete slab waterproofed with three-ply asbestos felt laid in asphalt. The turbine-room roof is similar except that a slab made up of a composition of gypsum and wood fiber is used, this construction being resorted to in order to avoid the possibility of condensation forming on the underside of the roof. The concrete slabs for roof and floors are supported by asbestos-protected corrugated metal with reinforcing fabric. The slabs are flat in both cases, being 2¼ in. thick for the roof and 4 in. for the floor.

The foundations for walls and equipment are supported on reinforced mats or footings which rest on hard river gravel or clay hardpan, the character of earth varying according to the elevation of the various foundations. Extensive soundings and test pits were driven to determine the nature of underlying earth previous to starting construction. A test pile was also driven in the deepest portion of excavation.

For the foregoing information and accompanying illustrations, *Power* is indebted to the E. W. Clark & Co. Management Corporation, who designed and constructed the Walnut Station.

PRINCIPAL EQUIPMENT OF THE PRESENT BIG WALNUT CREEK POWER PLANT, COLUMBUS, OHIO

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
8	Boilers	Water-tube	4,440 sq.ft. heating surface	Main steam generators	250-lb. steam, 150 deg. superheat	Babcock & Wilcox Co.
8	Superheaters	Single loop	855 sq.ft. heating surface	With water-tube boilers	150 deg. superheat under normal conditions	Babcock & Wilcox Co.
8	Soot cleaners	Diamond		Cleaning boiler tubes	As conditions demand	Diamond Power Specialty Co.
8	Regulators	Copes	2½-in.	Feed-water regulation	Automatic balanced regulating valve	Erie Pump & Equipment Co.
8	Meters	Bailey		Steam flow, air flow, draft	Automatic	Bailey Meter Co.
8	Stokers	Riley, self-dumping	8-retort	With steam boilers	Motor-driven, chain connection	Sanford Riley Stoker Co.
4	Economizers	Green, fuel	6,300 sq.ft. heating surface.	One serves four boilers	Under-pressure	Green Fuel Economizer Co.
4	Fans	Induced-draft	60,000 cu.ft. per min	Induced draft to furnaces.	Motor-driven, 3-in. pressure, variable speed.	Green Fuel Economizer Co.
4	Fans	Forced-draft	45,000 cu.ft. per min	Forced draft to furnaces	Motor-driven, 5½-in pressure, variable speed.	Green Fuel Economizer Co.
1	Fan	Forced-draft	45,000 cu.ft. per min	Forced draft to furnace	Motor-driven, 5½-in. pressure, variable speed.	B. F. Sturtevant Co.
4	Motors	Induction	75-hp.	Driving forced-draft fans	600 r.p.m., 220-volts, flexible coupling	Lincoln Electric Co.
3	Motors	Induction	75-hp	Driving forced-draft fans	600 r.p.m., 220-volts, flexible coupling	General Electric Co.
1	Motor	Induction	100-hp.	Driving forced-draft fan	900 r.p.m., 220-volts, flexible coupling	General Electric Co.
1	Heater	Hoppers		Heating and purifying feed water	One-third heats condensate, two-thirds heats make-up water	Hoppes Mfg. Co.
4	Pumps	Centrifugal, 4-stage	400 gal. per min.	Boiler feed	One motor-, one turbine-driven	Cameron Steam Pump Co.
1	Turbine	Curtis.	105-hp.	Drives feed pump	1,800 r.p.m. water-rate full load 49 lb. per b.hp	General Electric Co.
3	Motors	Induction	100-hp	Drives feed pumps	1,740 r.p.m., 220-volts, A.C.	General Electric Co.
1	Conveyor	Bucket	50-ton per hr.	Coal to bunkers	85 ft. height, speed 250 ft. per min	Jeffrey Mfg. Co.
1	Larry	Traveling	5-ton	Coal from bunkers to stokers	Track speed 400 ft. per min	Jeffrey Mfg. Co.
1	Crusher	Single-roll	24 x 24-in.	Crushing coal	Motor belt-driven, 900 r.p.m.	Jeffrey Mfg. Co.
1	Scale	Track	50-ton	Weighing coal	Provided with tare beams and type registering device	Fairbanks Morse Co.
2	Bunkers	Steel, circular	400-ton capacity.	Coal storage	Concrete-lined	Jeffrey Mfg. Co.
2	Conveyors	Drag	182 ft., 6 in. centers	Handling ashes	Motor-driven, 20 ft. per min	Jeffrey Mfg. Co.
1	Crusher	Single-roll	18-in	Crushing clinkers.	Motor, belt-driven, 40 r.p.m	Jeffrey Mfg. Co.
1	Crane	Locomotive.	15-ton	Reclaiming coal from storage	2-cu.yd. grab bucket, 46-ft. boom	Brown Hoisting Machinery Co.
1	Generator	Turbine	18,750-kv.-a.	Main generating unit	1,800 r.p.m., 13,200 volts, 3-phase, 60 cycles	General Electric Co.
1	Exciter	Turbo-generator.	100-kw	Exciting main generator	3600-1200 r.p.m., 250 volts, 250 lbs. steam pressure	General Electric Co.
1	Condenser	Surface, spiroflo	23,900 sq.ft. heating surface	With 18,750-kv.-a. turbine	Performance 180,000 lb. steam per hr., 22,000 g.p.m., 70 deg. water, 1.65 lb. vac.	Alberger Pump & Condenser Co
1	Pump	Centrifugal.	No. 10	Vacuum in condenser	Turbine driven	Alberger Pump & Condenser Co
2	Pumps	Circulating	20-in.	Water to condenser	12,500 gal. per min., 425 r.p.m.	R. D. Wood & Co.
1	Pump	Condensate	8-in.	Condenser condensate	600 gal. per min., 1,140 r.p.m.	Alberger Pump & Condenser Co.
2	Strainers	Twin	24-in	Straining circulating water.	Brass buckets, ⅜-in. holes	Elliott Co.
4	Pumps	Centrifugal	200 gal. per min	Water to feed-water pumps	Motor-driven 1,200 r.p.m	General Electric Co.
2	Motors	Induction	20-hp	Driving stokers	1,200 r.p.m., 220 volts, gear ratio 4.33 to 1	General Electric Co.
2	Motors	Induction, vertical	120-hp	Driving circulating pump	514 r.p.m., 220 volts, speed range 300 to 500 r.p.m	General Electric Co.
1	Motor	Induction, vertical	35-hp	Driving condensate pump	1,200 r.p.m., 220 volts	General Electric Co.
1	Motor-generator set.	Induction-motor, d. c. generator	35-hp., 15-kw.	Operating coal larry	1,800 r.p.m. motor, 220 volts, generator 125 volts	General Electric Co.
1	Crane.	Traveling.	35-ton	In turbine room	4 motors, 250 volts, d.c.	Case Crane & Engineering Co
1	Battery	Storage	10-amp	Control	60-cell, 125 volts	Electric Storage Battery Co.
1	Charging set	Motor-generator.	5-kw., 10-hp. motor	Charging storage battery	1,800 r.p.m., 125-170-volt generator, 220-volt motor	General Electric Co.
1	Compressor.	Belt-driven	10 x 10-in., 210 cu. ft. per min.	Miscellaneous	235 r.p.m., 125 lb. air pressure	Ingersoll-Rand Co.
	High pressure steam valves, 350-lb. pressure, 800 deg. temperature					Nelson Mfg. Co.
	Water meters for measuring condensate and make-up.					Alberger Pump & Condenser Co
	Transformers, switchboards, all switches and miscellaneous electrical apparatus					General Electric Co.

Rewinding Direct-Current Armatures

By R. THISTLEWHITE

The difficulties of winding armatures are easily overcome if a few general principles are kept in mind. These are given in a very brief form without any technical explanation, it being taken for granted that the statements are correct, and should the reader wish proof of the fact he can refer to any standard work on armature winding and find them.

WHEN an armature is to be rewound, the first thing to do is to count the number of slots in the core and the number of commutator bars, from which can be determined the distribution of the coils. Each coil has two sides, as in Fig. 1. Then (1) if there are one-half as many bars in the commutator as slots in the armature core, there will be only one side of a coil in each slot; (2) if there are as many bars as slots, there will be one side of two different coils in each slot; (3) if there are twice as many bars as slots, there will be one side of four different coils in each slot; (4) if there are three times as many bars as slots, there will be one side of six different coils in each slot. Always keep in mind that for every bar in the commutator there must be a coil in the winding.

As there is only one side of one coil in a slot in No. 1, this winding is known as a single-layer winding. In No. 2 there is one side of two different coils in a slot and the winding is called a two-layer winding. In No. 3 there is one side of four different coils in the same slot, therefore it is termed a four-layer winding. In No. 4 there is one side of six different coils in the same slot, consequently it is known as a six-layer winding.

Determining Spread between Coil Leads Connected to the Commutator

The next operation is to trace from the commutator along a lead to the slot it enters, then stretch a piece of string from the center of this slot to the end of the shaft and mark the bar the string passes over; count from this bar to the bar the lead is connected to, taking notice whether this is to the left or right when facing the commutator, Fig. 2, which shows the throw of the leads to be from 1 to 9 to the left. Now, mark bar 9 and lift up the leads about halfway round the commutator, then with a lamp test from the top lead in bar 9 and find the other end of the coil. Count the bars between these two points, including the two the coil's leads connect to, which will give the spread between leads, and with this information the coils can again be connected up to the commutator as they were originally.

There are two general ways of connecting an armature—parallel and series. In the former the spread between the leads will be one bar; that is, the two ends of the same coil will be found in adjacent bars, while in the latter the spread will vary, depending on the number of field poles in the machine. In four-pole machines the spread will be approximately halfway round the commutator, for a six-pole one-third, etc. In parallel windings the leads can usually both be lifted at the same time; that is, the beginning and ending of the coil, or as they are most commonly spoken of, the bottom and top leads. But in the series winding it is generally practice to place the bottom leads first, which are then covered with about two layers of tape, then the top leads are put down; therefore, when lifting the leads, the top ones would be lifted first. It will also be necessary to stretch the string as before and find the throw of the bottom leads in the same manner as the throw of the top leads was found, and also to observe the direction of the throw.

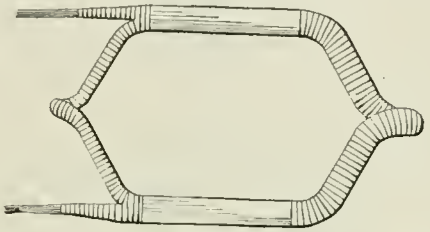


FIG. 1

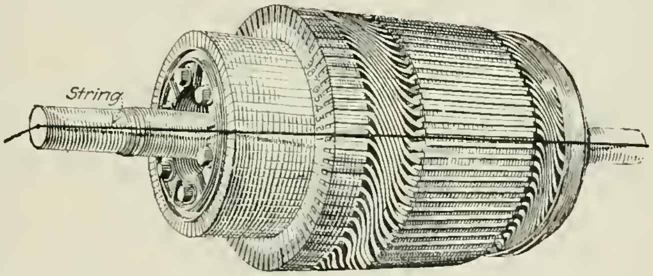


FIG. 2

FIGS. 1 AND 2. ARMATURE COIL AND ARMATURE WITH WINDING CONNECTED TO COMMUTATOR

The distance in bars between the bottom and top leads, counted so as to embrace the bars that the coil leads connect to, is the correct count of the lead spread. It will also be found, for a series winding, if the count is continued it will return to the adjacent bar started from. This is clearly indicated in Figs. 3 to 5. Figs. 3 and 4 show one series of coils connected to the commutator of a four-pole machine and Fig. 5 one series of coils connected to the commutator of a six-pole machine. This can be checked by building a short table thus: In Fig. 4 there are 39 commutator bars and for four poles the lead spread should be commutator bars plus or minus 1 divided by the number of pairs of poles; or, in this case, 39 plus 1 equals 40, 40 divided by 2 equals 20, then the coil leads spread bar 1, and bar 1 plus 20 equals 21; that is, the leads of one coil connect to bars 1 and 21. Continuing the count, bar 21 plus 20 equals 41; as there are only 39 bars, bar 40 would be bar 1 and bar 41 would be bar 2, as in the figure. The table will then read 1 and 21, 21 and 2, etc.

Coming back to the foregoing rule and using the minus sign, 39 minus 1 equals 38, 38 divided by 2 equals 19; then the lead spread would be 1 plus 19 equals 20 and 20 plus 19 equals 39, which is adjacent to bar 1. This is the condition in Fig. 3. The only difference between the connections in Figs. 3 and 4 is that with the motor connected to the line the same in both cases, the direction of rotation of the armature, when the minus sign is used, will be the reverse of that when the plus sign is used.

In the six-pole machine the spread of the leads would be equal to the number of commutator bars plus or minus 1 divided by the number of pairs of poles; in this case three counts have to be made before a series of coils encircle the commutator as in Fig. 5.

When the lead spread has been taken and checked, the armature can be stripped and the number of turns per coil counted and the size wire measured. The core is then cleaned of all old insulation and given a coat of shellac or other good insulating-compound varnish.

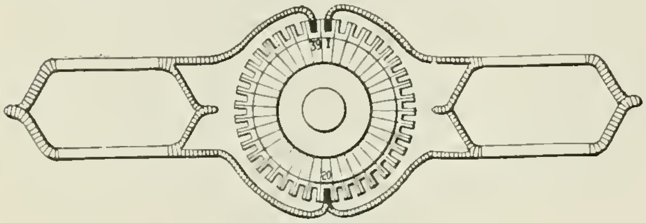


FIG. 3

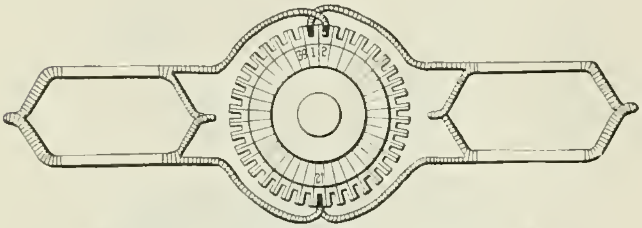


FIG. 4

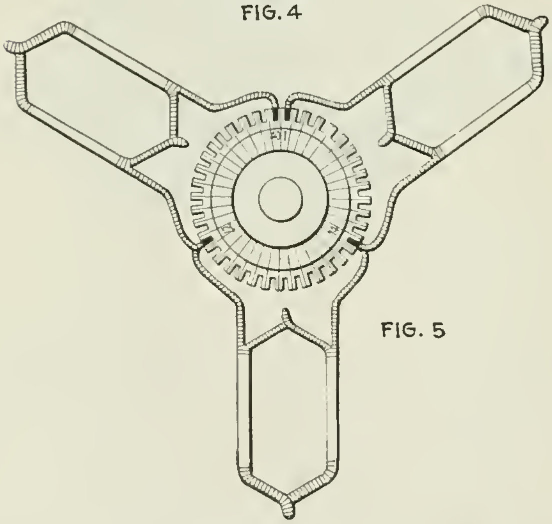


FIG. 5

FIGS. 3 TO 5. ONE SERIES OF COILS CONNECTED TO COMMUTATOR OF SERIES WINDING

Rewinding Four-Pole Armature

I have before me a four-pole armature that I am going to rewind, and will describe the operations as I go through them. I do not know the type of winding at the present time or the count, but from the foregoing it will readily be seen how to go about finding it.

The number of slots in the core is 15 and the number of bars in the commutator 29. Referring back to the data previously given, it will be found that this winding is four layer, that there is one side of four different coils in each slot. Two coils per slot would give 30 coils, and as we have only 29 bars, it would be impossible to connect them all, so one coil is wound in, but its leads are cut off short and it is not connected to the commutator. If this was not done, two slots would contain one side of only three coils instead of four, which would leave the armature out of balance mechanically and also allow the wires to move around in the slot and eventually destroy the insulation and cause grounds and short-circuits.

Stretching a string from the center of the slot to the center of the shaft, the top leads from one slot are found swung over to the left 6 and 7 bars. Since there is one side of four different coils in each slot, there are two bottom leads and two top leads coming from each slot. Lifting the leads about halfway round, the other ends of the coils are found brought out straight and the distance between these leads is from 1 to 15, or 14 bars between.

Checking the Winding Data

Checking this result, 29 minus 1 equals 28, divided by 2 equals 14; 1 plus 14 equals 15, 15 plus 14 equals 29, which is adjacent to bar 1 and is correct.

Before stripping the winding, measure the distance the end of the winding projects beyond the end of the core; in this case it is 0.75 in. The spread of the coil is found to be from slot 1 to 4. The winding can now be removed and the number of turns in one or two coils counted, which in the case in hand is 10 turns.

These results must be tabulated in a notebook and kept for future reference, thus: Number of armature slots, 15; number of commutator bars, 29; coils spread slots 1 and 4; top leads throw 1 to 6 and 7 to the left; bottom leads throw, straight; leads spread, 1 to 15 (14 segments between); coils have 10 turns of No. 17 double-cotton-covered wire, and the wire weighs 2 lb. This last item can be determined by weighing the coils after they have been removed from the core. Any other information can be kept along with these items, such as insulation, time to rewind, cost, etc.

Before rewinding, clean the slots in the commutator bars so there will be no difficulty in getting the wires in and file the top and side, Fig. 6. Scrape in between the commutator bars to remove all carbon dust, also on the ends. Using a 110-volt circuit and lamp test between each bar and also each bar to ground, if the insulation is in good condition there should not be the slighest spark between bars when the 110 volts is applied. If there is a defect, even though it is on the surface of the commutator, scrape it away until it tests clear. Do not allow the test to burn the carbon deposits away on the surface of the mica, as it only injures the insulation.

If the commutator tests out clear, the insulation for the armature slots can be cut to size, so as to allow it to project by the end of the core about $\frac{3}{16}$ in. on each end, and about $\frac{1}{2}$ in. above the core; this will protect the wire as it is wound into the slots. It is preferable to insulate the slots with oiled linen and fiber in the form of a sandwich. For instance, suppose that the slot insulation used is 30 mils thick, make this up of 5 mils of oiled linen and two thicknesses of fiber each 5 mils; this will make 15 mils on each side of the slot, or a total of 30 mils.

In the armature under consideration the insulation as measured from a piece of the old material taken from a slot is found to be 10 mils in thickness, therefore it will be better to make this up of 5 mils of oiled linen and 5 mils of fiber, because if two pieces of 3-mil fiber is used it would be too thin to stand the handling of the wire and would break. The slots are 2 in. long by ½ in. wide and ⅝ in. deep, shaped elliptical. The insulation is cut 2⅜ in. long by about 3 in. wide. In addition to this small pieces of oiled linen will be required to place between the ends of adjacent coils as they are wound, thus increasing the insulation between them.

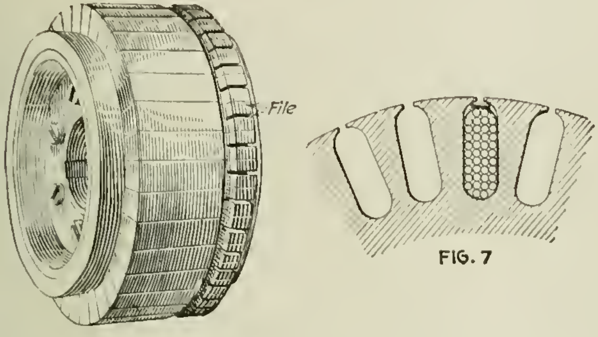


FIG. 6

FIG. 7

FIGS 6 AND 7. COMMUTATOR AND CROSS-SECTION OF ARMATURE SLOT AND COIL

Everything is now ready for the wire, and as the winding is four-layer, two wires can be wound together. To accomplish this, wind half the wire needed upon a second spool and then two wires can be wound into the same slot at once. Mark one of these spools No. 1 and the end of the wire coming from this spool with shellac or blue pencil; when the coil is completed, mark the other end to correspond. This will save a lot of trouble testing out when all the coils are in place. If No. 20 wire is used it would require four wires to be wound together and the wire would have to be wound upon four spools, marking two of them instead of one. It would not make any material difference which of the coils in the same slot came first, but it would make a difference if coils in two different slots were crossed. Begin at any slot, call this slot 1 and wind the first two coils in this and slot 4, then use the next slot and proceed until all are full, placing a piece of oiled linen in between the ends of the coils. Now cut the projecting insulation and turn back into the slot, pushing in a piece of $\frac{1}{16}$ fiber to cover and hold the wire in the slots, as this armature has no bands. A cross-section of one slot with the insulation and winding is shown in Fig. 7.

Looking up the throw of the bottom leads in the data taken from the armature, it will be found that they come out straight. Use the string to find the commutator bar that is opposite the slot started from, then bare the ends of the leads and place them in the commutator, leaving the top ones out. Get all the leads in rotation—that is, one marked and one unmarked lead all the way around the armature—then cover them with two layers of tape. When these leads are placed in the commutator, the ends will project out on the bars for about an inch, but do not cut them off short as it might be possible that some of these leads are twisted, and have to be changed. When the leads are being put down, interweave a piece of tape so as to properly separate each lead from its neighbor. When all the way around, one coil will be left over; this is the dummy coil already spoken of, and its ends must be found and cut off short. It is sometimes more convenient to place one or two coils in the slots and then put their bottom ends in the commutator instead of waiting until all coils are wound.

We are now ready for a test, and this must be made before the top leads are brought down to the commutator—first for rotation to see that no leads are twisted, then for shorts and opens. Arrange the top leads in the order that they come out of the slot and begin anywhere with the test lamp. Place one end of test circuit on the top lead and with other terminal find the commutator bar that the bottom end is connected to; this will light the lamp if there is no opening in the coil. Keep in contact with the top lead and touch the bar on each side of the one that the bottom lead connects to; no light shows no short-circuit between coils. Mark the bar which lights with chalk or anything else to identify it and place the test lead on the next commutator bar; a light should be obtained on the next top lead. Continue this all the way around. If any are crossed, make the correction on the bottom leads. Finally test for grounds; place one test lead on the core and with the other touch on each bar of the commutator. Next run a layer of tape over the bottom leads to make a nice even surface on which to lay the top leads, completely covering the ends of the coils, and begin to lay down the top leads. Select one top lead and find the other lead of this coil in the commutator, count toward the top lead 15 bar and place the top lead in this bar, and continue in rotation, making sure that none get crossed.

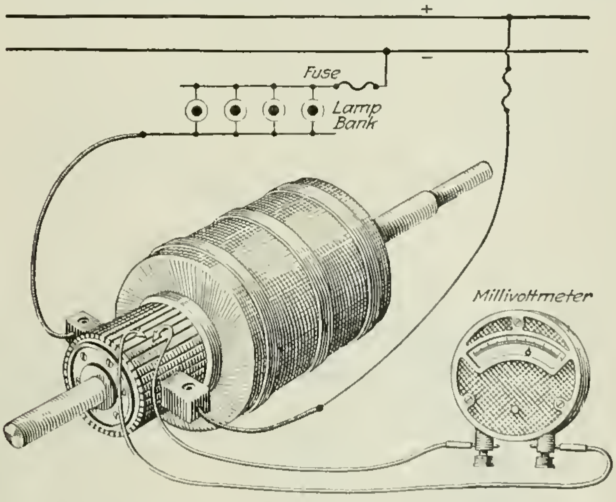


FIG. 8. METHOD OF TESTING ARMATURES

When all the leads are in place, hold them down with a temporary string band and place a little noncorrosive soldering paste on each bar and solder the leads in place. Raise the back end of the armature slightly to prevent the solder from running down the back of the commutator. Wash the commutator thoroughly with gasoline to remove all traces of soldering paste. Lastly, test with a millivoltmeter; the test can be made before or after the commutator is turned down.

With a bank of lamps in series, place two leads from the 110-volt circuit at points on the commutator where the brushes will rest when the armature is in place; that is, one-half way round for two-pole machine, one-quarter for a four-pole machine, etc. Pass a current through and measure the voltage between bars with a millivoltmeter; each reading will be the same if the work is correct (see Fig. 8).

Turn down the commutator and remove temporary string band on the leads and replace it with a permanent one. Place the armature in an oven until it is at a temperature of about 250 deg. F. for one-half hour, then remove and dip in or paint with clear insulating varnish and then rebake at a temperature of about 200 deg. F. for six or eight hours. This will make a very hard finish and warrant against the entrance of moisture or oil into the winding.

On parallel windings the procedure is somewhat simpler than that on series, as the leads of the coils are both brought together on one side of the coil because they are connected to adjacent commutator bars. All that is necessary is to use the string to find the throw of the leads, either to the right or left, and the spread of the coil in the slots. Usually, with small wires the coil is wound in, say, slots 1 and 4; then, instead of cutting a lead on the coil long enough to reach to the commutator readily, the wire is looped and the next coil immediately started. When the winding is completed, a loop is placed in each commutator bar; this will be the same as placing the ends of one coil in adjacent bars. The baking, etc., will be taken care of in exactly the same manner as for the series-connected winding described in the foregoing.

Portable "Chaingrip" Pipe Vise

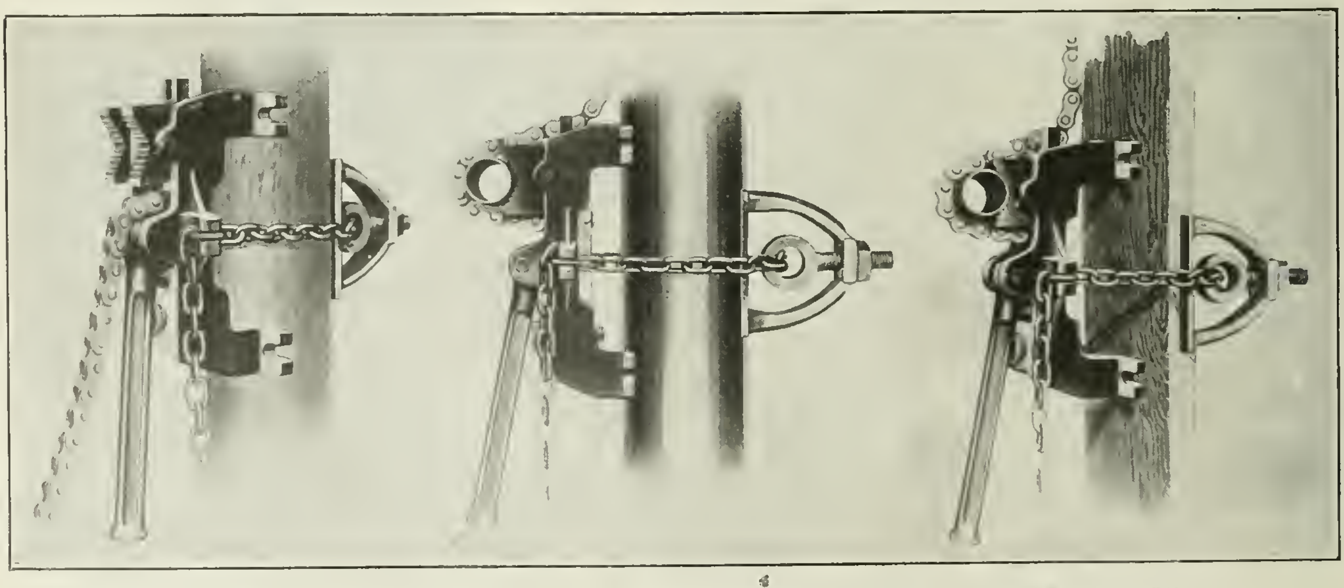
Most pipe vises are made to be permanently secured to a bench, and when the pipe has been threaded it must be carried to the point where the work is being done. Frequently, a portable vise bench is made, but it is not always convenient nor is it possible to move it to the point where it is wanted.

A portable vise known as the "Chaingrip," which can be easily and quickly removed from one location and mounted at another, is made by the Gerolo Manufacturing Co., Old Colony Building, Chicago, Ill. It can be fastened to any horizontal or vertical support, round, square or flat, without the use of bolts, and it locks any size of pipe or conduit within its limits by the slight push of a lever.

The base support of the vise is in the form of an inverted V, at the sides of which are bolt lugs to be used only in case the vise is to be permanently bolted in one position. It will therefore conform to a round, square or flat surface. A clamp support to fit on the opposite side of the column is a part of the equipment. The vise is clamped to any upright by means of a chain which passes through an eye-bolt that is part of the clamp. One end of the chain is riveted to one side of the vise base. After passing around the supporting column through the eye of the bolt, a link is held in position in a socket on the opposite side of the base. Screwing up on the eye-bolt nut tightens the supporting chain and holds the vise in position to the support, as shown.

The pipe or conduit is locked between a double set of steel pipe jaws on one side, and by a heavy close-linked steel chain on the other. The locking motion is accomplished by the downward movement of a lever. One end of the chain is riveted to one end of a horizontal bar which comes in contact with a cam on the lever end. The gripping chain passes around the pipe or conduit and is locked in a steel socket on the outer end of the base. The other end, or fulcrum point of the bar, is supported by a threaded bolt the enlarged knurled head of which rests upon a boss on the base of the vise. Rotation of the head of the bolt raises or lowers the fulcrum point of the bar and forms an adjustment of pressure exerted by the other end of the bar on the gripping chain when the handle of the vise is in a locked position.

The application of the vise to uprights is shown in the illustrations, also the method of attaching the vise and securing the pipe in place.



APPLICATION OF THE CHAINGRIP VISE TO SUPPORTS AND METHOD OF CLAMPING PIPE

Conditions in the Power Industry

BY LUDWIG W. SCHMIDT

A digest of the reports of the United States consuls on the power situation in the various parts of the world and the influence of the war upon this important industry. Also, see "Power," Dec. 11, 1917.

THE demand for electrical power is still very great all over the world. The principal reason, of course, is the industrial activity caused by the war. Secondary influences are the shortage of fuels used for power generation and in some cases their present high cost. The latter consideration, for instance, is responsible for an increased employment of electrical power in cases where gasoline was in use formerly.

Consul Franklin D. Hale reports from Huddersfield, England (C.R. 256)[1], that there is a great demand for electrical vehicles of all kinds throughout England. In some cities electric power has been adopted for omnibus service, and at many places power for commercial electrics can be had at the rate of 2c. per kilowatt-hour. A similar report is made by Consul E. Haldeman Dennison in Birmingham (C.R. 265).

The increase in the cost of coal has compelled additional expenditures in the budget of many electrical enterprises in England. It is reported (C.R. 273) that the Glasgow Corporation estimates an increase of $121,662 in the fuel bill of its electrical central station. The difficulties created by the increased cost of fuel for many of the central stations in England have made the last year a very unsatisfactory one, notwithstanding the fact that the kilowatt-hour output sold increased nearly everywhere. It is, therefore, interesting to note that the desire for a better organization of power distribution in England is gaining ground. Consul J. S. Armstrong, Jr., in Bristol, quotes in support of this contention, part of the engineers' report of the Bristol Electricity Department, where it is said: "It appears likely that in the very near future the organization of the electricity-supply industry throughout the country will be rearranged on a much broader basis than hitherto, the country being for such purpose divided into districts irrespective of municipal boundaries or the present limits of company-supply areas, and the generating stations of the future, being fewer in number, will be equipped with larger and more efficient machinery than at present in use" (C.R. 274).

In view of the great development of the hydro-electric power distribution expected in Italy as a result of the war, remarks made by Vice Consul Ilo C. Funk about the power situation in Milan are of considerable interest (C.R. 301). Milan today draws its electrical power from the Alps, where it is produced by hydro-electric plants. Power is distributed by the Societa Generale Italiana Edison di Elettricita and the Azienda Elettrica Municipale. Although both these enterprises have steam-electric plants in Milan, these stations are used only in time of drought. The energy consumed in Milan and adjoining towns is given as an average of 800,000 kw.-hr. per day, the maximum power demand varying from 56,000 to 70,000 kilowatts. Almost all the power is three-phase 42-cycle alternating-current transmitted at 8700 volts, only a limited quantity being 110- and 220-volt direct current used for lighting purposes in the central section of Milan. Two important power plants are now under construction—one at Sesto S. Giovanni, Province of Milan, belonging to Ernesto Breda & Son; the other in Milan, belonging to the Acciajerie e Ferrerie Lombarde. Both will produce three-phase alternating current and transmit it at 70,000 volts. The lack of fuel so prevalent in Italy has made necessary great economy among all those central stations using coal for generation. It is reported from Turin (C.R. 282) that the use of electricity has been restricted, in that city, by a decree of the prefect, resulting in a reduction of consumption of 50 per cent.

In Oporto, Portugal, a company has been organized to develop the water power of the northern part of the country (C.R. 271).

Denmark is feeling the effects of the war along with the rest of the neutral countries of Europe. The principal problem at present is the need of energy for lighting and power purposes. Denmark in this respect is rather unfavorably placed, as it has few hydro-electric possibilities. On the other hand, the proximity of Sweden, with its great hydraulic-power resources, has led to experiments to transmit power from that country to Denmark over submarine cables. This, in the case of several smaller villages in the north of Denmark, seems to have met with good results. The difficulty at the present time is, the power production of Sweden is considerably reduced during the winter months, and there has not been a sufficient surplus to continue a supply to Denmark during this period. With the increase of the Swedish power-producing facilities a better employment of part of the Swedish power reserves in Denmark should become possible. Commercial Attaché Erwin W. Thompson in Copenhagen reports (C.R.296) that additional cables will be laid across The Sound with the intention of furnishing power to the street-car service of Copenhagen and Frederiksberg. This power will come principally from the Laga Lakes and the Trolhättan Falls.

From the Gold Coast in Africa it is reported that the City of Secondee will be furnished with electric light by the Gold Coast Railway (C.R. 304).

Electrical development in New Zealand and Australia continues to be very active. Consul General Alfred A. Winslow writes that the City of Dannevirke intends to build an electric-lighting plant for its 6000 inhabitants (C.R. 264). Increasing attention is given to the use of electricity in the farming and dairying districts of the South Island of New Zealand. This is the country around Christchurch, and it is intended to erect a government hydro-electric station in that neighborhood.

Considerable activity in electrical development also is reported from all parts of the American continent south of the United States. Consul G. C. Woodward, Matamoros, Tamaulipas, Mexico, says (C.R. 262) that the

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[1] C. R. indicates "Commerce Reports" of 1917

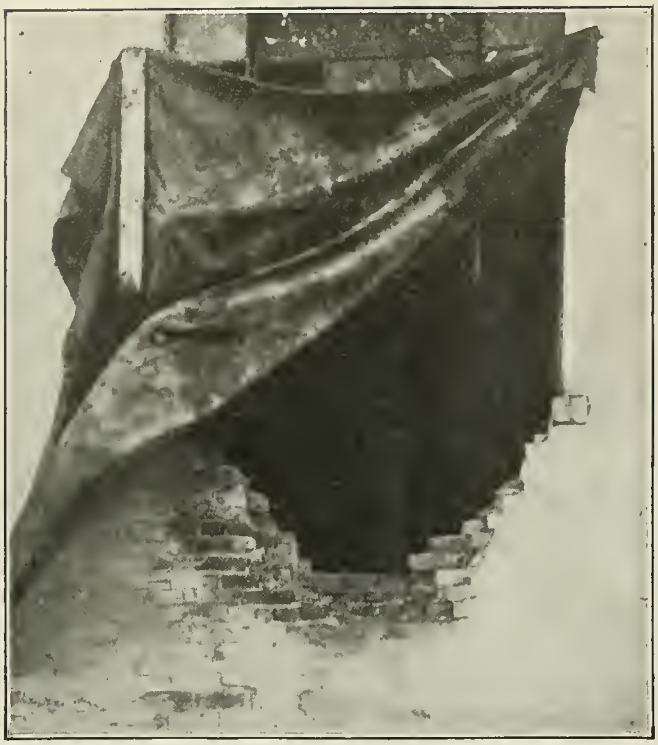


FIG. 1. WALL TORN OUT BY EXPLODED FLYWHEEL

only electric-lighting plants established in his district are at Victoria and Matamoros. The supply of electric light and power for public and private use is contemplated in Santo Domingo, Dominican Republic (C.R. 262). It is also reported from that republic that a franchise to build an electric railway in the City of Santiago de los Caballeros has been annulled. This would have been the first electric tramway in the Dominican Republic (C.R. 286).

Plans are under consideration in Guadeloupe, French West Indies, to build an electric railroad with a total length of track of 118 miles. The power will be obtained by harnessing two waterfalls, which are expected to supply sufficient energy (C.R. 275).

Consul Frank Anderson Henry reports from Venezuela (C.R. 275) that the South American Copper Co. at Aroa is engaged in enlarging its present small hydro-electric plant to about 800 hp. The City of San Felipe will have an electric-lighting plant, and it is further contemplated to furnish Barquisimeto and Yaritagua with electricity generated by a large waterfall near the latter city. Barquisimeto has already a small plant using anthracite for fuel. This, however, supplies light only at night. The war has brought a considerable weakening of German influence in electrical enterprises in South America. It is reported that the Compania de Tramways Electricos del Sud, of Buenos Aires, Argentina, has not renewed its power contract with the Compania Alemana Transatlantica de Electricidad, which is a German company, but has made arrangements for a power supply from the new Compania Italo Argentina. The income of the tramway company shows a falling off, and the operating expenses have increased (C.R. 234).

Interesting information as to power development in Peru is contained in a special report by Consul General William W. Handley, Callao, Lima (Supplement C.R. 46a). This report shows that the service provided by the Lima Light, Power and Tramways Co. has increased considerably with good effects on the income of that enterprise. This increase is due especially to the growing of general industrial activity in and around Lima, which holds good promise of a further extension of power demand in that city and its neighborhood.

Flywheel Explosion at Minot, N. D.

The photographs reproduced show some of the havoc caused by the failure of a flywheel on a direct-connected reciprocating-engine generating unit at the plant of the Northern States Electric Light and Power Co., Minot, N. D., at about 3 a.m., Oct. 17, 1917.

The night engineer was instantly killed and a large amount of property damaged. Fragments of the wheel went through the window and the brick wall below it, as shown in Figs. 1 and 2, rocketed a full city block (about 500 ft.), striking a newly erected brick building which was unoccupied except one apartment on the top floor, into which a piece of the wheel was driven, causing the damage shown in Fig. 4. Fortunately, a larger engine, set at right angles with its shaft almost in line with the flywheel that failed, was not running or greater damage no doubt would have resulted, as several large pieces of wreckage were found in its wheelpit, and some wreckage may be seen near it in Fig. 3.

A curious feature was the damage to a box-car and the tearing out of two rails from the main track of the Great Northern Ry. The "Oriental Limited" was about due, but was flagged in time to avoid a wreck. The city was without light until the débris was cleared away and numerous repairs made to the damaged plant.

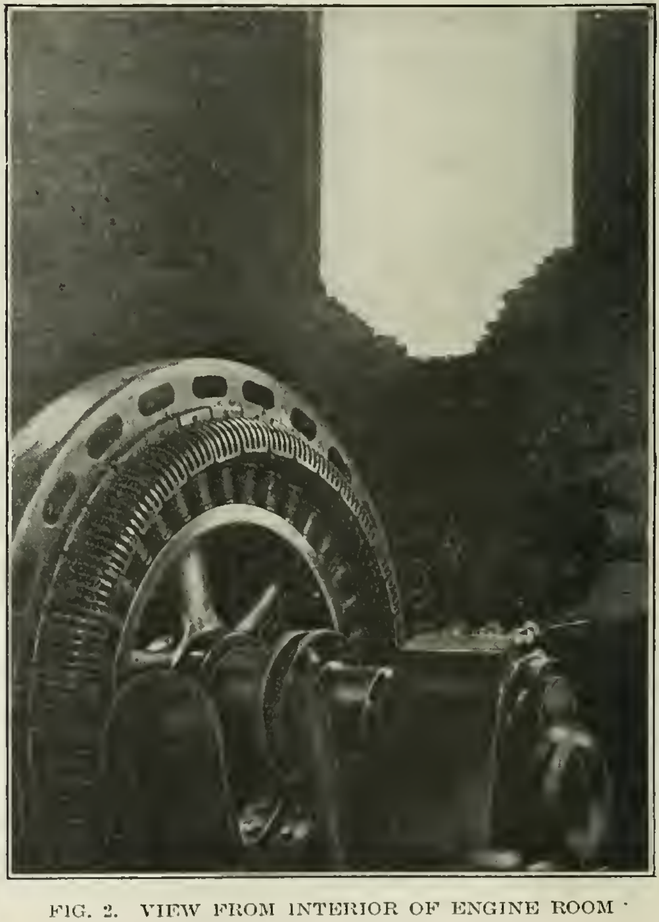


FIG. 2. VIEW FROM INTERIOR OF ENGINE ROOM

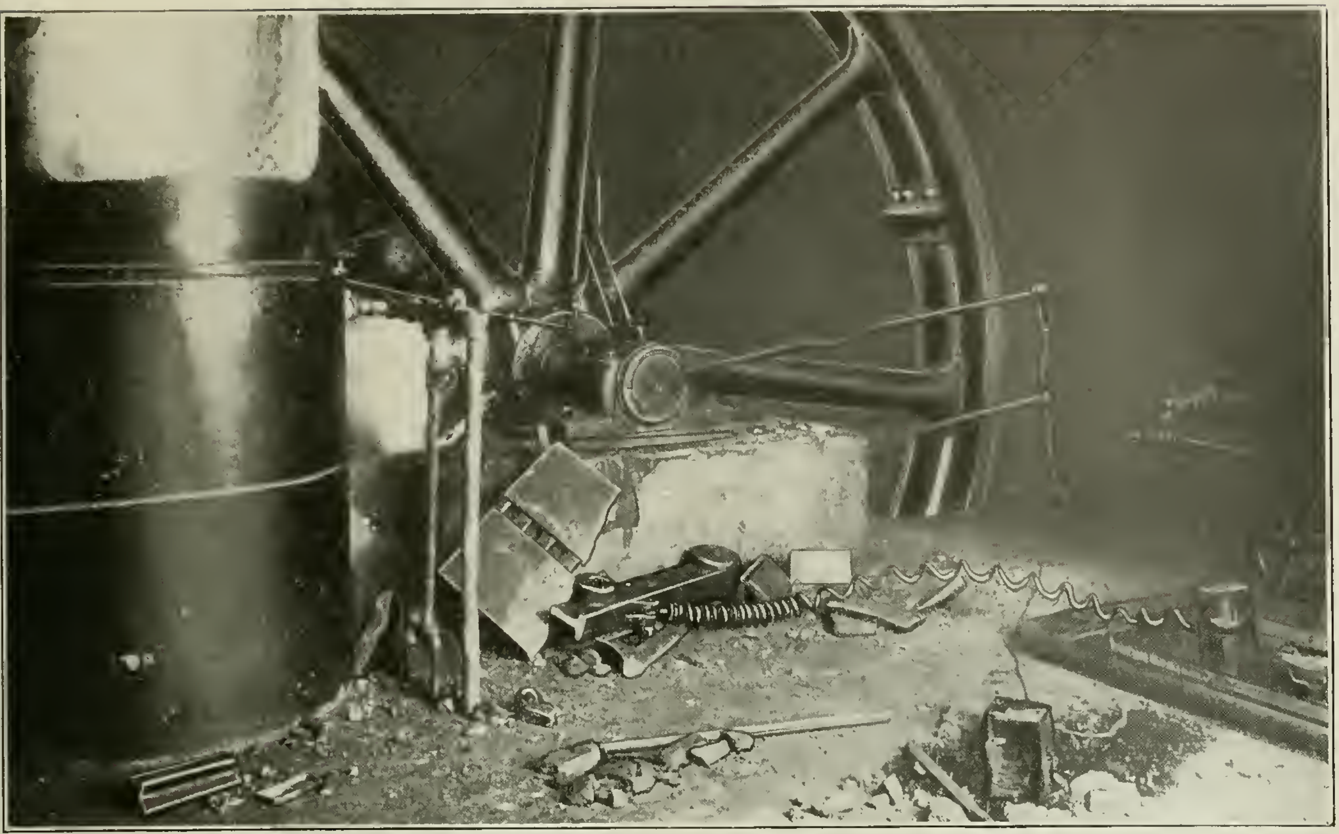


FIG. 3 FRAGMENTS OF FLYWHEEL AND GOVERNOR AGAINST FOUNDATION OF IDLE ENGINE

FIG. 4. INTERIOR OF APARTMENT WHERE DAMAGE WAS DONE

Average and Maximum Heating Demand

By M. W. Ehrlich

In heating work it has become an established custom to design plants to provide a temperature of about 70 deg. indoors when the minimum outside temperature is zero, but during the season the outside temperature may be as high as 65 deg., when but little artificial heat is needed. This range of outdoor temperature corresponds to conditions in the Middle Atlantic states; elsewhere the minimum outside temperature may be considerably above or below zero, therefore the local weather bureau records should be consulted to learn the lowest temperature. However, it is customary to base calculations for average conditions for the range from zero to 70 deg. In many localities zero weather may not be reached except in January and February, and then only during the early hours of the morning, just after midnight, lasting for periods of not more than about three to four hours at a time during the entire season.

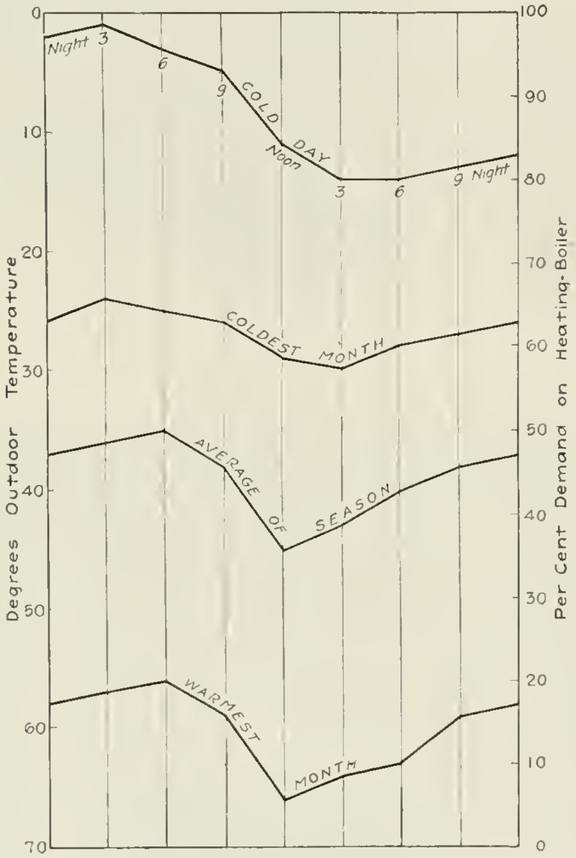


FIG. 1. TYPICAL TEMPERATURE-FLUCTUATION CHART

The maximum demand for heat therefore obtains only for very short periods. The average requirements for the locality referred to are given graphically in Fig. 1, which shows the typical fluctuations in outdoor temperature during a day in the coldest and the warmest month and for the entire heating season. The scale at the left gives the temperature in degrees, and the scale at the right is assumed to be the corresponding tax on the boiler plant to supply the required steam. The curve of the "warmest month" might represent April, while the "coldest month" might be January or February. In the first case the boiler would be taxed an average of about 15 per cent. of its capacity, while in the other case the average monthly demand is about 62 per cent., and for an "extremely cold day," the minimum temperature is nearly zero during the night, gradually rising to about 14 deg., averaging about 9 deg., taxing the boiler during that day to about 87 per cent. of its capacity. The average temperature for the heating season in New York City is about 38 deg., requiring approximately 44 per cent. of the assumed maximum boiler capacity.

The amount of coal or steam, which is the tax on the boiler, therefore is a proportionate variable of the outdoor-temperature fluctuations, and on this basis, using zero temperature as a maximum demand, diagram Fig. 2 has been prepared for average conditions in New York and vicinity or other localities having similar climatic variations during the heating season. It is intended more as an illustration of how such diagrams are constructed and used than as a standard of computation. As an example it should serve its purpose well.

The load curve, shown shaded, may represent the amount of coal or steam or boiler tax for each month. The scale at the left is given in percentage for convenience, as in that way a relative value is at once established regardless of the unit and numerical value selected. The monthly coal requirements are expressed in percentages of the total used during the season. For example, during December 18.2 per cent. of the coal used during the entire heating season will be consumed, while in April only 9.8 per cent., showing that considerable coal is wasted because the boiler drafts and radiators are not controlled in conformity to the weather variations, but with automatic temperature regulation and draft control the steam demand would correspond closely.

Keeping a Record of Outside Temperature

A monthly check on the coal consumption is conducive to operating economy. For a given locality it is therefore necessary to construct a diagram similar to Fig. 2, which would take the local weather conditions into consideration. By keeping a record of the outside temperature, either through personal observation or by watching the newspapers if there is no local weather bureau, the essential information may be obtained. It is useful to record at least the average daily temperature on the power-plant log sheet. Some engineers note down in addition the maximum and minimum outdoor temperatures. Then, according to the records, taking 70-deg. temperature difference as a basis, the average temperature for November is, say, 43 deg.; then 70 less 43 gives 27 deg. difference, and dividing this by 70 equals 38.6 per cent. Likewise in January the average is, say, 25 deg. and the difference is then 70 — 25 = 45, which divided by 70 gives 64 per cent. In the same way the relative heating demand for each month is determined and plotted. It should be noted that the divisor is the maximum or basic temperature difference, which represents 100 per cent. From the values found as shown, the average of the season is computed as well as the relative monthly coal requirements.

The actual quantity of coal required for a heating system is dependent on the variables heretofore noted, and for a particular installation the local physical conditions must also be known. This would mean the total or equivalent square feet of direct radiation in the building, the number of hours the system operates during the heating season and the grade of coal burned. The computation for the tons of coal required for the heating system during the season is:

$$\text{Tons of coal} = \frac{\text{sq.ft. radn.} \times \text{hours operation} \times 300}{\text{heat in coal} \times 2000 \times \text{efficiency} \times \text{average demand}}$$

This computation may be simplified for practical application as follows, so that the result will be the tons of coal approximating fair operating conditions. The variables are well accounted for in the fact that there are losses when fires are banked and cleaned and that the draft control does not correspond exactly with the weather variations. These variables comprise the useful heat in the coal, the over-all efficiency and the average heating demand.

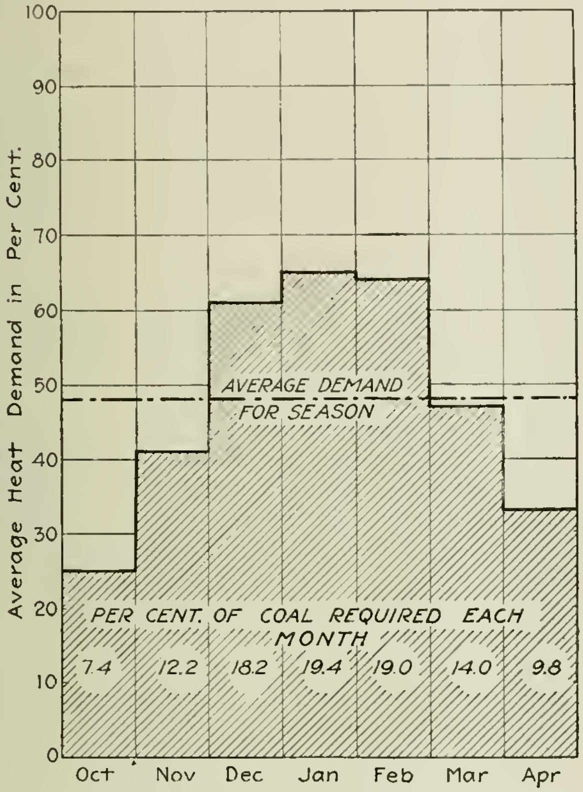


FIG. 2. SEASON'S MONTHLY AVERAGE TEMPERATURE

The average demand on the system for the entire heating season is a value that must be determined for the particular locality in which the plant is situated, as it depends on the weather variations and may be arrived at in the manner explained in connection with Fig. 2.

Taking all these variables as one combined whole, the component may be designated as a factor to be used in the simplified formula. This factor would naturally vary for different localities because the weather conditions give a different average demand on the system. It would also vary for hard- and soft-coal operation because of the characteristics of these fuels. Then, for observed averages of operation and heating demand in steam plants using hard and soft coal, the values for this factor may be computed for different localities. The numerical values of this complex factor so computed have been designated as *f* and are given in the tabulation herewith.

TABLE GIVING VALUES OF FACTOR (*f*)

Location	Hard Coal	Soft Coal
Boston, Mass	85	80
Columbus, Ohio	84	78
Detroit, Mich	89	83
New York, N. Y	70	73
Philadelphia, Penn	75	70
St. Louis, Mo	64	60

These values, when used in connection with the following formula, give a close approximation of what the coal consumption should be under fair operating conditions. The factor *f* may therefore be said to represent the tons of coal used per hour during the heating season for each square foot of radiation for a given locality when applied specifically to the formula which gives the total tons of coal required for the heating season as equal to:

$$\frac{\text{Sq.ft. radiation} \times \text{hours} \times f}{10{,}000{,}000}$$

Consider for example a shop running 24 hours a day for 200 days in the vicinity of Boston and the installation consists of several indirect radiators, pipe coils, and many regular cast-iron radiators, aggregating an equivalent of 2380 sq. ft. direct radiation. What will be the coal consumption under this condition? According to the foregoing the computation is as follows: 24 hours times 200 days gives 4800 hours as the total operating time. The average demand corresponding to *f* is 85 for Boston, when anthracite coal is used. Then, tons of

$$\text{coal} = \frac{2380 \times 4800 \times 85}{10{,}000{,}000} = 97.1 \text{ tons.}$$

Then with 97 tons required for the heating season, the monthly use of coal can be determined as has been shown, but it is a variable corresponding to the weather and not a direct fractional proportion of the total months in the season. Assume that this condition corresponds to the load diagram, Fig. 2. It will be seen, for example, that for the month of December 18.2 per cent. of this total, or about 17.7 tons of coal, will be required. In the same way it is found that during the month of March 14 per cent. is consumed, which is equal to about 13.6 tons.

Determining the probable coal consumption by the method outlined, gives a means of comparison, for if the actual coal consumption for any month exceeds the quantity as computed for the weather conditions and temperature differences, then apparently some coal has been wasted. If the difference is quite small, it may be just a variation due to averaging, but if there is a wide discrepancy, the conditions justify an investigation so that the same leak or waste will not occur or appear again.

This method of computing the coal consumption will be found to agree closely with practical conditions, and as a means of checking the operating efficiency of the plant it will be found helpful. Engineers who keep plant records or log sheets usually know what the total coal consumption is for the entire plant and equipment. Deducting the coal required for the heating system gives a remaining quantity that shows the other useful service the coal has given. If this figure is too high for the load carried, something requires attention and the sooner this waste is found and things set right the sooner will the over-all efficiency begin to pick up.

A Traveling Anti-Waste Exhibit

In a large manufacturing plant where thousands are employed, it is surprising to learn of the food products and manufacturing material wasted each day.

To give the employees of the Westinghouse Electric and Manufacturing Co. some idea of the waste, the management devised the idea of fitting up a storage-battery truck as a traveling exhibit and upon it a collection of food wasted, including bread, butter, meat, cakes, crackers, pickles, cheese, fruits, etc., as well as a quantity of manufacturing materials such as copper, zinc, lead, mica, rubber, felt, gum and similar materials, much of which could be used to advantage.

It is estimated that the foodstuffs wasted every day amount to between $35 and $50, the cost of which, of course, comes out of the employees' pockets; the waste of material amounts to hundreds of dollars per day—which would be a loss to the company if it were not that a force of men are continually assorting the seemingly scrap material and turning it back for use or so that the highest price may be obtained for scrap produce—all due largely to the carelessness of the employees.

A TIMELY OBJECT LESSON

Above the material is a sign reading in large letters, "Wasted"; and underneath the words, "Food Brought from Your Homes"; and on the other side, "Material Belonging to the Company."

This truck was driven up and down the shop aisles so that the employees could look upon it and form in their minds some idea of the waste. Such an object lesson is valuable at this time, when everyone should reduce waste as much as possible.

Fuel Saving "Don'ts"

To assist the Fuel Controller for Canada in his campaign for fuel conservation, the General Accident Assurance Co. of Canada has prepared the following series of "don'ts," which have been printed and are being distributed to manufacturers and boiler owners:

1. Don't fill the furnace with the intention that there will be no necessity for any additional fuel for the next two to four hours. This is quite a common practice with heating boilers, and with bituminous fuel results in very great waste.

2. Don't regulate the draft by closing the ashpit door, but regulate it with a damper in the smoke flue or pipe between the boiler and the chimney. This also applies to any kind of furnace.

3. Don't allow any cracks in the brick setting of the boiler, because cold air will enter through these cracks and absorb the heat that should have been transferred to the boiler.

4. Don't permit the use of grates of any kind which are in bad condition. This will permit the unconsumed fuel to fall through to the ashpit and be shoveled out as ashes or waste.

5. Don't use a grate that is larger than will permit the burning of at least 12 lb. of coal per square foot of grate per hour.

6. Don't permit any pipes or boiler surfaces to remain uncovered, unless it is necessary to transmit the heat through the surface of that pipe to the room in which it is located.

7. Don't permit any joint in the boiler or any pipe connected thereto to leak.

8. Don't permit any valve to leak which is located on a pipe supplied by the boiler. This is a very common source of loss. All valves should be positively tight when closed.

9. Don't attempt to control the quantity of condensation to be collected from any pipe or other apparatus by hand control. There are many good serviceable traps to collect these returns of condensation and they should be returned from these traps to the boiler.

10. Don't permit any surface on the boiler exposed to the furnace heat to become covered with soot or ashes. The tubes should be cleaned at least daily.

11. Don't use live steam for heating rooms, liquids or other substance when there is exhaust steam from engines or pumps available. If the exhaust steam is not of sufficient temperature to heat the room, the liquids, or other substance to the required temperature, arrange your heating to be done in two stages; for instance, water could be heated to nearly 212 deg. F. by exhaust steam, then passed through to another vessel to be heated to the desired temperature with live steam.

12. Don't feed a boiler with cold water when there is exhaust steam available to heat it. Every eleven degrees in temperature that feed water is raised by heating by exhaust steam there is a saving of 1 per cent. in fuel, and in wintertime especially feed water is very seldom any warmer than 42 deg. F. If this water is heated to 212 deg. F. it will then effect a saving of 15 to 16 per cent.

13. Don't allow the main steam valves on any engine or pump to leak. This is a very common fault, due to the fact that the leak is not seen.

14. Don't allow the piston of any engine or pump to leak. This is also a common defect permitted to go on day after day simply because the leak is not seen.

15. Don't take it for granted that pipes that lead to sewers, blowoff tanks or other places of discharge are tight. If the pipe is warm between the stop valve and the source of discharge, it will generally pay to investigate a little closer, because it generally is a sure sign of leakage, with great waste.

Editorials

Use Surplus Productive Power To Rehabilitate the Railways

THERE are indications on all sides that we are approaching an industrial and economic crisis. One of the most evident signs of this is the amount of criticism which is being showered on those in charge of Government activities, nearly all of which at present relate to the war. The attempts to blame these various inefficiencies on individuals are being made on all sides. It was only natural in this confusion that Army officers and Government officials in general should be the first to receive the blow, for we have always held the theory that Government officials were far more inefficient than our business men.

The number of applications from private manufacturers for the help of "efficiency engineers," which has so largely increased lately, is indicative of a realization on the part of many of our manufacturers that their methods also are not what they should be. The people who are applying for help are in many cases no worse off, as far as their methods are concerned, than others who have not yet discovered how badly they are doing their work. The whole subject seems to resolve itself into the fact that our business and industrial systems are not suited for times like these, when it is necessary to combine all our energies and exert our full driving power toward the achievement of one supreme object.

We should not be surprised that this is the case, for our economic theory has never contemplated teaming up all the industries of this country for one object, but has rather discouraged that idea and encouraged individual competition of the most strenuous kind. In other words, we are a nation of individualists who have never really seriously contemplated coöperation for the common good.

When this problem of coöperation is suddenly put up to us as it has been by the war, it is not surprising that our business men, trained in the individualistic school, should be entirely unfitted to solve the new problem. Moreover, it might be expected that the men who have been most successful in individualistic, competitive business, in which profit was the main aim, should be actually the ones least fitted to establish a scheme of business and production for the benefit of the community. This is a new problem to them, and one altogether outside of their experience.

It is to be granted that such business men may have individually great driving power, but this very excess of driving power in individuals or corporations is likely to make the confusion all the worse, unless a means of coördination is established which will keep the driving power of the individuals or corporations in proper balance.

It has become perfectly evident to all observers that the capacity of the nation for production of war material is enormously greater than its capacity for shipping it to Europe, and that we must at once not only balance this production, but slow it down in order to prevent such a choking of our Eastern ports as may produce an impossible condition. The five-day shutdown ordered by the Fuel Administrator and the one day per week shutdown are our first attempts to slow up this production, and we ask ourselves at once if this is the best way. The answer comes that if we are making too much war material we had better turn such of our activities as cannot be utilized in increasing our shipping capacity into the manufacture of articles of peace. Immediately we run into the financial situation, which at present seems to seriously hamper new undertakings.

It would seem that the claim of the railroads that they need $1,000,000,000 worth of improvements should at this juncture be considered. Here is one organization now devoted exclusively to the service of the community, which, being under the control of the Federal Government, can be financed directly by that Government, and there would seem no reason why the production programs of war material should not be limited, and a certain amount of the energy now being expended in that direction turned at once toward the improvement of our transportation facilities.

Our Fuel-Oil Supply

NATURE has been prolific in her provision of fuels for the benefit of man. The potential energy locked up in the interior of this planet of ours is enormous. The world's coal reserve, according to a recent estimate, is roughly 7,397,553,000,000 tons. Miners are cutting into the supply at the rate of about 1,500,000,000 tons per year, or less than two-hundredths of one per cent. In all probability the estimated amount of the world's coal reserve is much below the actual figures given, since coal is occasionally found in territory yet unexplored and in localities where its existence was not previously suspected.

The present world conflict has accentuated the demand for liquid fuel to the extent that the magnitude of our petroleum supply is one of the questions of the hour. The present demand for petroleum is in excess of production, in spite of the fact that over three hundred million barrels was marketed in the United States alone in 1916, and the estimates for 1917 and 1918 are 319,000,000 and 338,000,000 barrels respectively. Since the United States in normal times produces approximately sixty-five per cent. of the world's petroleum, we may expect a petroleum consumption for 1918 of over half a billion barrels. With the consumption increasing at the rate of six per cent. each year, we have a right to be somewhat concerned about the source of our future supply.

Where is the oil to come from? Unlike our coal resources, we have no means of estimating the contents of the oil sands below the earth's surface. Whether our oil reserve is being rapidly depleted or not, we have no means of telling. We may be fast approaching the limit, or we may be just scratching the corners off, as in the case of coal. This refers to our supply of oil from wells.

The history of the petroleum industry would tend to make our forecast optimistic in a way, while the general tendency is toward the pessimistic view. This attitude is caused more by the habit of jumping at conclusions than basing our decisions upon actual facts. We have it as the opinion of one well informed in the oil industry that there are possiblities of new fields in every state in the Union. It is a matter of fact that oil is often discovered in most unexpected places. Localities that are considered today as of no importance in the oil industry may, a few years hence, be pouring out a flood of oil.

This statement is substantiated by numerous examples. The production of the Kentucky oil fields was in the front rank for November, 1917, yet about a year ago this state stood at the bottom of the list. Wyoming is fast becoming an important factor in production. While six years ago its output was of practically no account, today it is giving us about five million barrels a year. But the rise of Oklahoma as a producing state was, perhaps, the most spectacular. In 1906 its production was so small that it was included with that of Kansas; in 1915 Oklahoma passed California and stood in the front rank with a production of nearly ninety-eight million barrels, which was 34.83 per cent. of our total production. This would give a reasonable foundation to hope for the discovery of new fields from time to time as the demand increases the incentive to search for them.

Leaving our own shores, we find that there is much potential oil territory in many parts of the world. China, for example, promises much for the future, although the present production in that country is small. Oil territories are being exploited in Australia and New Zealand. Many parts of South America hold out promises; for example, the oil fields of Argentina and Peru are already of considerable importance.

Passing from the oil well as a source of supply, we have within our borders another source of this valuable fuel, of almost limitless extent, as yet untouched. Unlike the oil from wells, it is possible to estimate the extent of this supply. Covering 100,000 acres in northwestern Colorado and extending into the neighboring states of Utah and Wyoming, there is practically a whole mountain range of bituminous shale, rich in oil. The sides of the precipitous cliffs in this region show layer upon layer of rich oil shale. A careful survey of this region, by representatives of the United States Geological Survey, indicates a deposit of petroleum in Colorado alone, of at least twenty billion barrels. Comparing this deposit to the output from oil wells, it is found to be nearly three times the total production of petroleum in the world from the beginning of the industry in 1857.

Analyses of the oil distilled from this shale show it to have a paraffin base and to be of most excellent quality. Chemical engineers state that it shows a gasoline content as high as 25 per cent. It carries valuable byproducts, chief of which is ammonium sulphate. The value of this one byproduct is sufficient to pay almost half of the cost of extracting and refining. So valuable are these deposits considered by our Government that the President on December 6, 1916, set aside forty-five thousand acres, or nearly one-half the Colorado shale-oil field, as a fuel reserve for the United States Navy.

There is nothing difficult about extracting oil from shale. The shale-oil industry has been a profitable enterprise in Scotland since the early fifties, and the output of oil from Scotch shales today is approximately two million barrels per annum.

But we need not stop here in our estimate of the liquid-fuel reserve. More or less oil shale has been discovered in many other states. In many parts of Ohio and Indiana, oil-well drillers penetrate a strata of dark brown shale, about one hundred feet above the Trenton sand. From the best information obtainable, this is a deposit of oil shale which it may pay us to mine some day, as is done in Scotland. We recall having seen the statement by one of our Government geologists that, in the oil shales underlying Ohio and Indiana, there is sufficient oil to fill Lake Huron. It would appear from this brief statement that we have no cause for alarm as to our oil supply for the immediate future, whatever the situation may be a generation hence.

Not Developing the Water Powers

In view of the fact that some 60,000,000 horsepower is continuously going to waste in the streams of the country, it is beyond comprehension why an enlightened people like ours should not only fail to encourage, but should blindly bar the way to the development of a great natural resource so important to the well-being of the nation. When we consider the benefits which have already accrued to industry from the water powers now developed and recall how we have besought, appealed and pleaded for legislation to permit further development, we contemplate the present unhappy power situation with pain and sorrow. How the cry for power must strike with hollow mockery the ears of the water-power obstructionist!—*Exchange.*

The data show that 120 out of about 1500 public-service corporations claim to own or control a total of 3,683,000 undeveloped water horsepower, or 80 per cent. of the total water power at present developed by public-service corporations.

Those who lay claim to such extensive ownership or control of undeveloped power sites are hardly in a position to contend that any legislation or lack of legislation or any administrative policies of the executive departments of the Government should be held responsible for the stagnation in water-power development which they allege exists. The fact, if it is a fact, that a comparatively few corporations hold unused nearly 4,000,000 water horsepower would of itself furnish sufficient explanation. — *O. C. Merrill, Chief Engineer, Department of Agriculture.*

Garabed Giragossian has appointed a commission satisfactory to Secretary Lane, to pass upon the merits of his alleged invention whereby unlimited power is to be gathered from a new source. In case he demonstrates to the satisfaction of the commission that he has anything, the Government has the free use of it, but guarantees him in the control of all other uses of it for seventeen years. In case he doesn't satisfy the commission—Oh, well!

All that one does in his lifetime that really counts is done in a short number of hours. The rest of the time is consumed in getting ready and in waiting.

Correspondence

The Administration's Water-Power Bill

The twelve-year fight to keep the nation's water power from capture by the power monopolists is at last on the verge of being won. The Administration water-power bill now before Congress opens the way to save for the people of the United States their most valuable natural asset. Some fifty million water horsepower is at stake. The bill in question was formulated under the direction of the Secretary of Agriculture, the Secretary of War and the Secretary of the Interior, was submitted to the President for his approval and recently put forward as an Administration measure. It deals with water power in national forests, public lands, Indian lands and navigable streams. A special committee of the House has been created to consider it.

It is an admirable measure, drawn with thorough knowledge and unusual skill. The principles essential for the wise use and development of our public water powers in the public interest are all embodied in it.

I have always urged the support of the following seven definite principles in water-power legislation:

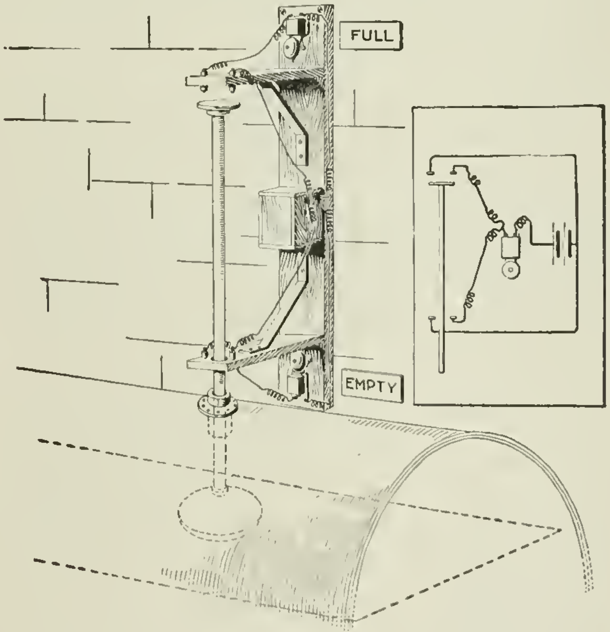
1. The thing to do with water power is to develop it. Whatever retards or restricts the development of public water powers on terms fair to the public is against public policy and hostile to the general welfare.
2. Water power belongs to the people. The sites where it is produced should always be held in public hands, for only so can effective control in the general interest be secured.
3. Where public development is not desired, the right to use water-power sites should be leased for periods long enough to permit sound, attractive and profitable investment, but never longer than fifty years. At the end of each lease all rights should return to the people who gave them.
4. In order to protect the consumer against extortion, rates and service should be regulated by Federal authority when state or local authorities fail to do so.
5. Reasonably prompt and complete development and continuous operation, subject to market conditions, should be required. Already millions of water horsepower are held out of use to further monopoly by private corporations.
6. Corporations or individuals that make money out of rights granted by the people should share their profits with the people.
7. The public has a right to complete information about every business based on the use of public property.

It is a real pleasure to know that every one of these principles is fully safeguarded in this bill. What remains, therefore, is for Congress to put this measure through without delay. The Administration water-power bill will first come before the House of Representatives, where an effort will certainly be made to amend it in the interest of the power interests. If that fails, the water-power lobbyists will endeavor to have the indefensible provisions of the Shields bill substituted in the Senate for the Administration bill. Beaten in that, they will fall back upon the formula of obstruction and delay they have used so successfully for the last ten years. This measure is practical, fair and wise. The friends of conservation should insist that their friends in Congress shall give their prompt and full support to the Administration bill and shall see to it that it is passed without emasculation, substitution or postponement. It is of vital interest to our country while the war is on, and will be equally important after the war is over. The passage of this law will secure to the American people forever vast resources whose use for the good of all will make this land a safer and a better place to live in. All the forces of conservation are behind it. I urge you to give the bill your strongest approval and support.

Milford, Penn. GIFFORD PINCHOT.

High- and Low-Water Alarm

The illustration shows without the need of much explanation a device for ringing an alarm bell when the water in a tank is high or low. As the water and the float lower, the cross-piece or disk on the end of the rod completes the electric circuit at the contacts, which causes the alarm bell to ring. When the water rises to a predetermined point, contact will be made at the other terminals and the high-water bell will ring, giving notice that it is time to stop the pump. Two bells are shown, but both of the contacts can be connected with the same bell if desired. D. R. HIBBS.

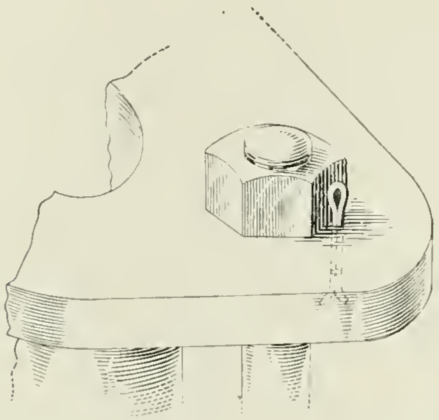


FLOAT-OPERATED HIGH- AND LOW-WATER ALARM

New York City.

Securing Gland Nuts

The valve-stem stuffing-box gland nuts on Corliss engines often give trouble by working loose and allowing the packing to blow out, requiring a shutdown to repack. This is more often the case on old engines that have worn valve stems having a side movement, every time the hook picks up the steam arm, which tends to move the gland and work the nuts loose. There is sometimes scant room on the studs for the jam nuts, so the engineer has to keep a close watch on the single nuts to keep them tightened. While overhauling recently, I drilled a small hole in each end of every gland in such a position that a small cotter pin inserted in the holes acted as a nut lock. This is also a good kink to use on the piston-rod glands of big engines and may prevent a serious accident. J. W. Stanley.



COTTER PIN TO KEEP NUT FROM TURNING

Braemar, Tenn.

Power-Plant Burns Locomotive Sparks

My attention has been called to an article in *Power*, page 13 of the Jan. 1 issue, descriptive of a large electric power station in Germany wherein locomotive cinders are burned under the boilers. It is said to be "the first large railway power station in the world to be operated entirely on cinders taken from the locomotive."

It may be of interest to recall that twenty years ago the New York, New Haven & Hartford R.R. built three power stations, from 500 to 2500-hp. capacity, in which horizontal return-tubular boilers were fitted to burn this same kind of fuel. Most of this work, both construction and operation, was under the immediate supervision of the writer who, at that time, contributed an article to *Locomotive Engineering* in which it was described fully.

To most railroad men locomotive cinders are known as "sparks" and are, of course, small pieces of partly burned coal, which is really coke, drawn through the tubes by the exhaust and confined in the front end by the screen, from which they are dumped at the end of each trip. A number of experimenters had previously discovered that sparks could not be successfully burned by the use of the ordinary forced draft under the boilers unless mixed with coal. Success was obtained by the use of a forced draft in which steam is mingled with the air blown into the ashpit. A steam blower fitted to the ashpit doors supplied this combination. The hydrogen of the steam combined with the carbon of the sparks, forming what is commonly known as water gas. The boilers were set high above the grates, forming a large combustion chamber; they were hand-fired and not overloaded.

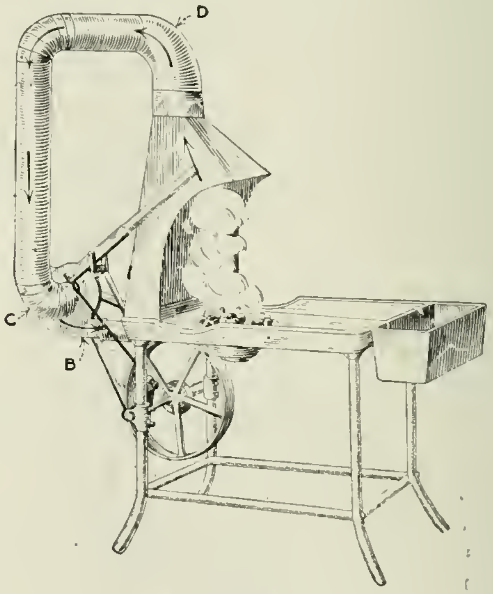
No coal was ever mixed with the fuel except on rare occasions when a heavy load dropped the steam pressure seriously. For eight or ten years, at least, to my knowledge two of these power stations were operated entirely by sparks.

Shortly after they were in operation, a number of European engineers and railroad officers (some Germans among them) were on a tour of this country and were being shown the boiler room of one station. Mr. Aspinwall, then general manager of the Lancashire & Yorkshire R.R., was closely examining the sparks and also the ashes. Holding a small portion of each in his hands he remarked: "Do I understand that you have already burned this stuff in your locomotives, and you are burning it over again here?" I replied, "That is so." "Then," said he, "pray tell me who burns it after you get through with it?" Edward C. Boynton.

New York City.

A Smokeless Portable Forge

A small forge is a handy device about a steam plant, but it has one disadvantage—it will fill the room with smoke unless there is a smoke connection to the outside, which is not commonly the case. Much of the smoke can be avoided by arranging the forge as shown in the illustration. I used a common forge with the hood attached, and connected at the top, at D, a tin pipe of the same size as the opening into the intake side of the blower B, as shown at C. When the blower is in use, the smoke that rises from the fire is drawn up into the hood in the direction of the arrows and down to the blower, which forces it up through the fire without its escaping into the open. J. A. Lucas.



A SMOKELESS FORGE

New York City.

Piston Packing Burns Out

In reply to Mr. Noble's letter on page 129 in the issue of Jan. 22, I would suggest that he look over the oiling system and make sure that the proper amount of oil is reaching the cylinder at all times. If, as he states, the material and workmanship are of the best, I am inclined to think the heating of the rod is from undue friction caused by the stoppage of the oil supply—perhaps for a short time, but long enough to permit overheating. J. H. KENDEL.

Chicago, Ill.

I believe it may be caused by any one of several reasons. The rod may be too small and at times of peak load may spring, thereby throwing excessive pressure on the packing. This might occur and yet not show in the packing for some time afterward, but the most probable cause in my opinion is in the packing itself, although Mr. Noble assures us he is using a good grade of packing and backs it up by the statement that it cost $1.50 per pound, but that is no proof that it is adapted to his special need.

Twenty-five years of engineering experience has taught me that packing can cause any amount of trouble and worry, yet I do not think that we can recommend any one brand or make that will suit all places or conditions. In former years I made many changes and tried every new packing that I could get hold of, but now I use but one make and have no packing trouble.

Syracuse, N. Y. M. E. WEBBER.

I almost "sweat blood" over an experience similar to that described by Mr. Noble, shortly after taking charge of a Corliss engine plant. The coal consumption was enormous for the size of the plant, and after setting valves and testing for leaks, I opened the boiler and found it badly limed. After cleaning by mechanical means as much as possible, I started a heavy treatment of soda ash and hydrated lime. Then trouble with piston packing began with evidences of lack of proper cylinder lubrication. We fixed up an oiler for the piston rod and did considerable fussing with the lubricator, but to no avail. It finally occurred to me that the trouble was greatest when the engine was heavily loaded; then came the inspiration, the boiler was foaming! That was easily remedied, and we had no more trouble on that score.

The next day we cleaned the boiler and, before refilling, put in a gallon of kerosene to float upon the water and soften the scale. Shortly after starting up, the steam valves would not close until pushed down by the hooks and there was a strong smell of hot kerosene around the engine; so it was surmised that the kerosene vapor had washed the oil off the valves. After getting rid of the kerosene via the safety-valve route, the engine valves acted properly and the packing did not heat.

By the way, the real cause of the foaming was a worn-out blowoff valve that we were afraid to use often enough. HOWARD WOLCOTT.

Ponca, Neb.

I have had the same kind of trouble as that described by Mr. Noble, on an Ideal engine, and it seemed to be caused by the packing expanding excessively. I now pack the piston in the usual way, drawing up the gland nut with a wrench and then backing off. As we only run ten hours a day, I back off the packing nut every morning until I feel that it is not tight, after which I do not touch the gland until I hear it blowing, when I repack the piston. I have only had trouble with one brand of packing, and with this brand it does no good to draw up on the gland after blowing begins. W. G. WALTERS.

Aurora, Ill.

I think the packing gland is too tight after the new packing has been put in, and for a day or less Mr. Noble should back the gland nuts off till steam starts to blow, then take up enough to stop it; and the next day try to back off some more. In the meantime he should have a small pail of cylinder oil and graphite (there should be enough graphite to make it thick) and every three or four hours for a few days give the rod a good coat of this mixture; then after three or four days, two or three times a day will be enough. He should try this treatment on any rod and see how much longer the packing will last and what a good finish it will put on the rod. FRANK WELLS.

Jeffersonville, Ind.

The trouble with ordinary "soft" packing (no matter how good the quality may be) is that when adjusted with the gland nuts just set to hold the packing in place—say finger-tight—the steam works in behind the packing and exerts a force in exactly the same manner and with the same effect as if the packing gland nuts were drawn too snug, and overheating follows. On the other hand, if the gland nuts are drawn so tight that the steam cannot get behind the packing, it will pinch and the rod will heat. My suggestion as to a remedy is metallic packing. ROBERT E. HICKS.

Houston, Tex.

Discussion on Ammonia-Compressor Diagrams

Regarding the ammonia-compressor diagrams of J. C. Harrison in the Jan. 15 issue, neither set seems to have been taken under correct conditions of suction-gas temperature. The Wolf-Linde compressor is of the wet gas type, in which the frost is carried right up to the compressor, the temperature being regulated by the amount of liquid ammonia carried into the cylinder with the suction gas.

With the temperature of the suction gas shown by diagrams Figs. 1 and 2, the temperature of the cylinder and discharge would be too high, and the ammonia rod would be hot and troublesome. With conditions as revealed by diagrams, Figs. 3 and 4, too much liquid ammonia is being carried with the suction gas, the temperature of suction gas being approximately 4 deg. F. below the boiling point of the ammonia due to a pressure of 24 lb. Better results are obtained when the temperature of the suction gas is about 10 deg. higher than the boiling point of the ammonia due to the suction pressure.

Fig. 1 indicates either incorrect gage readings or a mistake in locating the atmospheric line, as scaling with a 120-lb. scale shows the suction pressure 24 lb. and the head pressure 140 lb. Fig. 2 shows a larger reëxpansion loss than necessary with this type of compressor and may be due to excessive clearance. Figs. 3 and 4 show the loss in capacity due to too much liquid ammonia entering the cylinder. This is indicated by reëxpansion taking place during 30 per cent. of the suction stroke, being about 25 per cent. more than necessary with a correct suction-gas temperature.

I believe that in this case the compressor cylinder itself was well frosted, as the compression line leans more toward the isothermal curve than in Figs. 1 and 2, indicating that some of the heat of compression was being removed by the extremely cold cylinder walls.

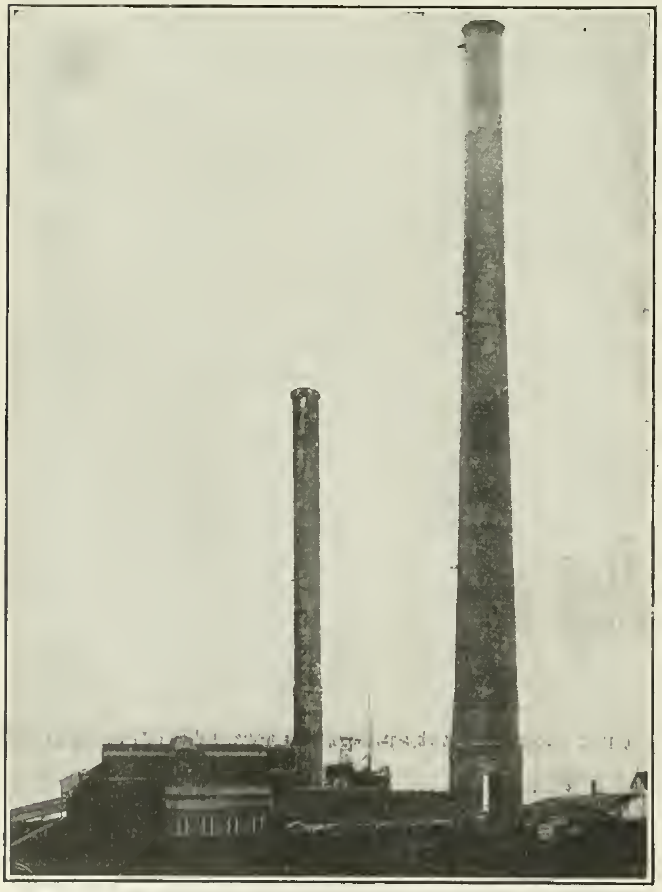
The discharge-valve springs on both ends of the compressor seem to be too strong, although this may be necessary owing to the speed of the compressor, as the normal speed for which this type of compressor was designed is about 50 r.p.m.

I would advise that lighter springs be tried and some diagrams taken with the suction temperature regulated to give a discharge temperature of 120 to 140 deg. F.

New York City. F. G. **Schoenfeld.**

Tallest Chimney in the World

In the issue of Jan. 8, 1918, page 56, it is stated that a smelter stack in Japan is 570 ft. tall and that it is claimed to be the highest in the world. I am sending a photograph of one recently completed in Tacoma, Wash., by the Tacoma Smelting Co., the height of which, from top of the concrete base, is 572 ft. 10 in. It is 50 ft. in diameter over-all at the bottom, where the walls are 4½ ft. thick. It tapers to 25 ft. outside diameter at top, with walls 17 in. thick. The chimney is lined and has a 2-in. dead-air space between the lining and walls. The concrete base is 31 ft. thick, and 2,400,000 bricks were used in constructing the chimney. The original contract called for 571 ft., but it was built 1 ft. 10 in. higher. I wish you would publish this in *Power* as we don't want anyone to get away with anything on us. Glenn Martin.

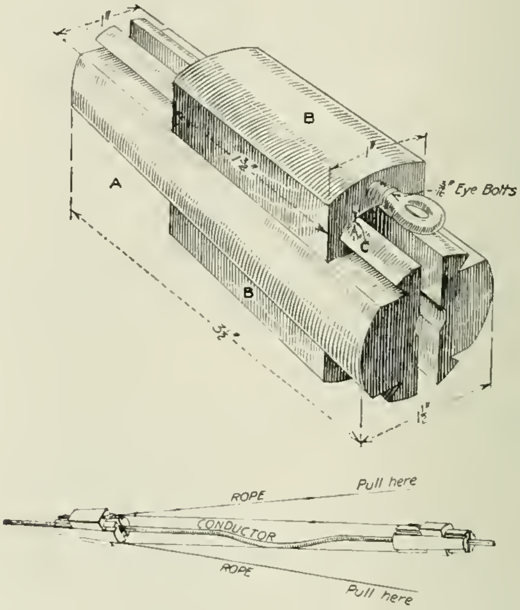


TACOMA, WASH., SMELTER STACK 572 FT. 10 IN. HIGH

Tacoma, Wash.

Wire-Tightening Tool

It is generally a somewhat difficult job, without the use of proper tools, to get a hold on an insulated or a bare wire to take a strain on it without injuring the insulation or kinking the wire, especially if the conductors are of large size. It was to provide a satisfactory means for putting the proper tension in electrical conductors when they are being run in the open on insulators that the tool shown at *A* in the figure was devised.



PARTS AND ASSEMBLY OF WIRE-TIGHTENING TOOL

The construction of the device is self-explanatory, and the dimensions given are sufficient for anyone to go ahead and make one. The one shown was made from a taper pin 1.5 in. in diameter on the large end and 1 in. on the small end. Eye-bolts in the pieces *B* are used to apply the strain to the conductor. The grooves in the movable parts must be cut of sufficient size to allow the large end of the V on the stationary parts to fit into them as at *C*, or the former will jam on the latter. To take a strain on a wire from two directions two of the tools may be used, spaced at convenient distances apart on the conductor, with a rope run through the eye-bolts to apply the tension, as shown at the bottom of the figure. The dimensions shown in the figure are right for a tool to be used on conductors up to ⅜ in. diameter.

Ozone Park, N. Y. M. P. **Bertrande.**

The buying of War-Saving Stamps has developed a finer sense of thrift and economy among the people.

Inquiries of General Interest

Greater Sensitiveness of Loaded Governors—How does loading an engine governor affect its sensitiveness? W. N. B.

Omitting friction, the sensitiveness of a loaded or unloaded governor would be theoretically the same. But in practice the friction of a governor and its gear may be considerable, and the sensitiveness of a loaded governor is actually much greater than the unloaded one, as the friction is a smaller proportion of the total forces acting on the governor when loaded than when unloaded.

Long Pump-Suction Pipes Objectionable—What are the objections to a long pump-suction pipe? R. H.

Long suction pipes are objectionable because the greater amount of pipe friction to be overcome by the suction pressure requires the pump to make a higher vacuum; the momentum of the suction water at each reversal of the pump, or sudden stoppage of the pump, may be productive of damaging water-hammer; and in addition to having more joints to give trouble from air leakage, with the water taking longer time for its passage through the suction pipe, more air is liberated out of the water, thus impairing the capacity and proper operation of the pump to a greater extent than with a short suction pipe.

Location for Tightener-Idler Pulley—Where should a tightener-idler pulley be placed for increasing the driving capacity of a belt when there is short distance between centers of the main pulleys? H. B. F.

An idler should be employed for increasing the arc of contact of the belt on the smaller pulley rather than for increasing the tension of the belt and should be on the slack side of the belt near the smaller pulley. To minimize friction, the diameter of the idler should be as large as compatible with obtaining the necessary arc of belt contact on the smaller of the main pulleys, and the idler frame should be held to its position by means of screws or other adjustable fastenings.

Disadvantage of Excess Air—What is the disadvantage of excess air to a boiler furnace? R. A. E.

The surplus air has to be heated up to the furnace temperature without adding anything to the combustion, and carries off to the chimney as many units of heat as are required to raise it from the temperature at which it enters the furnace to the temperature at which it enters the uptake, or about 0.24 of one B.t.u. per degree difference of temperature for each pound of excess air. To be sure that each atom of carbon of the fuel will meet with an abundance of oxygen, it is necessary to admit 50 to 100 per cent. more air than is required for theoretically complete combustion, and determining what proportion of excess air is most advantageous is best done by flue-gas analysis.

Deposit of Scale at Girth Seam Over Fire—Where scale is formed by the feed water of a return-tubular boiler why is there greater accumulation of scale at the girth seam over the fire? J. J. O.

Local deposits of scale are generally due to the circulation. In a return-tubular boiler the heat of the fire causes disengagement of steam bubbles that, in rising to the steam space, induce an upward current of the water, which is replaced by a flow along the bottom from the rear of the boiler. The change in the direction of the circulation and also the obstruction offered to flow by the rivets and lap of the joint cause eddies and swirls that include places where the water is quieter and out of which a larger proportion of the suspended matter is precipitated than from water that is moving at higher velocity.

Wasting Live Steam When Used With Exhaust—In a plant where exhaust steam for heating is supplemented by live steam passed through a pressure-reducing valve, less total steam appears to be required from the boilers to do the same heating when no exhaust is used and the heating apparatus is supplied with only live steam. What is the explanation? A. B. C.

The results obtained signify that when the exhaust is used in conjunction with live steam, there must be a waste of more heat than the exhaust is capable of supplying. This may result from escape of steam through the back-pressure relief valve because the heating apparatus is oversupplied, or rejects steam at the relief pressure of the back-pressure valve; or from passage of unused steam through the apparatus and discharging it direct to the atmosphere; or that the excess of steam is received by a vacuum pump that removes more steam than should be necessary for obtaining good circulation in the heating apparatus. When live steam is used to supplement exhaust, a waste is likely to occur unless the discharge pressure of the live-steam pressure-reducing valve is well below the pressure at which the back-pressure relief valve opens, or when unused steam is allowed to escape from the heating apparatus.

Estimate of Chimney Draft—What should be the force of draft, in inches of water, of a brick chimney 120 ft. high with the temperature of the atmosphere 40 deg. F. and temperature of the chimney gases 500 deg. F.? N. G. D.

The force of draft may be found by the following formula, which makes an allowance of 20 per cent. for friction in the chimney:

$$D = 0.42H \times P\left(\frac{1}{t} - \frac{1}{T}\right), \text{ where}$$

D = Force of draft in inches of water shown by the difference of level of water in a U-tube;

H = Height of the chimney in feet;

P = Pressure of atmosphere in pounds per square inch (14.7 at sea level);

t = Absolute temperature of atmosphere (deg. F. + 460);

T = Absolute temperature of gases in the chimney deg. F. + 460);

Substituting gives,

$$D = 0.42 \times 120 \times 14.7\left(\frac{1}{500} - \frac{1}{960}\right) = 0.71 \textit{ in. of water}$$

Slippage and Readjustment of Eccentric—Without indicating an engine or uncovering the valve, how may it be known whether the eccentric of an engine has slipped on the shaft? H. G.

Slippage usually has the appearance of having occurred backward, though in fact due to the shaft having continued in forward rotation while the setscrew or other fastening of the eccentric to the shaft was not sufficient to overcome the resistance that the valve and valve gear offered to their motion. If the initial position of the eccentric cannot be determined by the setscrew impression on the shaft or other marking, then, to test the position, place the engine nearly on the center and turn it forward until steam begins to be admitted as may be seen by opening the throttle a little and observing when steam is seen to issue from an indicator hole or drip-cock in the end of the cylinder. Then place the engine on the other center to see whether the same amount of lead is obtained. If there does not seem to be the same amount of lead, readjust the eccentric forward or backward to compensate for one-half the apparent difference. It does not follow, however, that because the eccentric is turned to the correct position to give equal leads that the valve is properly set, for if the valve rod was not in proper length of adjustment, the other valve events will not be equalized.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Internal-Combustion-Engine Lubrication[*]

BY W. F. OSBORNE

Some of the important facts relating to the lubrication of internal-combustion engines are set forth and discussed.

THE film of oil placed on the cylinder walls by the piston on the compression strokes of an internal-combustion engine lubricates the piston on the explosion stroke. As the piston moves towards the crank, the walls are exposed to the high temperatures of the burning gases; thus the flame comes in contact with the oil film only after it has served its purpose of lubricating the piston on the instroke. The greater part of the damage to the oil film is done during the firing stroke. The oil between the rings and between the piston and cylinder walls also is subjected to the pressure of the burning fuel and thus assists the piston ring in preventing loss of power through leakage of gases into the crank case. If there is any trouble with the lubrication, it will occur on the exhaust stroke, as the oil film on the cylinder wall has just been exposed to the high temperature of the burning gases and has undoubtedly been somewhat damaged. However, if the oil possesses the proper characteristics, some lubricating value remains, which, together with the oil film on the piston itself, lubricates the piston on this stroke.

There are, in the mechanical construction and in the operating conditions of an engine, a number of factors which determine the characteristics of an oil that will satisfactorily meet the requirements cited. Some of the more important of these are: Temperatures in the cylinders, piston clearance, speed, cooling systems, ignition, fuels, carburetion and oiling systems.

EFFECT OF TEMPERATURE CONDITIONS

The temperatures existing in the cylinder of a four-stroke-cycle engine as given by Lieut. G. S. Bryan, U. S. N., in his paper on "Motor Cylinder Lubrication," published in the Journal of the Society of Naval Engineers, February, 1915, are as follows:

Maximum temperatures obtained at top of explosion stroke, 2700 deg. F.; minimum temperature during suction stroke, 250 deg. F.; and an average temperature during the complete cycle, 950 deg. F. These are the temperatures of the gases in the cylinder, and not of the cylinder walls.

Basing calculations on an investigation made by the Bureau of Mines in 1912, of the transmission of heat in steam boilers, it would appear that the temperature of the inner surface of the cylinder walls ranges from 55 to 60 deg. higher than that of the circulating water. Later investigations have shown the temperature difference to be as low as 30 deg. in some instances. As long as the water is not boiling, the cylinder-wall temperatures will hardly be much better than 267 deg. F., while at normal circulating-water temperatures of 140 to 150 deg. F., the wall temperatures will probably range from 170 to 210 deg. F. The temperature of the center of the piston head, which in most cases is not water-cooled, runs from 800 to 1300 deg. F.

The maximum temperature of 2700 deg. F. occurs when the piston is practically at dead-center, and the temperature then rapidly drops as the piston moves inward, uncovering the oil film and exposing it to the flame until the end of the stroke. The outer surface of the oil film in contact with the cylinder walls at the comparatively low temperature of between 170 and 210 deg. F. is probably never affected by the high temperatures, but the inner surface of the oil film, directly exposed to the flame, is undoubtedly damaged, probably the greater part being destroyed.

With a maximum gas temperature of 2700 deg. F., and an average temperature of 950 deg. F., as it is impossible to produce a petroleum lubricating oil of any kind having a flash point over 700 deg. F., it would seem that any oil film would be promptly destroyed and that the so-called high-flash oil of 450 deg. F. would afford very little more resistance to burning than a low-flash oil of 325 deg., under these conditions. Either oil will burn if kept in contact with these temperatures for any appreciable time, so that the outer surface of the oil film will be affected, regardless of the flash point of the oil. However, lubricating oils burn comparatively slowly, and in the short period the film is exposed to the flame it will not be completely destroyed if it is of the proper thickness. It would therefore appear that the film must be thick enough to permit of a part being destroyed and at the same time sufficient thickness of good oil being maintained to lubricate the piston and cylinder on the exhaust stroke.

While the high temperatures of the exhaust gases, around 800 deg. F., continue to destroy the film on the exhaust stroke, the advancing piston smears a fresh film of oil over the cylinder's surface, which lubricates the piston for the suction stroke. The cool, fresh charge of fuel, even when mixed with the exhaust gases remaining in the cylinder, does not average over 250 deg. F., so that no damage is done to the oil from high temperatures on this stroke. As the increase in temperature on the compression stroke does not become very great until the piston has completed the greater part of its stroke, there is very little effect on the oil film. An oil to be suitable should maintain a film of a proper thickness under the working temperatures of the cylinder.

THE EFFECT OF PISTON CLEARANCE

The seal between the pistons and cylinders obtained by mechanical means is secured at the expense of greatly increased friction. In fact, the rings can be so tight that the engine cannot be turned over at all. A more desirable form of seal can be secured by making use of the film of lubricating oil necessarily existing for lubrication. As the piston advances, a supply of oil builds up on the edge of the piston head and on the advancing side of the rings, which opposes the force of the compressed gases, and if the lubricating oil has sufficient strength or viscosity to resist the force of the gases, a perfect seal is obtained.

The benefits secured by a perfect seal maintained by the lubricating oil are: Minimum lubricating-oil consumption; minimum fuel consumption, by preventing leakage of fuel past the rings on compression and waste of power on firing stroke; minimum friction, through the use of looser-fitting pistons and rings working on a lubricating film; minimum carbon, due to minimum quantity of oil working into the combustion space. Where a crank-case oiling system is provided, a perfect seal, by preventing the hot gases from reaching the crank case, maintains lower oil temperatures and thus prevents excessive bearing and cooling-water temperatures. In the operation of crank-case oiled engines, a perfect seal is of great benefit, as it prevents liquid fuel or vapors from passing the rings and later condensing into a liquid in the crank case, thus thinning down the oil and destroying it.

CAUSE OF THINNING DOWN OF OIL

Some elaborate experiments were made in 1911 to determine the cause of this thinning down of the oil. During these experiments many different kinds of oil were run to the breaking point in a Singer motor. An examination before and after the test showed, in every case, that the body of the oil had become lighter and that the flash point had been lowered, sometimes to the surprisingly low point of 150 deg. F., whereas the original oil had a flash point of 450 deg. F. To determine whether this was caused from the breaking down of the oil or its being thinned by the amount of fuel working past the piston rings, tests were made, using benzol as a fuel. The presence of benzol is readily detected in lubricating oil, whereas gasoline or kerosene and the products of the decomposition of a petroleum oil, which are similar to gasoline, are not. These

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[*] Abstract from a paper published in January, 1918, issue of the National Gas Engine Association's Bulletin.

tests established the fact that the gas leaked past the piston rings, evidently afterward condensing and affecting the motor oil. As high as 3 per cent. of benzol was found in the motor oil after four hours' running. The effect of this admixture of fuel is to lower the flash and fire, increase the Baumé gravity and lower the viscosity. Many tests made in subsequent years confirm these general facts.

Judging from these tests it would appear that a large proportion of motors of this type operate on an oil that is quite different from the new oil introduced into the engine. This varying condition of the oil is directly the result of the condition of the engine, and the condition of the engine, as time goes on, is the result of the changed condition of the lubricating oil. What becomes of the argument that a high-flash oil is necessary to properly lubricate motors, when this same oil promptly has a flash point of 200 deg. F. when the motor is warmed up and operating?

THE EFFECT OF TIME OF COMPLETE CYCLE

A thin film of oil smeared on a hot (300 deg. F.) piece of iron or steel will burn several seconds if ignited, so that even with the engine running as slowly as 100 r.p.m., if the oil film is of reasonable thickness it will not be entirely destroyed. When the speed is increased to 1000 r.p.m., as in the case of automobiles, which allows a total time of 0.06 of a second, and even less with higher speed motors, for the lubricating-oil film to be exposed to the burning gases, the viscosity of the oil, and consequently the thickness of the film, can be reduced considerably without meeting with trouble. In any case the viscosity should be high enough to maintain a film of such thickness that it will not be destroyed on the firing and exhaust strokes.

Air-cooled motors, such as motor-cycle engines, air-plane engines and one or two types of automobile engines, naturally run with very hot cylinders. With circulating-water systems it is possible to hold the cylinder-wall temperatures at a much lower point, and the required viscosity of a suitable oil will be higher or lower as the cooling water leaving the cylinder jacket is hotter or cooler. With a given oil the cooler the engine the better will be the seal, owing to the increased viscosity of the oil.

If ignition takes place at exactly the proper time, resulting in the most complete combustion possible of the fuel mixture supplied, the temperature falls off rapidly. If the spark is retarded, a slower and later burning results, extending over a considerable portion of the stroke. Continuous retarded-spark operation raises the temperature of the cylinder walls and the cooling water, thinning down the oil and frequently reducing its viscosity to the dangerous point.

EFFECT OF DIFFERENT FUELS

Natural gas, blast-furnace gas, producer gas and coke-oven gas, being comparatively slow-burning, do not produce high initial temperatures, but expose the oil to more severe temperature conditions. These slow-burning gases are generally used in comparatively low-speed engines on account of the time required for complete combustion, and a thicker oil film on the walls is necessary for protection against the long exposure to high temperatures.

Kerosene being slow burning, slower than gasoline, permits of higher compression, and requiring somewhat higher circulating-water temperatures, imposes a severe service on the lubricating oil, which must have exceptionally good body and lubricating qualities to stand up to the requirements.

The question of complete carburetion or vaporization of the fuel has great bearing on the efficiency of lubrication. The ideal condition is, of course, high initial pressure, and very early, complete combustion, approaching the gunpowder explosion. In this case the maximum temperatures are obtained when the piston completely covers the working surface of the cylinders and the lubricating film is not exposed to these extremely high temperatures. If the fuel is not completely vaporized and thoroughly mixed with the proper proportion of air, slow burning occurs, with the bad effects indicated in the foregoing.

The method of supplying the oil to the cylinders and bearings affects somewhat the viscosity of the oil that can be used, in that the suitable oil must be thin enough to flow to the parts to be lubricated from the point of supply; but instead of selecting an oil that is suitable for working in the system provided, it seems much better to select an oil suitable for the parts to be lubricated and then arrange the oiling system to properly handle that oil.

The most discussed, perhaps because it is the most visible, effect of unsuitable oil, is the carbon deposit in the combustion space, on the valves, the piston head and behind the rings. It is generally assumed that all carbon deposits are caused by poor oil or by poor gasoline, whereas the carbon deposits may be caused, and probably in many cases are caused, by the use of unsuitable oil or imperfect carburetion. An analysis of the carbon deposits in a cylinder generally shows the presence of considerable quantities of dust, drawn in through the air intake, and rust held together by a small quantity of oil.

A motor oil should consist of refined and filtered mineral oils or mixtures, having a cold test of not over 25 deg. F., fully suitable for use in internal-combustion engines. An oil meeting these specifications would be perfectly satisfactory when used in an engine for which it was suitable, its suitability being largely determined by its viscosity.

There are a number of tests that are used for the purpose of determining the suitability of a lubricating oil, which it might be well to mention, together with the qualities they determine.

The gravity reading is merely an indication of the crude from which a lubricant is refined, and is no indication of its lubricating value for internal-combustion cylinders.

Flash and fire tests are no indication of the ability of an oil to stand up under the working temperatures of the cylinders. As previously stated, the temperatures in the cylinders are far beyond the highest possible flash tests of any lubricating oil, and a high-flash oil would afford very little more resistance to destruction than a low-flash-test oil.

The pour test is an indication of the temperature at which the oil will flow, and where the engine is operated under conditions of temperature below 30 deg. F. the pour test of the oil is of considerable importance.

VISCOSITY OF OILS

The viscosity reading is the measure of the body of the oil, and may also be considered as a measure of the thickness of the film of oil maintained on the cylinder walls. It is also an indication of the ability of the oil to resist the pressure of the explosion gases, which tend to force their way past the piston rings. In other words, the higher the viscosity the greater will be the ability of the oil to withstand the high temperatures encountered and the better would be the effect in maintaining the piston seal.

The average purchaser of motor oils, having no data on their actual viscosity readings, must select the oil according to the general trade name of light, medium, heavy and extra-heavy motor oils. These terms at present having a somewhat indefinite meaning, it would appear that there is a great need for the standardization of viscosity, and the following suggestions are made, based on the viscosity of 100 deg. F., Saybolt Universal Viscosimeter: Motor oil, light, from 170 to 230 sec.; medium, from 270 to 330 sec.; heavy, from 470 to 530 sec.; extra-heavy, from 720 to 780 seconds.

Color in itself is no indication of the lubricating value of an oil. About the only information as to its value that can be obtained from noting the color is whether or not the oil is contaminated by moisture or foreign matter.

The author realizes that there are a number of additional influences affecting the selection of suitable oils, but it is hoped that the points brought out will be of some benefit to those interested in the use and purchase of internal-combustion cylinder oils.

Under the Iowa statute which empowers cities to fix the rates to be charged by electric-power companies and other public utilities, and under a power company's franchise, fixing a schedule of charges on the basis of kilowatt consumption, without any provision for meter charges, the company is not entitled to increase its service charges by imposing a meter fee or by any other subterfuge. (Iowa Supreme Court, Iowa Railway and Light Co. vs. Jones Auto Co., 164 Northwestern Reporter, 780.)

Mixing Coal in Storage*

BY GEORGE FREDERICK ZIMMER

Because of the problem of mixing culm and other fine coals with bituminous coal preparatory to use in boilers, the following article should be of especial interest to American engineers.

THE writer will here deal with the subject of accumulating coal in such a way that it can be reclaimed from the base of the pile. This method is more scientific and has the advantage that not only is accumulation of the small coal prevented, but the coal at the deepest part of the pile is kept just sufficiently in motion for the bulk to be slightly broken every time coal is withdrawn, two advantages that minimize spontaneous combustion and therefore make a deeper or higher pile admissible with a sufficient degree of safety. This is important if the available storage area is limited, as is often the case in plants within the precincts of large cities.

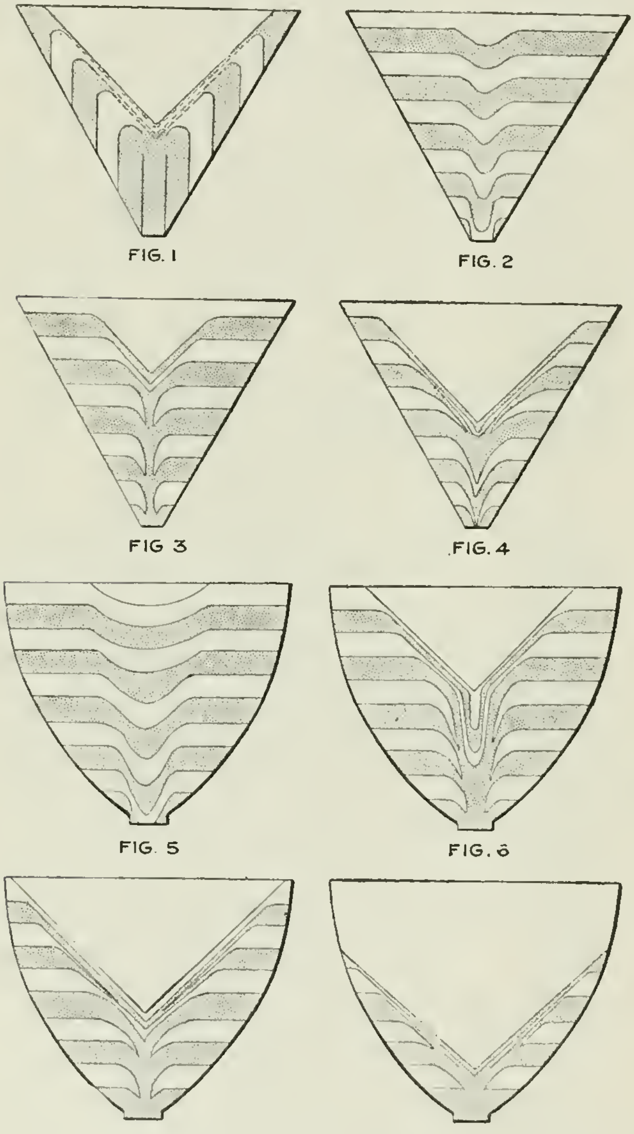
FIG. 1 FIG. 2 FIG 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7 FIG. 8

FIGS. 1 TO 8. SHOWING MOVEMENT OF COAL AS IT RUNS OUT OF VARIOUS SHAPED BUNKERS AS REVEALED BY COLORED MATERIAL DEPOSITED IN ALTERNATE LAYERS

Concerning the movement of the coal in a hopper pocket, it might not here be out of place to record the results of some tests made by the writer. The diagram, Fig. 1, shows the movement of a granular material, which was deposited in alternate vertical layers of different color, during withdrawal; while Figs. 2 to 4 show three stages of a similar test where the material was arranged in alternate horizontal layers. The movement in bunkers of the form now frequently employed is shown in Figs. 5 to 8.

As the diameter of the descending column in the bunker depends upon the size of the outlet, it is well to make this as large as possible and withdraw the coal relatively slowly by employing mechanical feeding devices. A large outlet is advantageous for a twofold object; namely, the slowly descending column of coal will have a ventilating or cooling effect if there should be a tendency to heat, and a larger outlet will prevent, or at least lessen, the tendency for large pieces to bridge or cave and cause a stoppage in the coal supply through the outlet.

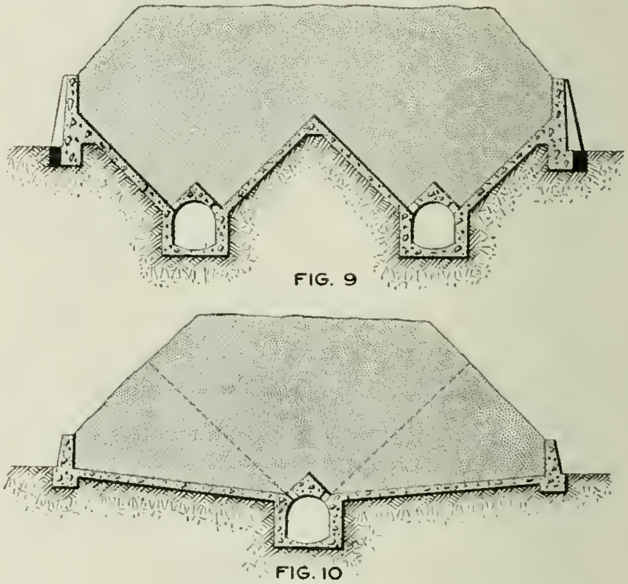
FIG. 9 FIG. 10

FIGS. 9 AND 10. CONCRETE BUNKERS WHICH DROP COAL INTO CARS LOCATED IN TUNNELS BENEATH THE PILE

The diagrams give a clear picture of what takes place, and if the sides of the hoppers are chosen of a more shallow or even a somewhat more acute angle, it will not alter the proceedings; as soon as a funnel-shaped depression has been formed of the angle of repose of the coal, the pieces around the crater will roll down and descend.

The experiments were made with a model having a glass front, but in practice the same process can be proved to take place, for if the upper layer of coal is limewashed, this washed surface will not be disturbed beyond the formation of a crater; that is, the central column will be withdrawn from the bunkers before the whitewashed pieces begin to descend, and they will presently appear through the outlet. This shows, incidentally, that the coal deposited last in the bunker will mix with some of that stowed earlier, so that we might almost depend on having in the descent an average sample of the contents of the bunker, provided the outlet is big enough. Where gas pipes are used in such coal stores for the reception of thermometers—to record any change in the temperature—these pipes remain in an upright position as the coal-level in the bunker becomes lower, until practically two-thirds of the coal which used to hold them has been withdrawn.

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*From an article in the Jan. 18, 1918, issue of "Engineering" (London), entitled Modern Methods for the Storage of Coal.

Coöperation an Essential Element in the Winning of the War

By E. W. Rice, Jr.
President, General Electric Co. and the A. I. E. E.

Abstract from a lecture delivered Feb. 15, at the dinner of the sixth annual midwinter convention of the American Institute of Electrical Engineers held in New York City. The speaker outlines what the country has already accomplished since entering the war and then points out the great need of coöperation between the industrial organizations of the country, and between these organizations and the Government in order that the maximum output of brains, labor and material may be obtained.

There was never a time in the history of the world when work was more needed and when talking is only justified which may help forward the great work at hand. We all know what that great job is—the winning of the war. Everything else must wait and take a back seat until that job is done.

We were all greatly encouraged and thrilled during the early months of the war by the patriotic attitude of Congress, which supported the Administration in an unprecedented manner, without distinction of party.

Activities This Country Has Started

The two great Liberty Loans, aggregating between five and six billion dollars, were voted and raised with the patriotic and enthusiastic support of all the country, and we are told that when history has been written wicked Wall Street will deserve a decoration for its patriotic and efficient assistance. A great scheme of taxation, more drastic and bearing more heavily upon the wealth of the country than anything known in our history, has been passed and will be loyally supported even by those who are most heavily hit.

The selective-draft system was prepared and put into operation and accepted by the country in a truly magnificent manner. The Red Cross has been reorganized and an enormous amount raised by voluntary subscriptions and is well started on its beneficent and valuable mission. The Knights of Columbus are also doing magnificent work in a similar field. I will not take your time to sketch any further the tremendous activities which this country has started during the past year.

In view of this record of accomplishment and our truly splendid start in the war, why has this feeling of nervousness come over the country? Why has Congress suddenly changed its attitude of unquestioning support to one of investigation and criticism? What does it all mean? Is it true that we are making a failure of the job?

It seems clear to me that we have not made a failure and that everything is moving along as well as we had a right to expect under all the circumstances. When we consider that less than a year ago, our nation of a hundred million of people, entirely unprepared for war, with institutions and traditions adapted only to the conditions of profound peace, was thrust into this greatest of enterprises, I think we have already accomplished wonders and that we should not be discouraged. In spite of eminent authority a million men cannot spring to arms over night, nor can dreadnaughts, destroyers, submarines, anti-submarine devices, heavy ordnance and all the great mechanism of war be produced in a day, in a month, or even in a year, no matter how much we pray or "cuss" or work. Business men, and especially engineers and manufacturers who understand the nature of the equipment required for this conflict, however, must appreciate that our fundamental, and let us hope not fatal mistake, is that we waited until the war was thrust upon us before we started to get ready.

I think that a little reflection will make it clear that the mistakes we have made since we started in the war, however numerous or avoidable, are in the aggregate negligible compared with the overwhelming mistake of failure to prepare for the war during 1915 and 1916. That precious time has been lost forever, and no effort or time, criticism or talk can cancel that mistake and give us back the lost time. We must expend untold billions and we must make superhuman efforts, but we must also be patient and realize that inconsiderate haste is likely to result in added friction, lost motion, false starts and a general retardation of our program.

Done Well Since We Started in the War

While it would seem that, considering our history and our type of government, with its checks and balances, we have done fairly well since we started in the war, we realize that we have fallen short of what we would like to have accomplished, and we should not be satisfied nor should constructive criticism be discouraged. I believe, however, that we should not become unduly disturbed, but rather be encouraged at the prospect. "While there is life there is hope," and the very fact that the country has energy enough to kick violently while it is working, clearly demonstrates that there is no possibility of dissolution or thought of defeat.

It seems quite probable that the questioning attitude of the country today is due more than anything else to a growing fear that the full ability, wisdom and experience of the country is not being properly utilized. When at war every important force in our nation must be enlisted to the fullest extent and in the most efficient manner. The support of the country has been magnificent. Would not this confidence be greatly strengthened if those in political control would look beyond their party and take into the service of the nation its strongest men without reference to political affiliation?

There are plenty of such men who are willing to help the country, and the country wants them put to work worthy of their records and abilities, not under dictation but as partners of our great enterprise. England has met the situation by a so-called Coalition Government. Why can't we do something similar?

Large Number Volunteer for Service

The country is greatly encouraged at the large number of able men, prominent in business and other walks of life, who have volunteered for service in various departments of the Government and who have been accepted and set to work. This policy should be encouraged, as the more it is followed the better the country will be satisfied and the sooner we will win the war.

It is essential that the men who are charged with enormous responsibilities in our Governmental enterprises have the confidence of the country, as their orders, no matter how drastic or arbitrary or apparently unnecessary, should be followed with confidence. At the present time orders are patriotically obeyed, but with some misgiving. There is no lack of confidence in their good intentions and character, but there is some questioning of their wisdom and practical experience.

Every organization must demonstrate what it can do to help the country in its hour of need. Every organization, whether of capital, labor, manufacture or business, and every individual must be subjected to the test of whether it is doing its best and most effective work to win the war. This will be the only and supreme test. Every individual who fails to put forth the maximum effort in the most efficient manner must be brought into line.

It is obvious that no single element by itself can win the war. Capital alone is helpless; labor alone is equally helpless. The Navy cannot win without the help of the Army, and both are helpless without ships. The sacrifices cannot be made by capital alone, or by labor alone, but must be distributed on a fair basis.

The test of patriotism will be the willingness to work, each in his own sphere, to the absolute limit. We need the maximum output of brains, labor and material; the country demands it, and the country will see that it is obtained. Any man or organization of men that stands in the way of the purpose which this country has set for itself will be eventually crushed.

It is manifestly impossible to build up a new organization that will operate satisfactorily at once. It has taken many years to build and perfect the great industrial organizations of our country. The transfer of a man to Government service does not change his character or necessarily increase his efficiency. After any organization has been brought into existence, time is required for the different units to learn their duties and particularly to learn how to coöperate with one another.

It takes time for us to get over our ideas and practices, based upon our competitive conditions and education. We are now to forget our education in competition, and think of nothing but coöperation; in other words, of what is best to increase the country's production as a whole, for that is vital in winning the war.

It is obvious that the Navy and Army cannot be built up without drawing upon the organization and facilities of the country and that their activities cannot be maintained without an efficient industrial organization constantly at work behind them in this country. Therefore, our Government, as well as ourselves, must never forget that the preservation of the country's industries in the highest state of efficiency is a vital matter.

I like the President's expression, "Spirit of accommodation," for that is an essential element of coöperation.

Now I wish to emphasize the fact that it takes time to produce really efficient coöperation. No new organization can possibly work as smoothly and effectively as one which has had time to become perfected. Moreover, coöperation in Washington between departments will not entirely settle the matter. We have a duty to perform. There must be coöperation among the industries. We must forget to compete and learn to coöperate with other units.

But this is not all; we must have coöperation between the Government and industries, and to be effective, this means that each must be a party to the coöperation. It cannot be a "lion and lamb" sort of affair. If the Governmental heads use their vast power arbitrarily and unwisely, they can easily cripple the industries of the country, and thus delay victory for years.

I believe that the problems facing us will be successfully solved in time, but we need more coöperation, more of the spirit of accommodation, all our patience and wisdom and, above all, a willingness to work to the limit.

We must discipline ourselves until a shirker in any field of useful effort will be regarded with the same contempt as a shirker in the military service of the country, for there is no difference, or if there is any difference, a shirker behind the lines is worse than one in the trenches.

It has taken a world tragedy, the tragedy of war, to arouse the nation to an appreciation of the value of its technical men. This great strife is not, as in other ages, a contest of brute force in which the bulkiest muscle is bound to win, but it is a battle of intellectual giants struggling for supremacy in destructive creation, and protective and defensive development. The civil engineer, the mechanical engineer, the electrical engineer, the mining engineer, the chemical engineer, the aëronautic engineer, the marine engineer—a great coöperative brotherhood working for peace and victory—have cast their skill, knowledge and effort into a crucible from which our country is drawing the metal from which victory will be fabricated and a world peace be secured.—*American Association of Engineers.*

Ships, Ships, and More Ships

The question of whether we are going to allow our country to become a German province has now to be answered. And it must be answered by ships, and ships, and more ships. It must be answered now—at this moment. We have got to decide instantly whether we are going to live up to our promises to our Allies—to England and her colonies, that are putting their last men into their armies; to France, that is in desperate straits; to Italy, which has so bravely pulled herself together after an almost withering defeat.

Without ships we cannot win the war; we cannot justify the faith with which our Allies honor us. Wanting ships, we can send no more men to the battlefield; we cannot even maintain the American soldiers who have reached the other side and who depend for their very lives on the support of their fellow-citizens at home.

To build ships we must have men. Our shipyards will need, must have, 250,000 workers. Men of all trades who can work in wood, iron or steel with a fair degree of skill will be welcomed by the Government and by the Shipping Board, so long as they are willing to serve with faith, loyalty and perseverance. Workmen in our shipyards to-day are absolutely vital to our military success, and those who answer the call will be just as truly defenders of our country and its Allies as are our soldiers on the fighting front.

The men required are not asked to give up their jobs and move somewhere else immediately. That would cause confusion. What is asked is that every man who stands ready to go to work building ships when the United States Shipping Board asks him to, shall now enroll in the United States Shipyard Volunteers of the Public Service Reserve. Such enrollment will include registration and an examination as to fitness for the work. Application for enrollment can be made at any office of the United States Employment Service, and such offices are now being established all over the country.

If there is no enrollment agent of the Public Service Reserve in your community, see the local representative of the State Council of Defense, or write to Edward N. Hurley, Chairman, U. S. Shipping Board, Washington, D. C.

Culm and Bituminous Coal as Fuel

In an address delivered before the manufacturers and business men of Reading, Penn., William P. Frey, fuel engineer of the Lehigh Coal and Navigation Co., gave some interesting figures relating to the use of a mixture of anthracite culm and bituminous coal as a fuel. The tests from which his figures were obtained were conducted at the plant of the Carpenter Steel Co., Reading, Penn., from Nov. 19 to Nov. 24, 1917. The following excerpts are taken from Mr. Frey's address:

Given the large amount of anthracite culm available for immediate use and the great shortage of bituminous coal, is there a possibility of combining the two fuels into one? What are the proportions to be used, and what will be the resulting effects practically and economically?

The first question is answered by mixing soft and hard coal mechanically or by hand and developing a firing practice to burn the combination of the two. In a small plant the mixing may be done very much like the mixing of sand, gravel and cement, using a box or wheelbarrow as a measure. The better the mixing the better will be the results. Accordingly, all lumps that will not pass through 1½-in. round mesh should be crushed to smaller sizes. In large plants this crushing can be done through a rotary crusher. The mechanical mixing can be done in many different ways—common dump pockets, screw conveyors, paddle mixers, rotary drums, spray-out mixing devices like revolving tables with scraper arms or shaking tables with collecting chutes and spouts.

If the mixing is done properly, firing practice need not be changed, though there should be a tendency to damp off fires. Firing in thin layers will give better results but not quite so high ratings. Grate bars up to ½-in. air space can be used, as the culm bakes with the soft coal to a coarsely granulated material having the appearance of coke, which will not fall into the ashpit.

In all these tests the mixing was done by hand. Beginning with bituminous coal only, culm was added in increasing amounts until the mixture consisted of 66.7 per cent. of bituminous coal and 33.3 per cent. of culm. The results obtained are given in Tables I and II.

TABLE I. RESULTS OBTAINED USING NATURAL DRAFT

Average feed-water temperature	198 deg. F.
Average steam pressure, gage . . .	112.5 lb
Average stack draft, water gage .	0.4 in.
Cost of bituminous coal per short ton, delivered .	$4.60
Cost of anthracite culm per short ton, delivered	$1.90

Bituminous Coal Per Cent.	Culm Per Cent.	Equiv. Evaporation from and at 212 Deg. F. per Pound of Dry Coal Pounds	Boiler Rating Per Cent.	Boiler Efficiency Per Cent.	Cost per Boiler-hp. Per Hour Cents
100.00		10.03	112	69	0.78
80.00	20.00	9.47	106	68	0.73
75.00	25.00	8.76	96	64	0.75
66.67	33.33	7.34	80	55	0.89

TABLE II. RESULTS OBTAINED USING FORCED DRAFT

Average feed-water temperature	198 deg. F.
Average steam pressure, gage	112 lb.
Average stack draft, water gage	0.15 in.
Cost of bituminous coal per short ton, delivered.	$4.60
Cost of anthracite culm per short ton, delivered	$1.90

Bituminous Coal Per Cent	Culm Per Cent.	Equiv. Evaporation from and at 212 Deg. F. per Pound of Dry Coal Pounds	Boiler Rating Per Cent.	Boiler Efficiency Per Cent.	Cost per Boiler-hp. Per Hour Cents
100	.	10.80	140	75	0.73
65	35	9.90	112	74	0.63
50	50	8.42	96	66	0.65

The boiler used was a Newburgh fire-tube boiler, having 1549 sq.ft. of heating surface and 32.25 sq.ft. of grate surface. Forced draft was supplied by two calibrated Parson blowers, the steam used by them being deducted to obtain the data in Table II.

Chemical analysis of the bituminous coal showed 2.41 per cent. of moisture, 9.66 per cent. of ash, and 17.34 per cent. of volatile matter. The heating value was 14,000 B.t.u. per pound of dry coal. Similar analysis of the culm showed 9.65 per cent. of moisture and 25.60 per cent. of ash. The culm was clean and its heating value was 10,800 B.t.u. per pound of dry coal.

The tests were run under ordinary normal conditions, without overworking the firemen, and all the test results are given in the tables. The Carpenter Steel Co. ran two check tests, and their results agreed very closely with those shown. The points to be observed are that with natural draft at least 20 per cent. of culm should be used, and if forced draft is employed, the amount of culm in the mixture should be increased to at least 35 per cent.

National War Savings Committee of New York

The method of procedure followed by divisional chairmen of the Commercial, Industrial and Professional groups of the National War Savings Committee of New York is about as follows:

The chairman, immediately upon his selection, proceeds to organize his division by appointing as follows—provided his group is of sufficient size to warrant a duplication of the state organization: vice-chairman, secretary, manager of publicity, manager of speakers' bureau, manager of war-savings societies, executive committee of 3 or 4, managing committee of 15 or 20. As soon as possible, the chairman sends to everyone in his division a letter urging all firms and corporations, co-partnerships or individuals doing business, to take out selling agencies. The letter should cover the following points:

1. The Government is anxious to make War-Savings Stamps and Thrift Stamps the easiest things in the world to buy, the object being twofold: First, to obtain funds to carry on the war and second, to encourage the habit of economy among the people.

2. No capital is required to become Treasury Department agents—merely the investment of a few dollars in stamps, which can be obtained from the postman or post office after receiving appointment as an agent, and that the stamps, which are sold at cost to employees, members of the firm or to the general public, may be replenished from time to time, depending on requirements.

3. After an application has been filled out in the name of an individual and returned to the chairman direct or to state headquarters for Greater New York, 51 Chambers St., New York, a full supply of posters, literature and information regarding sale of these stamps will be sent to the applicant.

4. It is the duty of all to apply for agencies to sell these stamps, even if, as in some cases, only a few dollars' worth of stamps will be sold.

5. Foremen and department managers should be induced to become selling agents, as a greater interest is usually maintained when the employee is the personal representative of the Treasury Department and not the employer.

A few days after a general letter has been sent out, the members of the committee generally make personal calls on all those in their divisions, urging them to carry out to the fullest extent of their ability the suggestions contained in the letter.

Quotas are assigned to the various trades, and in order that these may be made on a fair basis, divisional chairmen send in, as soon as their committees are completed, to the vice-chairman of the Pioneer Division, approximate statements as to the number of employees in their group.

When 100 per cent. of all the firms in a division have become selling agents, it is suggested that committeemen secure members for the United States Government War-Savings Limit Investment Society of New York. This field is limited, however, to employers and principals, so that no very strenuous campaign is necessary to secure membership.

The principal idea of the Limit Club is that every individual who can possibly afford to take the limit allowed by law ($1000 at maturity, which costs only $826 in February, 1918, $828 in March, etc.) do so.

All employers are urged to start their employees saving by the gift of a 25c. Thrift Stamp and card, or the gift of the sixteenth stamp in order to complete the Thrift Card, or—as in some cases it has been done—by the gift of both the first and last Thrift Stamp for their employees. Various schemes can be worked out which will stimulate the sale of stamps among employees.

Food Administration on Ammonia and Ice

In view of the discussion of the Food Administration's ruling and desires relative to ammonia and ice harvest, the following letter from the Administration is of interest:

Your [*Power's*] letter of Feb. 5 addressed to Mr. Hoover on the subject of the ice industry has been referred to this division for reply, as the matters therein mentioned come directly within our jurisdiction, and we take pleasure in giving you below the Food Administration's position on the subject.

It is our desire that every possible ton of natural ice be harvested and stored now, in order to displace a similar amount of artificial ice and thereby permit of the diversion of ammonia from the manufacture of artificial ice to the making of ammunition for our soldiers. There is serious danger of a shortage of ammonia, and ice producers are not only serving their country by heeding our request to store natural ice, but they are actually protecting their trade and insuring their customers against a serious misfortune, which might follow in the event that the War Department felt it necessary to commandeer a considerable amount of ammonia and thereby materially curtail the manufacture of artificial ice. We hope and expect that by the coöperation of all parties in interest, and by careful conservation of the limited supply, it will be possible to avert a depleted ice supply during this year, but this possibility must be kept constantly in mind.

In your letter you referred to a conversation with a member of the committee of New York ice men, which, some time ago, was in conference with officials of the Food Administration. We do not see how any member of this committee could take the position that "he does not know what Washington wants," for we thought our position was made very plain, and men representing 96 per cent. of the ice-producing capacity of New York City have signed agreements whereby an additional million tons of natural ice is being harvested in New York today. This will result in the saving of approximately two hundred thousand pounds of ammonia and will guarantee that New York City will not suffer an ice famine this summer and that the people will not have to pay exorbitant prices for ice.

As you know, nearly all ice factories have large storage rooms, which they fill by operating at capacity during the winter months, in order to have ice in the summer to take care of their peak load. In general, it is not desired to stop the filling of these rooms. However, it is desired that wherever possible, they be filled with natural ice instead of the artificial article, in order to save as much ammonia as possible.

It is also the case that in most communities there are more ice factories than are necessary to supply the trade, and there is a consequent waste of ammonia and fuel, duplication of delivery service and a general economic waste. We are asking that wherever possible, this condition be cured by having the individual firms enter into a voluntary agreement with the Food Administrator, whereby a few of these plants may operate at capacity and the others be shut down, the plants which are closed to be furnished with ice for their customers by those in operation at practically the cost of manufacture.

We are restricting the supply of ammonia for ice-producing plants and refrigerating plants to their legitimate 60-day requirements, in order to insure against the hoarding of this chemical, and are only allowing the sale of ammonia for new plants when we can be convinced of their urgent necessity in the community where it is proposed to erect them.

With regard to your suggestion that it may be unwise to fill up cars with ice and thus add to the congestion of the railroads, we beg to advise that most of this ice is stored very close to the point where it is harvested and that it will add very little to the difficulties of the transportation situation. It can be hauled the short distance necessary in old cars which are not suitable for through traffic, and will not, in any event, seriously affect the transportation system. We might add that a general embargo-lifting order was issued on Feb. 11 by the Car Service Commission, covering about 75 or 80 different seasonal commodities, which would indicate that the railroad situation is improving in a very marked degree, and that no one need worry greatly about the effect of the natural-ice harvest on railroad congestion.

We trust that this gives you sufficient information, but if there is any point that we have not covered or on which you desire further advice, we shall be glad to have you call on us. The Food Administration appreciates your attitude and desire to be of assistance to us in this matter.

U. S. Food Administration,
Charles W. Merrill, Division of Chemicals.

Annual Exhibit of Evening Work at Pratt Institute

Thursday evening, Mar. 7, will be "Visitors' Night" at the School of Science and Technology of Pratt Institute, Brooklyn. From 8 to 9 o'clock all the shops, laboratories and drawing rooms of the school will be open to the public, giving an opportunity to those interested in industrial education to observe the students at work in the various courses and to inspect the results and methods as well as the equipment and general facilities of the institute for conducting this kind of industrial training.

The school provides instruction in industrial electricity, technical chemistry, mechanical drawing and machine design, strength of materials, stationary engineering and power-plant machinery, internal-combustion engine work, machine work and toolmaking, forge work, carpentry and building, patternmaking, and trade teaching for the training of skilled workmen who desire to prepare themselves for the teaching of their trades. A special feature of the work this year is the organization of a number of new courses to meet the extraordinary demands for skilled mechanics arising from the war. These courses are boat woodworking, ship drafting, marine-engine operation, and gasoline-engine operation for men desiring to enter the aviation service.

This school is now giving instruction in its evening courses to more than 1300 men who are regularly employed in various vocations and who use these courses as a means to prepare themselves for more effective service.

This will be the only public exhibit of the work of this school held this year.

A 35,000-Kw. Turbine Is Wrecked in Boston Station

About 4:55 p.m., Thursday, Feb. 14, the 35,000-kw. horizontal single-cylinder steam turbine in the O Street Station of the Boston Elevated Railways Co. exploded, so completely wrecking the machine that it will be sold for junk as it stands, it is reported. Fortunately no one was killed or injured. The trouble developed in the low-pressure stages—the 17th, it is believed. All diaphragms and wheels, together with the blades from this stage on to the 20th, were fractured and broken in many pieces and released with such force as to smash away the whole top half of the low-pressure end of the casing.

The initial cause of the accident is, at this writing, thought to be due to excessive steam pressure between the diaphragm and the 17th wheel concaving the diaphragm, causing it to foul the wheel, closing up the buckets and in this way increasing the steam pressure at this point until the next diaphragm was similarly affected, when the whole low-pressure end let go.

The accident occurred at a time when 27,500 kw. carried by engines in another station of the Railways Co. dropped their load. Assumably, the wrecked turbine tried to take all of this load, opening its secondary valve to get all the high-pressure steam available.

A member of the *Power* staff is, at this writing, in Boston endeavoring to get details of the accident.

One of the tendencies of the present day is to overdo the stop-watch and the watch-dog method. Efficiency of product does not lie in that direction. It is not right to imagine that the men have no other interest in the success of the undertaking than to watch the hands of the clock go round.

New Publications

BOILER ROOM ECONOMICS—By A. L. Potter and S. L. Simmering. Dean Engineering Experiment Station, Kansas State Agricultural College, Assistant Professor of Steam and Gas Engineering, Engineering Experiment Station Kansas State Agricultural College.

Boiler Room Economics is the title of Bulletin No. 2, originally published in 1914, but which the Agricultural College is again circulating in the hope that the contents may be of material aid in assisting in the campaign to cut down the waste in the use of coal in boiler furnaces. The bulletin gives considerable cost data, which of course need some modification at this time, owing to the changes in the market brought about by the war. The bulletin deals with boilers, pumps and injectors, feed-water heating and purification, stokers, economizers and superheaters, and the subdivisions of each of these subjects.

THE CALORIFIC POWER OF FUELS—By Herman Poole. Third edition. Rewritten by Robert Thurston Kent, M E., New York. John Wiley & Sons, Inc. Pages, 627; illustrated. Price, $3.

Since the original publication of this work in 1900 the available information upon the subject has multiplied to such an extent that its practical rewriting was necessary. This rewriting was entrusted to Robert Thurston Kent, M. E. It deals with calorimetry in four chapters, with solid, liquid and gaseous fuels in a chapter each, devoting then a chapter to the combustion of coal and another to the calorific power of coal burned under steam boilers. The final chapter treats of the analysis and measurement of the products of combustion. English units have been substituted for the metric units of the original volume. The rewriting appears to have been well done, and the book presents, in an attractive form, information that is very timely.

INTERNAL - COMBUSTION - ENGINE MANUAL. By F. W. Sterling. Published by R. Beresford, Washington, D. C., 1917. Cloth; 6 x 9 in.; 168 pages; 92 illustrations. Price, $2.

This is the fourth edition of this book; it has been completely rewritten, enlarged and brought up to date, and a chapter added on airplane engines to cover all five types of these motors. Every type of gasoline and heavy-oil engine used in the United States Navy, including those used on submarine chasers and naval launches, the Diesel and Standard types, is described.

The subject is divided into twelve chapters, taking up in order fuels, solid, liquid and gaseous; comparison of internal-combustion, and steam engines; construction; types, cycles, etc.; carburetion, the mixture, its preparation, carburetors and vaporizers; ignition and ignition systems; cooling and lubrication; governing and indicator cards; operation, troubles and remedies; gasoline, kerosene and alcohol engines, aërial motors; the Diesel, Nürnberg and Sulzer types of engines.

The work is not a book on design, but it gives a practical description of the construction and operation of the different types of internal-combustion engines. The practical way in which the subject is presented both in text and illustrations makes the work easily understood even by the uninitiated, and it should meet with favor from all those who are interested in internal-combustion engines.

TESTING CURRENT TRANSFORMERS

The Bureau of Standards has recently issued Scientific Paper No. 309, entitled "A Method for Testing Current Transformers." A general method is outlined in this paper for the determination of the ratio and phase angle of current transformers in terms of the constants of previously calibrated standard transformers of the same nominal ratio. It has been shown that such methods are essentially more sensitive or, conversely, may be used with much less sensitive instruments than the laboratory methods now in use for the absolute determination of the ratio and phase angle of a single transformer. Two of the most convenient of the many possible modifications of the general method are described in detail. It is hoped that the methods will be found useful in commercial plants where delicate laboratory equipment is not available and where large numbers of transformers must be tested rapidly and with moderate accuracy. This paper is now available for distribution, and those interested may obtain a copy by addressing a request to the Bureau of Standards, Washington, D. C.

Obituary

F. G. Rollins, late president of the Holmes Metallic Packing Co., of Wilkes-Barre, Penn., died at his home in Philadelphia on Feb 20, in his 57th year. He is survived by his wife, mother and one sister.

Personals

J. C. Bertsch has resigned his position as refrigerating engineer with the Westinghouse Electric and Manufacturing Co. Machine Works, to become established as general consulting engineer, with offices in the Monongahela Bank Building, Pittsburgh, Penn.

W. H. Thompson, for many years prominent in the heavy electric-traction work of the Westinghouse Electric and Manufacturing Co., has resigned to accept the position of works manager of the Fairmont Mining Machinery Co., Fairmont, W. Va., makers of coal-mining equipment.

W. C. Austin, auditor of the Eastern Pennsylvania Railways Co., Pottsville, Penn., has been elected assistant secretary and assistant treasurer of that company. In 1917 Mr. Austin was transferred from the staff of traveling auditors of the J. G. White Management Corporation, New York, to the accounting department of the Eastern Pennsylvania Railways Co., which company is being operated by the Management Corporation.

Engineering Affairs

The Arkansas Association of Public Utility Operators will hold a state convention at Hot Springs, Ark., May 21-23, with headquarters at the Arlington Hotel.

The Engineering Council's first annual meeting was held Feb. 21. The following officers were elected: Chairman, J. Parke Channing; first vice chairman, Harold W. Buck; second vice chairman, George F. Swain; secretary, Alfred D. Flinn. Committees were appointed as follows: Executive committee, the chairman, the two vice chairmen and David S. Jacobus, Calvert Townley, George J. Foran; finance committee, E. Wilbur Rice, Jr., chairman; Charles F. Loweth, Sidney J. Jennings, David S. Jacobus; rules committee, J. Parke Channing, chairman; Clemens Herschel, Nathaniel A. Carle, Irving E. Moultrop; public affairs committee, Charles Whiting Baker, chairman; George F. Swain, Benjamin B. Thayer, E. W. Rice, Jr., Charles E. Skinner. American engineering service, George J. Foran, chairman; George C. Stone, Alfred D. Flinn, Dr. Addams S. McAllister, Edward B. Sturgis, secretary; war committee of technical societies, D. W. Bruntno, chairman; Arthur H. Storrs, secretary; James M. Boyle, Nelson P. Lewis (American Society of Civil Engineers), Edmund B. Kirby (American Institute of Mining Engineers), A. A. Greene, Jr., R. N. Inglis (American Society of Mechanical Engineers), Harold W. Buck, Dr. Addams S. McAllister (American Institute of Electrical Engineers), Dana D. Barnum, E. C. Uhlig (American Gas Institute), Joseph Bijur, Dr. Charles A. Doremus (American Electrochemical Society), Louis B. Marks, Preston S. Milar (Illuminating Engineering Society), Christopher R. Corning, George C. Stone (Mining and Metallurgical Society of America), Henry Torrance, F. E. Matthews (American Society of Refrigerating Engineers); fuel conservation committee: L P. Breckenridge, chairman; Ozni P. Hood, secretary; Robert H. Fernald, Charles R. Richards, Charles L. Edgar, Carl Scholz, David Moffat Myers, Edwin Ludlow, Harold W. Buck.

The definition of the Engineering Council that was adopted declared that "the Engineering Council is an organization of national technical societies of America created to provide for consideration of matters of common concern to engineers, as well as those of public welfare in which the profession is interested, in order that united action may be made possible. The Engineering Council is now composed of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, having a membership of 33,000 and known as the 'Founder Societies.' "

Miscellaneous News

A Boiler Exploded on the Croffett plantation, near Bastrop, La., on Feb. 12, injuring two persons, one perhaps fatally, and wrecking the entire machinery.

A Boiler Tube Blew Out at the plant of the Sioux City (Iowa) Gas and Electric Co. on Feb. 8, injuring two firemen, one seriously. The accident necessitated shutting off the power until repairs were made.

Urges Higher Compensation for Engineers—At the conference in Washington Feb. 26, between representatives of capital and labor, held to forward the adoption of a national labor policy, a representative of the Engineering Council urged the necessity of higher compensation for engineers, to enable them to take their proper part in the nation's activities in war and peace.

An Order Authorizing the construction of a power dam at Muscle Shoals, Ala., has been signed by President Wilson, as part of the $60,000,000 project for the erection of a Government plant there for the fixation of atmospheric nitrogen for use in the manufacture of munitions and fertilizer. The site has been offered to the government without cost by the Alabama Power Co.

The Schütte & Koerting Co., of Philadelphia, has been taken over by the United States Government as an alien concern. It will be operated by A. Mitchell Palmer, alien property custodian. Adalbert Wilhelm Fischer, its former president, is now interned as a dangerous enemy alien. His wife is the daughter of Ernest Koerting, of Hanover, Germany, believed to be a near relative of the German Emperor.

An Economizer Exploded recently at the plant of the Ithaca Traction and Lighting Co., Renwick, N. Y. From an investigation of the circumstances under which the accident occurred, it develops that the economizer had been shut off from the line and the bypass used without shutting the dampers leading to the economizer, these dampers having been warped so they could not be operated. The engineer who was responsible for the explosion was instantly killed.

Business Items

C. W. Hunt Co., Inc., has moved its New York offices from 45 Broadway to the Astor Trust Building, 501 Fifth Avenue.

The H. W. Johns-Manville Co. is now comfortably installed and working full speed in its new building at St. Louis, Mo., on the southeast corner of Olive and 11th Streets.

The Cleveland (Ohio) Electric Illuminating Co. is planning on building a two-story and basement addition to its present power station on East 70th St., at a cost of about $1,000,000. A 25,000-kw. turbine will be installed.

The Westinghouse Electric and Manufacturing Co. announces the removal of its office from Phoenix, Ariz., to Tucson, Ariz. Its representatives, J. H. Knost and W. G. Willson, will have headquarters in the Immigration Building at the latter point.

The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., has recently secured the exclusive sales agency for the United States for Frankel solderless connectors, widely used for joining electrical wires and cables. The Westinghouse company will act also as a distributor of Frankel testing clips.

Trade Catalogs

Safety Auto-Lock Switches. Krantz Manufacturing Co., Inc., Brooklyn, N. Y Special publication No. 1585-A. Pp. 4; 8 x 11 in.; illustrated. Describes a type of safety switch manufactured by this company and also gives list prices.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
Buckwheat	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
Clearfields	....	$3.00	....	$4.25—5.00
Cambrias and Somersets	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.25—7.50
Buckwheat	4.30—5.00	2.75	5.50—5.80	7.00—7.25
Barley	3.25—3.50	1.95	4.00—4.25	4.00—4.25
Rice	3.75—3.95	2.20	4.50—4.80	5.00—5.50
Boiler	3.50—3.75	2.20	....	3.50—4.00

Quotations at the upper ports are about 5c. higher

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
6-in. lump	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.50-2.75
2-in. lump	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Steam egg	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Mine-run	2.40-2.55	2.75-3.00	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen	2.15-2.30	2.50-2.75	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Calif., Ontario—The San Antonio Water Co. plans to build a power plant in the San Antonio Canyon. G. D. Smith, Mgr.

Fla., Wauchula—City plans an election soon to vote on $25,000 bonds for the erection of an electric-lighting plant.

Ga., Montezuma—J Harrison and E. M. McKenzie are considering plans for the installation of a hydro-electric plant on Whitewater Creek, 4 miles from here.

Ill., Jacksonville—The Board of Education plans to build a boiler house

Iowa, Lorimor—The Lorimor Light and Power Co. has been granted a franchise by the Board of Commissioners, to build and operate an electric transmission line in Union Co.

Iowa, Maquoketa—The Iowa Electric Co plans to extend its 33,000-volt transmission line from here to Anamosa. J. I. Reed, Gen. Mgr.

Iowa, Waterloo—The Citizens Gas and Electric Co. has been granted a franchise by the Board of Railroad Commissioners, to build and operate an electric transmission line. H. B. Maynard, Secy.

Md., Monkton—The Monkton Roller Mills Co plans to build a hydro-electric power plant on Gunpowder River to operate a proposed flour mill. Estimated cost, $25,000. O E. McCoy, Mount Washington, Pres.

Mich., Marquette—City is in the market for a waterwheel and a generator to cost about $45,000, in connection with the new electric power plant. C. Retallic, Supt T. W. Orbison, Consult. Engr.

Minn., Nashwauk—City plans to install a new electric deep well pump. Estimated cost, $7,000.

N. Y., Buffalo—The Eastern Monolithic Co., 96 South Park Ave., is in the market for electric motors.

N. Y., Greenwich—The Consolidated Electric Co. has petitioned the Public Service Commission for authority to build a 3 mi. transmission line from Northumberland Bridge through Bacon Hill and along highway leading from Bacon Hill to Grangeville. H. C Gray, Mgr.

N. Y., Utica—The Savage Arms Corporation, Turner St., is in the market for 1000 hp. power plant equipment. Noted July 31

N. C., Raleigh—The Empire Steel Co. plans to build a hydro-electric plant to operate its steel plant which will be equipped with electrically driven machinery.

N. D., Nome—City plans to install an electric-lighting plant

Ohio, Cleveland—The Cleveland Electric Illuminating Co., Public Sq., is in the market for 25,000 kw. turbine and accessory equipment. Noted July 31.

Okla., Okemah—City has plans under consideration for the erection of an electric-lighting plant.

Okla., Shattuck—City plans to install either an oil fuel or steam plant for power. J. C. Fowler, Secy., Chamber of Commerce.

Okla., Stillwater—City plans an election soon to vote on $175,000 bonds for improvements to its electric-lighting plant, etc. G M. Smith, Supt

Tex., Grapevine—The Grapevine Light and Ice Co. plans to build a new plant soon. Burrough & Harmon, Owners.

Utah, Monticello—The Blye Mountain Irrigation Co. has increased its capital stock from $15,000 to $16,000; the proceeds will be used to improve and extend its transmission line.

Utah, Provo—S. P. Stewart has applied to the State Engineer for permission to take 10 second feet of water for the electric generating plant to be erected here.

Wash., La Grande—The American Nitrogen Products Co. plans to install 3 electric ovens in its plant.

Wash., Seattle—The Board of Public Works will receive bids until March 15, instead of March 1, for the erection of a hydro-electric power plant. Estimated cost, $5,000,000. J D. Ross, Supt. of Light and Power. Noted Feb 8

W. Va., Charleston—The State University plans to rebuild its boiler house which was recently destroyed by fire.

Wis., Appleton—The Patton Paper Co. plans to build a hydro-electric power plant. J. McNaughton, Pres.

Wis., Kilbourn—The Wisconsin Power, Light and Heat Co., Milwaukee, has purchased the property of the Omro Electric Light Co., Omro, and plans to extend its Kilbourn and Price due Sac transmission lines to Berlin and Omro. J. I Beggs, 1428 1st Natl. Bank Bldg., Milwaukee, Pres.

Wyo., Wheatland—The Town is in the market for a 150 hp. engine with a 100 kw.a. generator.

Ont., Beeton—City plans to issue $15,000 bonds for the installation of a hydro-electric system.

Ont., Toronto—The Swift Canadian Co., Keel St. and St. Clair Ave., plans to build a concrete and brick addition to its boiler house. Estimated cost, $10,000.

Ont., Tottenham—City plans to install a hydro-electric system here.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T .fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	1.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			⅜-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T .P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	100
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$21.50
No. 16 cotton twisted	29.00
No. 18 cotton parallel	24.00
No. 16 cotton parallel	36.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	39.40
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No 18 cotton Canvasite cord	21.75
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$10.50	$12.50	$15.00	$23.50
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	56.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	228.60	....
000	....	....	271.24	....
0000	....	....	332.40	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$10.90	$15.15	$27.25	$13.50	$16.25	$31.25	$13.50	$16.25	$31.25
10	23.70	27.05	49.35	25.00	28.50	56.40	25.00	28.50	56.40
8	33.60	37.35	74.45	34.85	38.85	74.70	34.85	38.85	74.70
6	....	57.15	....	59.75	64.25	....	59.75	64.25	....
4	....	81.70	....	84.40	84.90	....	84.40	84.90	....
2	....	121.80	....	125.50	132.00	....	125.50	132.00	....
1	....	158.50	....	163.00	171.15	....	163.00	171.15	...
0	....	189.40	....	216.00	225.00	....	216.00	225.00	....
00	....	298.05	....	263.00	273.50	....	263.00	273.50	....
000	....	362.15	....	320.00	331.50	....	320.00	331.50	....
0000	....	448.50	....	388.50	400.50	....	388.50	400.50	....

LOOM—Price per 100 ft., in coils:

	Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$69.70	$74.80	$0.1672	$0.1786	$0.0616	$0.0658
¾	92.00	98.90	.22	.235	.088	.094
1	136.00	146.20	.3256	.3478	.1144	.1222
1¼	184.00	197.80	.4185	.4496	.1581	.1698
1½	220.00	236.50	.558	.5994	.1953	.2098
2	296.00	318.20	1.023	1.10	.2604	.2797
2½	468.00	503.10	1.674	1.80	.372	.3996
3	612.00	657.90	4.464	4.79	.558	.5994
3½	763.60	818.80	9.86	10.59	744	.7992
4	926.50	991.90	11.39	12.23	.93	.999

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$65.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B—Watts	Plain	Frosted	No. in Package	Mazda C—Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

FANS—It is prophesied that there will be a scarcity of electric fans this summer.

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2⅝-in.	75c. per ft.
Common, 2½-in	40%

Air

	First Grade	Second Grade	Third Grade
¾ in. per ft.	$0.55	$0.30	$0 25

Steam—Discounts from list

First grade... 30% Second grade... 30-5% Third grade.. 40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50%	Best grade	20%
Standard	35%		

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	35%
Denver	40%	35%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0 90
Asbestos for high-pressure steam	1.30
Duck and rubber for piston packing	1 00
Flax, regular	.90
Flax, waterproofed	1 10
Compressed abestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.90
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in	$0.27	½-in.	$0.27
2-in.	.36	1 -in	30
6-in.	.80	1½-in	.45
4-in.	.60	2 -in	60
3-in	.45	2½-in	.75
8-in	1.10	3 -in	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		5% off
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St Louis	Birmingham	Denver
Cup	7	5¼	6.1	7½	10
Fiber or sponge	8	6	6.4	15	15
Transmission	7	6	6.4	10	15
Axle	4½	4	3.3		5
Gear	4½	4½	6.5	7½	6
Car journal	22 (gal.)	3½	4 6	5	6

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Feb. 28, 1918	One Year Ago		
Colored mixed	8.50 to 12.00	10.00 to 12.00	12.50	12.00 to 12.50
White	11.00 to 13.00	13.00 to 15.00	16.00	10.00 to 11.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13½	$45 00	13¼ x 20½	$52.00

In Chicago they sell at $30@33 per 1000

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Feb. 28, 1918	1 Year Ago	Feb. 28 1918	1 Year Ago	Feb. 28 1918	1 Year Ago
Raw per barrel	$1.36	$0.90	$1.35	$1.00	$1.35	$0.98
5-gal. cans	1 46	1.09	1.50	1 10	1 45	1.08

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Feb. 28, 1918		1 Year Ago		Feb. 28, 1918	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50	10.50
12½-lb. keg	11.75	11.25	10.75	11.25	10.75	10.75
100-lb. keg	11.25	11.50	11.00	11.50	11.00	11.00
1- to 5-lb. cans	13.25	13.00	12.50	12.50	13 00	12.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/8 and smaller	30%	35%	40%*
Tinned	30%	35%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York ..... $7.00 Cleveland .... $5.85 Chicago $5.50

Coneheads same sizes:

New York ..... $7.10 Cleveland .... $5.95 Chicago $5 60

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$50.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	....
Magnesite brick, per net ton	135.00 to 145.00	....
Chrome brick, per net ton	135.00	....
Deadburned magnesite brick per net ton	85.00 to 90.00	....
Special furnace chrome brick per net ton	60.00 to 70.00	60.00 to 80.00

Standard size fire brick 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade $55 to $65. St. Louis grade, $40 to $50

Birmingham—Fire clay, $25 to $30; Denver, $23 per 1000.

Chicago—Second quality $25 per ton

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	5c.	None
Mexican heavy, 12-14 Baumé	7c.	7 1/16c.

Note—There is practically no fuel oil in Chicago at present time.

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Feb. 28 1918	One Year Ago
New York	$15.00	$8.00
Cleveland	15.30	7.50
Chicago	15.00	6.00

In coils an advance of 50c. usually is charged.

Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft	7.40	6.60	6.60	5.80
7 in. by 35 ft	10.70	9.60	9.60	8.55
8 in. by 35 ft	12.20	10.90	10.90	9.65
7 in. by 40 ft	12.35	11.00	11.00	9.75
8 in. by 40 ft	13.75	12.15	12.15	10.65
8 in. by 45 ft	18.20	16.20	16.20	14.30
8 in. by 50 ft	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads

For plain pine poles, delivered New York the price is as follows:

10-in butts, 5-in. tops, length 20-30 ft	$6.00
12-in. butts, 6-in. tops, length 30-40 ft	8 50
12-in. butts, 6-in. tops, length 41-50 ft	9.50
14-in. butts, 6-in. tops, length 51-60 ft	17 00
14-in butts, 6-in. tops, length 61 71 ft	18.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
¾ to 3	49%	35½%	¾ to 1½	33%	17%

LAP WELD

Steel	Black	Galvanized	Iron	Black	Galvanized
2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			

BUTT WELD, EXTRA STRONG PLAIN ENDS

Steel	Black	Galvanized	Iron	Black	Galvanized
¾ to 1½	47%	34½%	¾ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD EXTRA STRONG PLAIN ENDS

Steel	Black	Galvanized	Iron	Black	Galvanized
2	40%	28½%	2	27%	14%
2¼ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13 as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

	Per Net Ton		Per Net Ton
1 in.	$340	1¾ in.	$220
1¼ in	280	2 to 2¼ in	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

POWER

Vol. 47 NEW YORK, MARCH 12, 1918 No. 11

Help Yourself

By Rufus T. Strohm

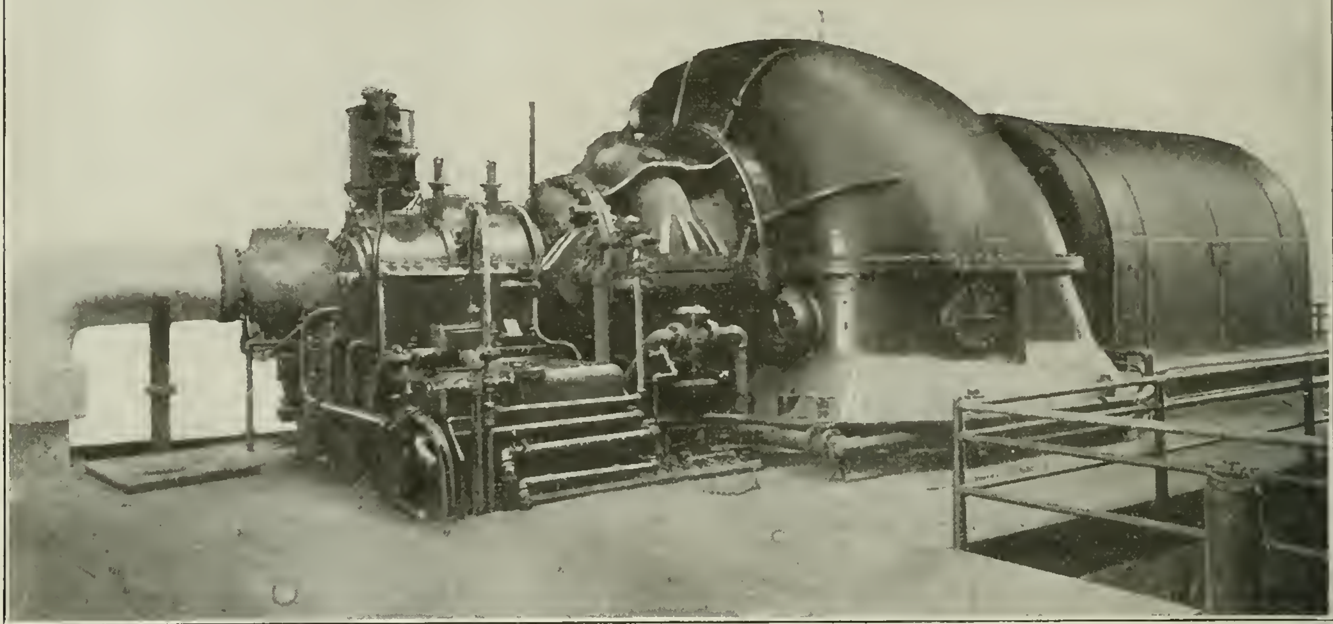
WE'RE apt to be filled with envy
At the mention of the chap
Whom circumstance, by a lucky chance,
Has tossed into Fortune's lap;
For the ordinary mortal
Is a poor and hapless elf,
And the best that he can expect to see
Is a way to help himself.

IT'S a comfort to the climber
Who would scale the mountain wall
To know a friend is at hand to lend
Swift help should he chance to fall;
But the man who scans most keenly
Each inch of the rocky shelf
Is the lonely wight on the dizzy height
Who is forced to help himself.

THE strides that the race is making
In its struggle toward the light
Have come by the throes and the sweat of those
Who have had to work and fight;
For earth doesn't owe its progress
To the Guildford or the Guelph,
But in shire and town to a Jones or Brown
Who has learned to help himself.

THE gawk who inherits millions
Has a cheap cause to be vain,
Since not one sou of the sum is due
To his use of brawn or brain;
But the engineer who labors
As he garners in the pelf
Has the cheering thought that his wealth is wrought
By the way he helps himself.

Ninety-Five Thousand Kilowatt



The Commonwealth Edison Co., of Chicago is completing the installation at Northwest Station of three additional turbo-generators of an aggregate capacity of 95,000 kw. Two are of the compound reaction type and the third an impulse machine of new design. One of each type is now in operation, and the second compound machine is in course of erection. At the turbine throttle steam is supplied at a pressure of 230 lb. gage and 200 deg. superheat.

WITH the present installation of three turbo-generators, two with a rating of 30,000 kw. and one of 35,000 kw., Northwest Station of the Commonwealth Edison Co., Chicago, Ill., will have an aggregate rated capacity of 165,000 kw. The plans calling for six units will have been completed, and the present building fully occupied.

As previously recorded in these columns, the station was first equipped with two 20,000-kw. vertical machines generating 25-cycle current. The next addition was unit No. 3, a horizontal compound turbine, with the double-flow low-pressure element in a separate casing, driving a 30,000-kw. 25-cycle generator. In service this machine has been found to have ample capacity for continuous operation at 35,000 kw. Full details of the unit are available in the June 20, 1916, issue of *Power*.

Of the three new units No. 4 (see headpiece above and Fig. 3) consists of an impulse turbine arranged in a single casing and a 25-cycle three-phase generator rated at 35,000 kw. at unity power factor. Units Nos. 5 and 6 consist each of a compound reaction turbine driving a 60-cycle three-phase generator (see headpiece on opposite page) rated to deliver 30,000 kw. at 85 per cent. power factor.

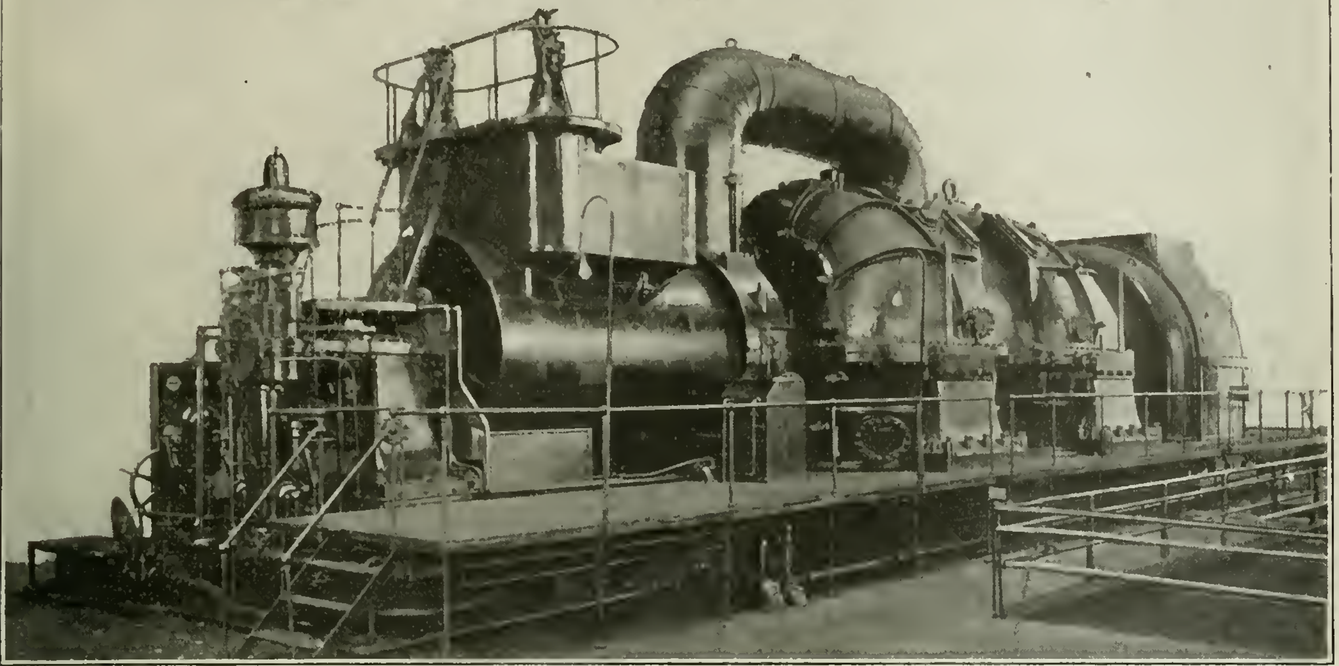
Unit No. 6 was the first of the new machines to be placed in service, and No. 5, now in the course of erection, will be a duplicate. The turbine is of tandem-compound design, the two rotating elements being connected by a solid flanged coupling. The generator is in turn connected through a flexible coupling so that all three rotors turn as one unit, in contradistinction to the cross-compound type, where each element of the turbine drives a separate generator. There are five main bearings, three on the turbine and two on the generator, with an additional small bearing on the outboard end of the direct-connected exciter. All bearings are served by the usual system of oil circulation. Normal oil temperature is maintained by an oil cooler supplied with water from the condenser circulating-water system. There are no cooling coils in the individual bearings.

The shaft packing consists of the well-known water gland with a steam labyrinth added, by means of which vacuum may be established before placing the turbine in operation. After sufficient speed is attained, the water gland is put in operation and the steam labyrinth shut off.

The high-pressure element of the turbine, which contains the governor and valve mechanism, is of standard single-flow pure reaction construction, containing a total of 90 rows of rotating and stationary blading. In this element the steam expands from the throttle pressure of 230 lb. gage down to a pressure of about 34 lb. absolute, at the most economical load. The steam passes next through an exhaust at the top of the cylinder into an overhead passage leading to the low-pressure element.

In the low-pressure element there is a combination of single- and double-flow construction, employing all-reaction blading. Steam from the high-pressure element enters at the top near the center and passes through a single-flow stage consisting of 20 stationary and

Addition to Northwest Station



rotating rows of blading, expanding from a pressure of 34 lb. absolute to approximately 8.5 lb. absolute. It is then divided, one half continuing through an adjacent low-pressure stage consisting of 16 rotating and stationary rows of blading, while the other half passes back around the single-flow stage, through passages between the inner and outer cylinders, to a duplicate pressure stage on the opposite end of the spindle. Each low-pressure stage has its separate exhaust passage to a condenser.

Steam admission is controlled by means of standard Westinghouse control mechanism, consisting of a governor controlling the main or primary steam-admission valve and two overload valves through an oil relay. The designed capacity on the primary valve is 25,000 kw., this being the point of maximum efficiency. The designed capacity on the secondary is 30,000 kw., and on the tertiary, 35,000 kilowatts.

The turbine is served by two condensers, shown to the right in Fig. 1, containing 28,000 sq.ft. each, or a total of 56,000 sq.ft. of cooling surface, in 12,972 tubes 1 in. in diameter and 16.5 ft. long between tube heads. The surface is disposed equally between the two shells, each taking steam from one of the low-pressure elements. On a basis of 30,000 kw. the condenser has 1.87 sq.ft. of surface per kilowatt.

At the entrance to each shell is a primary heater containing 750 sq.ft. of surface through which the condensate is passed, so that it may be heated to substantially the temperature of the exhaust steam. A bi-rotor circulating pump direct-connected to a 600-hp. induction motor (at the left in Fig. 1) furnishes cooling water to both sections of the condenser. This pump, when running at a speed of 350 r.p.m., has capacity to deliver 60,000 gal. of water per minute against a head of 18 feet.

Each shell of the condenser is served by a condensate pump and a hydraulic air pump of the Leblanc type, Fig. 2. Both pumps are turbine-driven on a common shaft. Each of these auxiliary sets is of sufficient size to serve the main unit when operating at its maximum capacity, thus giving one set for reserve. The condensate is pumped through the condenser preheater and to the feed-water heater. From the heater the feed water passes through the boiler-feed pumps and thence through the economizers to the five boilers of the unit.

The makeup water, which serves to supply any deficiency in the boiler feed, is drawn from a fresh-water reservoir in which is collected the heater overflow, trap discharges and condensation that would otherwise be wasted. At such times as the supply of condensation to the fresh-water reservoir is insufficient, filtered water is admitted through a float valve. The makeup water is drawn from this reservoir into the condenser by the vacuum, the amount being regulated by a float valve on the feed-water heater.

The generator of unit No. 6 (see headpiece on this page) is of standard construction, star-connected, being designed to deliver three-phase 60-cycle current at 12,000 volts. The speed is 1200 r.p.m. and the rating 35,300 kv.-a., or 30,000 kw. at 85 per cent. power factor.

For cooling the generator windings, a motor-driven blower has been installed with capacity to deliver 120,000 cu.ft. of air per minute. The air-intake passage is equipped with an air washer of suitable capacity, which comprises the usual complement of spray chamber, eliminators and tempering coils to clean, cool and humidify the air. Sufficient steam at low pressure is supplied to the tempering coils to maintain the humidity at the desired point below saturation. The motors driving the blower, circulating pump and economizer fans operate on 440-volt service and have standard remote-control starting equipment. The motors are brought up to speed automatically by a system of accelerating relays and air-break contactor-type circuit-breakers with push-button control.

Unit No. 4 (see headpiece on page 354 and Fig. 3), the second of the new machines to be placed in service, is of a relatively new type of which a striking feature is the compactness of arrangement for a unit of such large capacity. The turbine is of the impulse type. The wheels, arranged in a single casing, increase progressively in diameter from the first to the last stage. Similarly, there is an increase in the length of the blading conforming in a general way to the increase in volume of the steam in its expansion as it passes through the turbine.

Steam is admitted to the annular ring supplying the first-stage nozzles through a single-balanced valve closed by a spring and opened by a cam-actuated lever under the control of the governor. A secondary control valve of similar design supplies steam to one of the intermediate stages of the machine, this valve opening automatically when the load on the unit reaches a certain predetermined capacity. By the new arrangement the numerous admission valves of former designs have been eliminated.

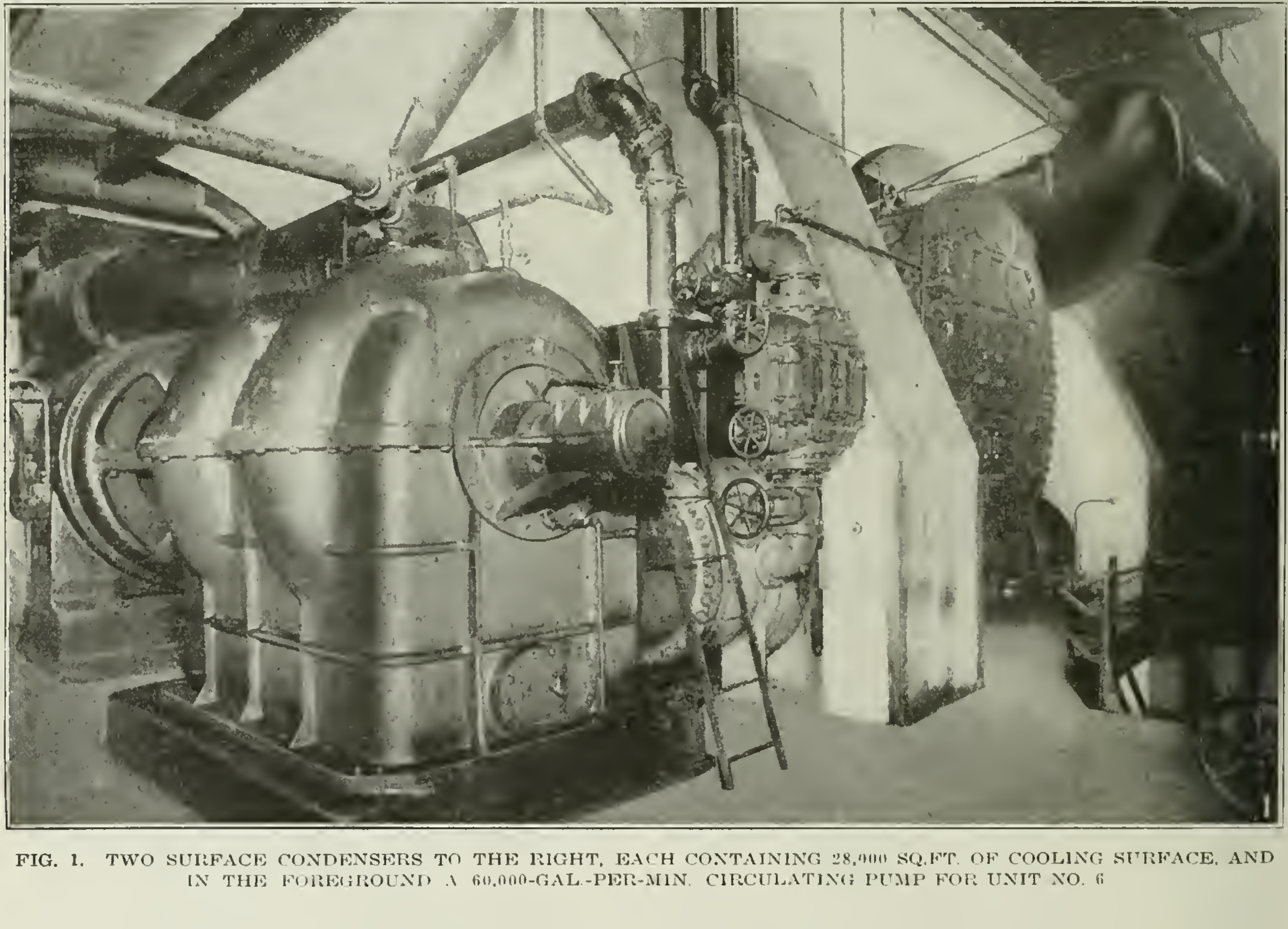


FIG. 1. TWO SURFACE CONDENSERS TO THE RIGHT, EACH CONTAINING 28,000 SQ.FT. OF COOLING SURFACE, AND IN THE FOREGROUND A 60,000-GAL.-PER-MIN. CIRCULATING PUMP FOR UNIT NO. 6

The unit has four main bearings cooled by water from the house service. Bearing oil is supplied under forced circulation at about 20 lb. pressure, by a screw pump geared to the turbine shaft. In starting, use is made of an auxiliary steam pump that is cut out of service when the unit is up to speed.

The turbine of unit No. 4 is served by a two-pass surface condenser, Fig. 4, containing 56,000 sq.ft. of surface. The condenser is rigidly connected to the turbine exhaust, the necessary freedom for expansion being provided by supporting the condenser on springs. Cooling water is circulated by a bi-rotor 48-in. centrifugal pump, Fig. 5, driven by a 600-hp. induction motor. The speed is 300 r.p.m. and the capacity against an 18-ft. head, 60,000 gal. per min. There are two sets of combined air and condensate pumps, Fig. 6, each set being driven by a 190-hp. turbine running 1500 r.p.m. One set is a stand-by to the other.

The general arrangement of the auxiliaries is somewhat similar to those for unit No. 6. With the combination pump, both air and condensate are withdrawn from the condenser, separate piping connections being provided. The air is discharged with the hurling water to a reservoir from which it escapes into the room, and the condensate is passed through the preheater at the top of the condenser to the feed-water heater. Cross-connections allow either pump to serve the condenser. As the hurling water is constantly recirculated, it requires cooling. For this purpose a surface-type cooler is inserted in the hurling-water reservoir and a certain percentage of the condenser circulating water is passed through the tubes. Arrangements for the supply of makeup water to the condenser are as previously described for unit No. 6.

The electrical generator of unit No. 4 is a three-phase 25-cycle machine rated to deliver 35,000 kw. at unity power factor, the speed being 1500 r.p.m. A 250-volt 110-kw. shunt-wound exciter is mounted at the end of the generator shaft. Cooling air for the main generator is washed, cooled and humidified as in the case of the other unit, but the air is forced through the machine by the action of the generator rotor, no independent blower being used. The heated air from the generators is discharged to the boiler-room basement, whence it finds its way to the boiler furnaces. This saving of heat that otherwise would be wasted is in line with modern tendencies.

In general the new boiler installations are similar to the equipment installed for unit No. 3, which, as previously mentioned, was described in the June 20, 1916, issue of *Power*. May 16 and 30, 1916, issues dealt with the condenser-circulating and the coal-handling system.

As a brief summary it may be stated that the steam-generating equipment for each of the new units consists of five cross-drum water-tube boilers generating steam at 240 lb. gage and 200 deg. F. superheat. Each boiler contains 12,200 sq.ft. of steam-making surface, giving 61,000 sq.ft. for the unit. Two chain grates having a total active area of 304 sq.ft., bearing a ratio to the steam-making surface of 1 to 40, are placed under each boiler. The furnace is of the expanding type with a tile roof and the first pass at the rear. Each boiler is connected to an economizer containing 6450 sq.ft. of tube surface and equipped with a motor-driven induced-draft fan capable of handling 90,000 cu.ft. of hot gases per minute. Five boilers are served by a self-supporting steel stack 18 ft. in diameter and 250 ft. in height above the boiler-room floor, the base of the stack resting on a steel structure at a level 66 ft. above the boiler-room floor. Two turbine-driven boiler-feed pumps are installed for each unit, the capacity of each pump being 900 gal. per minute.

The electrical system follows the standard practice of the company of simple two-bus arrangement. The alternators are star-connected with the neutral end of each phase brought outside of the machine for the purpose of connecting in current transformers used in connection with protective relays. Beyond the current transformers the three leads are brought together to form the neutral point of the star, from which connection to the neutral bus is made through an oil switch.

For each unit the stator leads consist of two cables per phase. In the case of unit No. 4 each cable has 1,500,000 cir.mils cross-section, and the cables of No. 6, the 60-cycle generator, have 1,250,000 cir.mils. cross-section each. The leads are lead-covered and are carried within barrier structures similar to the busbar construction. The lead sheath is grounded solidly at the generator end and through a resistance of about ten ohms at the other end.

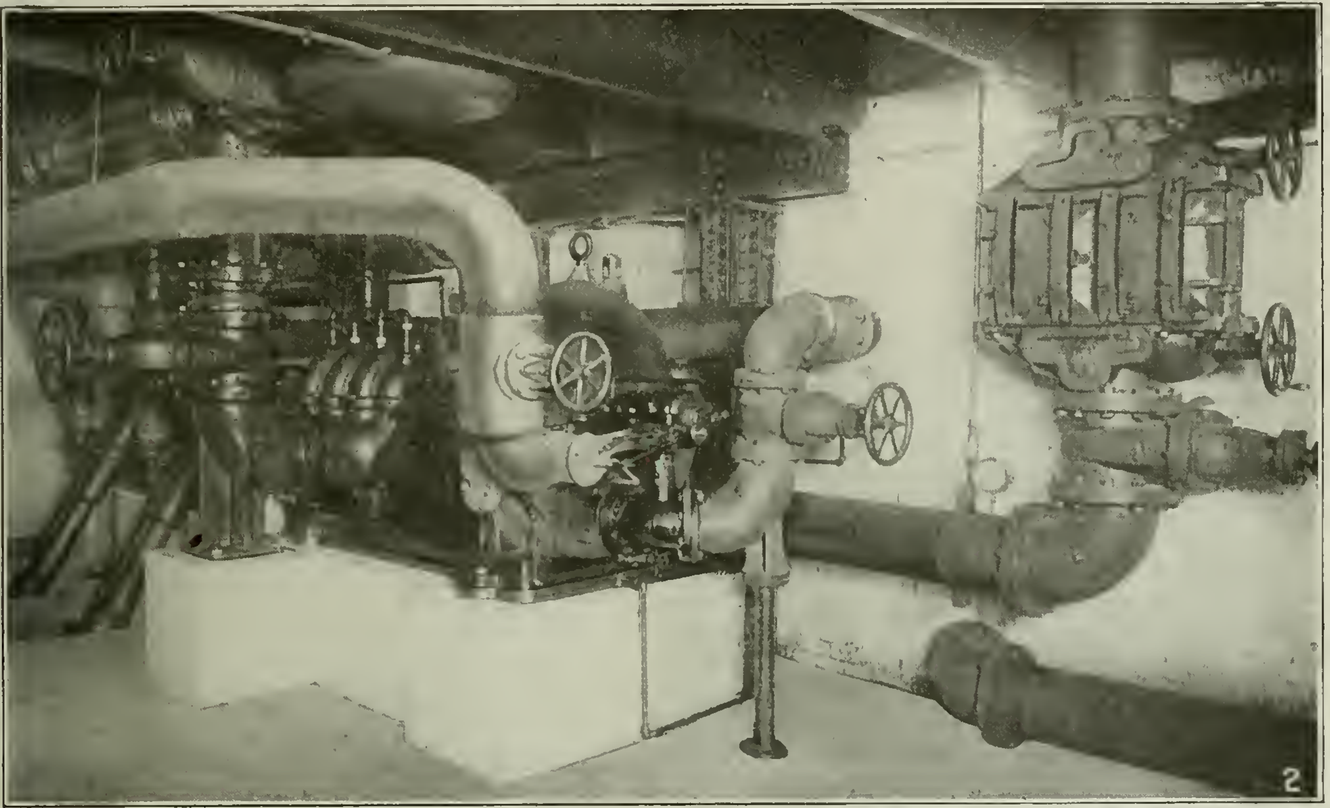


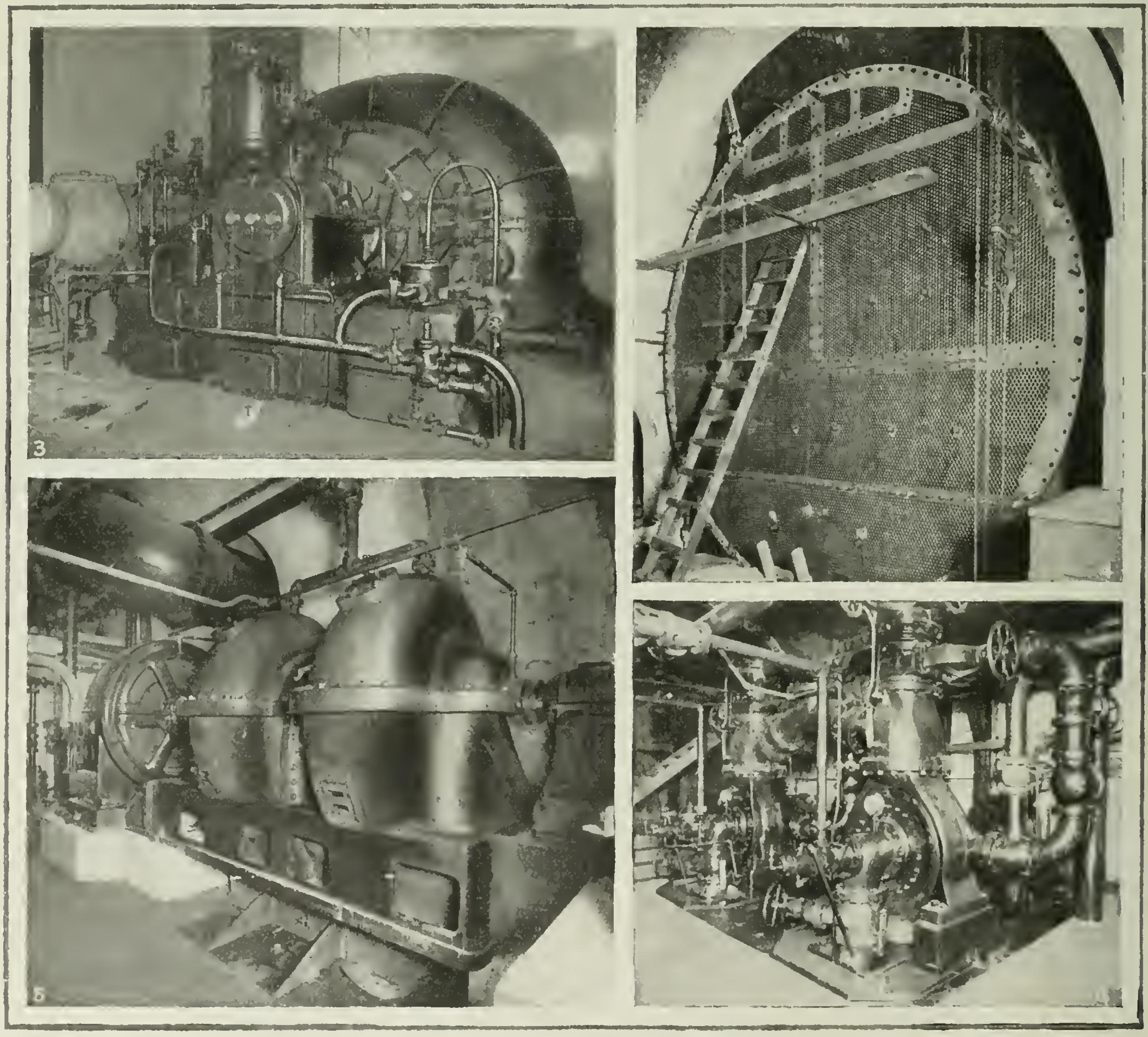
FIG. 2. TURBINE-DRIVEN CONDENSATE AND HYDRAULIC AIR PUMP FOR UNIT NO. 6

On each unit is used the company's standard system of protection for the generator. It consists of balanced relays that balance the current going through the neutral end of each phase winding against the current flowing in that same phase lead at the oil-switch end of the connection. In case of a fault in the generator windings or leads between the windings and the oil switches, which include in the 25-cycle units the generator reactor coils, these relays operate and instantly open the main oil switch, the neutral oil switch if it is closed, the field switch, and in the case of the 60-cycle machine, the switch on the motor driving the generator's ventilating blower. The opening circuit of the field switch is connected in series with contacts on the main oil-switch mechanism so as to insure against the opening of the field before the alternator's stator circuit has been opened.

For the preceding information on steam equipment, *Power* is indebted to Sargent & Lundy, consulting engineers for the Commonwealth Edison Co. The electrical data came from the electrical department of the company.

PRINCIPAL DATA ON EQUIPMENT OF NEW UNITS

Turbo-Generator No. 4	
Turbine	General Electric single-cylinder horizontal impulse type
Capacity, kw	35,000
Speed, r.p.m	1,500
Generator	Three-phase, 25-cycle, 9,000 volts
Capacity, unity power factor, kw	35,000
Exciter, direct-connected, capacity, kw	95
Air for cooling, cu.ft per min	60,000
Unit:	
Length, over-all, ft	50
Width, ft.-in	19–10
Floor space per kw. (35,000 kw.), sq.ft	0.028
Condenser	Two-pass surface, Wheeler Condenser and Engineering Co.
Number of tubes, including preheater	12,959
Tube diameter, o. d., in	1
Length between heads, ft	16.5
Surface, sq.ft	56,000
Surface per kw. (35,000 kw.)	1.6
Circulating pump	Wheeler bi-rotor
Capacity, 18-ft. head, gal. per min	60,000
Driven by G E., 440-volt 3-phase 600-hp. induction motor, speed, r.p.m.	300
Combined air and condensate pumps, two units	Wheeler
Each unit driven by 190-hp. G. E. turbine, r.p.m	1,500
Capacity condensate pump, gal. per min	1,200
Turbo-Generator No 6	
Turbine	Westinghouse two-cylinder reaction
Capacity, kw	30,000
Rows of blading, h.-p. element	90
Rows of blading, l.-p. element, single-flow	20
Rows of blading, l.-p. element, 2 double-flow stages, each	16
Speed, r.p.m	1,200
Generator	Three-phase, 60-cycle, 12,000 volts
Capacity, 85 per cent. p.f., kw.	30,000
Exciter, direct-connected, shunt-wound, capacity, kw	110
Cooling air, cu.ft. per min	120,000
Unit:	
Length over-all, ft.-in	72-9
Width, ft.-in	19-2
Floor space per kw. (30,000 kw.) sq.ft	0.046
Condenser	Westinghouse surface, two shells
Number of tubes	12,972
Tube diameter, o.d., in	1
Length between heads, ft	16.5
Surface, including preheater, sq.ft	56,000
Surface per kw. (30,000 kw.), sq.ft	1.87
Circulating pump	Westinghouse bi-rotor
Capacity, 18-ft. head, gal. per min	60,000
Driven by Westinghouse 600-hp., 440-volt ind motor, speed, r.p.m.	350
Air pump	Leblanc, same shaft as condensate pump, two units, each driven by 139-h.p. Westinghouse turbine
Capacity condensate pump, gal. per min	1,200
Boiler Unit for No. 4 or No. 6	
Boilers	B. & W Cross-Drum
Number of boilers to each turbine	5
Tubes per boiler	588
Diameter of tubes, in	4
Length of tubes, ft	18
Steam-making surface per boiler, sq.ft	12,200
Pressure at turbine throttle, lb. gage	230
Superheat at turbine throttle, deg. F	200
Temperature of steam at throttle, deg. F	600
Nominal capacity each boiler, lb. steam per hour	85,000
Size steam main to turbine, outside diameter, in	20
Stoker, two per boiler	B. & W Chain Grate
Active area two stokers, sq.ft	304.6
Ratio grate area to steam-making surface	1 to 40
Pumps, two boiler-feed per unit	Worthington, turbine-driven three-stage
Capacity, lb. per hour	450,000
Feed-water heater	Open type, Warren Webster
Capacity from 60-150 deg. F., lb. per hour	400,000
Economizer, one per boiler	B F Sturtevant
Number of tubes	456
Length of tubes, ft.	12
Heating surface in tubes, sq.ft	6,450
Fans, induced-draft	B F Sturtevant multivane
Capacity, cu.ft. hot gases per min	90,000
Stack	Steel self-supporting
Height above boiler-room floor, ft	250
Diameter inside, ft	18



FIGS. 3 TO 6. TURBINE AND CONDENSER EQUIPMENT OF UNIT NO. 4
Fig. 3—End view of turbine. Fig. 4—End view of condenser with cover plate removed. Fig. 5—Bi-rotor circulating pump. Fig. 6—Two sets, combined air and condensate pumps.

The Selection of Ammonia Condensers

By M. A. SALLER

Some suggestions are made to assist the engineer in getting acquainted with the chief factors that should guide him in the selection of condensers for the refrigerating plant.

IN THE following it is not the intention of the writer to go into a thorough analysis of the advantages and disadvantages of the various types of condensers for refrigeration plants, but merely to suggest the chief points with which the engineer should acquaint himself before selecting a particular type.

Condensers for use in compression or absorption plants are made in four general types: Atmospheric, or open-air type; double-pipe, or closed condensers; straight-tube surface condensers; submerged condensers.

In the atmospheric, or open-air condenser, a number of coils or passes are employed through which the ammonia gas flows, the cold cooling water trickling down over the outside of the pipes from a trough or distributor above, to a collecting pan or basin below.

The double-pipe condenser, as the name implies, consists of a double set of pipes, one located inside the other, the ammonia passing through the inner tube, while the cooling water is passed through the coil surrounding it.

The straight-tube surface condenser is designed along the same lines as the surface condenser regularly used in steam-engine and turbine practice.

The submerged condenser consists of ammonia-carrying coils submerged in a tank through which the cooling water is circulated.

SELECTION OF TYPE RESTS LARGELY ON CONDITIONS

The decision as to which of the four types should be used rests largely on the conditions surrounding the plant, its method of operation and the amount of money available. That the operator may have suggested to him all the various factors, the different points for and against each type are briefly outlined. Present-day practice in refrigerating-plant service tends toward the use of the atmospheric and double-pipe types in the great majority of cases, the outstanding feature of the atmospheric type being its simplicity and low first cost, while the double-pipe condenser is often preferred because of its high efficiency.

One of the worst features of the double-pipe condenser is that if a water containing an appreciable quantity of foreign matter or scale-forming impurities is used for cooling purposes, it will quickly collect in the pipe and cause a coating of the surfaces which will greatly reduce the efficiency and finally cause complete stoppage of the pipe. It should be remembered that scale in a double-pipe condenser is a more serious matter than in the atmospheric type. With the exposed surface of the atmospheric condenser any deposit which forms will be quickly noticed and may be readily scraped off even while the condenser is in operation, while in the double-pipe condenser the coating of scale can be detected only by shutting down the plant for examination or by noting a reduction in the efficiency of the plant, following which the unit must be cut out of service for cleaning.

A scale formation of the same thickness is also a more serious matter in the double-pipe condenser than in the atmospheric type. In the latter case the scale gathers on the outer surface of the tubes and really might be said to increase the area of the cooling surface, though probably not sufficiently to counterbalance the insulating properties of the scale.

Scale in the double-pipe condenser forms on the outer surface of the inner pipe and materially decreases the heat-transmission efficiency; also, it forms on the inner surface of the outer pipe and reduces the sectional area of the water passage.

OTHER DISADVANTAGES OF DOUBLE-PIPE CONDENSER

The decrease in the transverse area of the water-carrying tubes caused by scale in a double-pipe condenser also requires an increase in power to circulate the water through it, and in the same proportion the flow of water decreases if extra pressure is not applied. In the atmospheric condenser, where the cooling water merely flows over the coils by gravity, the quantity or distribution of the water is not affected by scale formation. As in cooling-tower practice, advantage is taken in the atmospheric condenser of the reduction in temperature resulting from the evaporation of some of the water which is cooled by the natural air currents and the outside temperature prevailing. This slight advantage is lost with the double-pipe condenser.

It should also be considered that the matter of ammonia leaks in the double-pipe condenser operates to its disadvantage. Because of the great affinity of anhydrous ammonia for water, a leak in a double-pipe condenser may continue for a long time, the ammonia being absorbed by the circulating water, without detection. The double-pipe condenser requires extra attention when shutting down the plant, especially in winter. Should the water remaining in the closed circuit of the double-pipe condenser be frozen, the rupture of one or more of the pipes or fittings is likely to occur.

In first cost the atmospheric condenser has an advantage over the double-pipe condenser because only a single coil of pipe, with much simpler connections, is required with a distributing and collecting trough, as compared to the double set of coils and special fittings usually found in the double pipe. As a general rule it can be figured that the first cost of the double-pipe condenser runs from three to four times the cost of the atmospheric type, figured on the basis of square feet of cooling surface.

In the matter of compactness, however, the double-pipe condenser has the advantage because, due to its higher efficiency, a small condenser will do the same work as a larger atmospheric condenser. The double-pipe condenser can also be installed indoors, while the atmospheric type must be installed outdoors or in a room separated from other machinery because of the presence of moisture. By reason of its compactness and freedom from moisture and water splashing, the double-pipe condenser can be located close to the ice machine, with a saving in cost of pipe lines, therefore this type is frequently used in small plants.

Where the cooling water is to be used over again for other purposes under pressure, the double-pipe condenser also possesses an advantage, in that the cooling water can be taken from the condenser under pressure to any other point of use, whereas in the atmospheric type all the pressure is dissipated when the water is exposed to the atmosphere. Where an unlimited supply of cheap water under pressure is available, the double-tube condenser can also be used to advantage and can frequently be installed in the lower portion of the building, saving the investment in an extra set of pumps which might be required to force the water up to an atmospheric condenser installed up high on the roof. In congested localities, such as in the heart of cities, the water and moisture passed out to the atmosphere by the open type of condenser is often objectionable, and in these cases the double type offers a nice solution of the problem.

HIGH EFFICIENCY OF DOUBLE-TUBE TYPE

Given favorable operating conditions—good clean cooling water, clean pipes and high velocity of circulating water—a high efficiency can be secured from the double-tube condenser. Giving the double-tube condenser the benefit of these favorable conditions, the comparison of the two types expressed in number of B.t.u. exchanged per square foot of cooling surface per hour can be stated as: Atmospheric type, 60 B.t.u. per deg. difference; double-tube type, 100 B.t.u. per deg. difference.

Because of this theoretically higher efficiency it should be possible to do the work with the double-tube condenser with 40 per cent. less cooling surface than in an atmospheric condenser; but when it is considered that the cooling surface in the double-tube type costs about 300 per cent. more than the atmospheric, this apparent advantage must be qualified. It should also be remembered that this theoretical efficiency will not always be encountered because of the unfavorableness of operating conditions.

Summed up, it would appear that the atmospheric condenser is the type that can be used to advantage in the average plant where no restrictions are encountered as to roof space, building congestion, etc., though the double type appears to be the most attractive where good cooling water is available or where the condenser can advantageously be located inside the building or near the compressor.

As to the straight-tube surface condenser, this is not so generally used on account of the expensive construction involved as against the atmospheric type, because it is subject to the same troubles from "scaly" water as the double-tube type, and because trouble is usually experienced in maintaining tight connections at the tube heads, the ammonia leakage being quite considerable unless constant attention is paid to keeping the tubes tight.

The submerged type of condenser is very cheap, comprising merely a tank and some ammonia coils, though it is not desirable for large-plant work because of the large size of tank required and the weight of the large volume of water it carries. The matter of detecting leakage is also unfavorable. In a condenser of this type it is also often necessary to install stirring apparatus to insure proper circulation.

Fyrox Moving West

The present condition of stress makes the public more susceptible to the exploitation of nostrums that are supposed to save a large percentage of coal. Purveyors of these preparations are alive to the situation. Our old friend "Fyrox," so active in the East last summer, and of which *Power* had something to say on page 56 of the July 10, 1917, issue, recently bobbed up in Detroit. As may be remembered, the compound is in powder form put up in one-pound boxes which sell for one dollar. A box of the compound is dissolved in 8 to 10 gal. of water, depending upon the size of coal burned, and the resulting solution is sprinkled over the coal. According to the directions given this amount is sufficient to treat two tons of coal. It is claimed that ordinarily two tons of treated coal will last as long as three tons of the untreated, thus saving one-third of the coal bill.

An inquisitive citizen of Detroit brought a box of the preparation to J. C. McCabe, director of the Department of Safety Engineering, requesting an opinion on its merits. An analysis by the Detroit Testing Laboratory showed the following ingredients:

	Per Cent.
Moisture	0.51
Common salt with trace of potassium chloride	89 93
Potassium permanganate	0 23
Potassium chlorate	0 88
Carbon	2.45
Sugar	6 00
	100 00

In other words, nearly nine-tenths of the preparation is common salt, and the cost of one pound of the mixture at the present high prices is about six cents. Apparently, if there were any advantage in using such a compound, it would be considerably cheaper to patronize the local stores.

When sprinkled on a hot fire salt produces a highly colored flame, but does not add to the heat value of the fuel. If used in sufficient quantity, it would tend to slow up combustion and eventually extinguish the fire. Less coal would be burned and less heat would be generated.

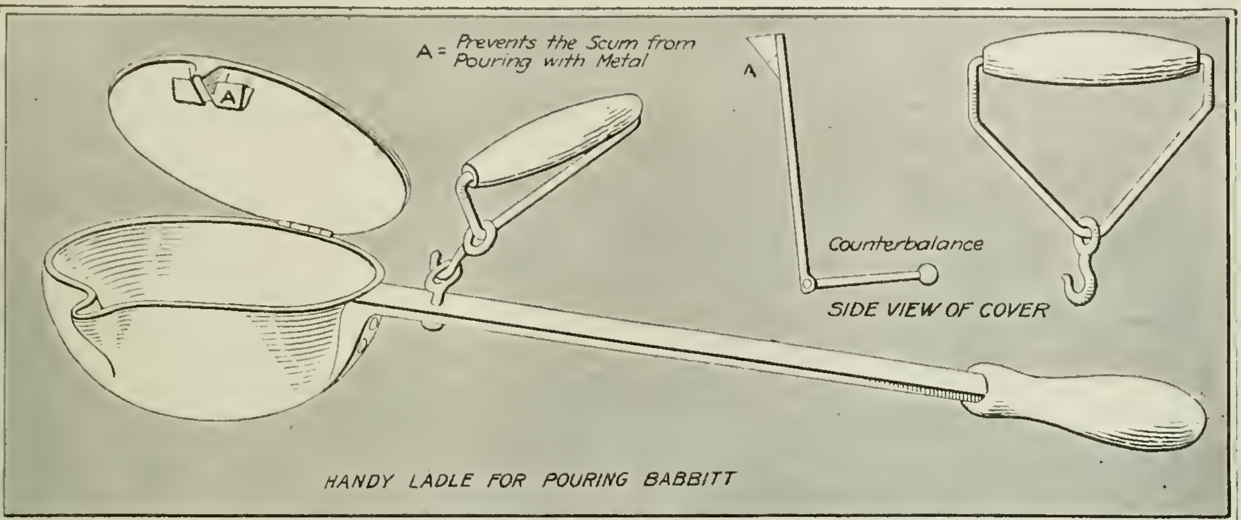
It will be noticed that one pound of Fyrox is used to 4000 lb. of coal, the proportion being 0.025 per cent. It should be evident that any benefit, or for that matter injury, to combustion must be negligible.

Calorimetric tests on two identical samples of coal, one without and the other with 400 times the amount of Fyrox specified, gave 11,517 and 11,767 B.t.u. respectively. The second test was made with a slightly heavier fusion wire, which would mean a little more heat in the calorimeter. The usual variation between readings is about 2 per cent., or in the present case, say, 200 B.t.u., so that for all practical purposes the heat from each sample of coal was identical.

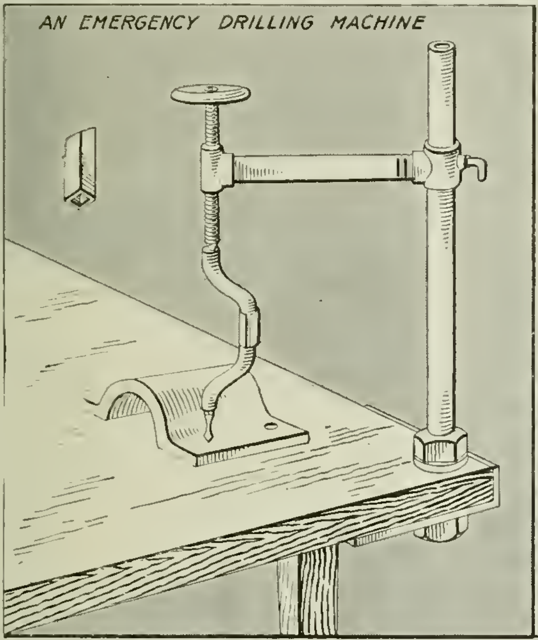
If it is the psychological effect that is desired, something that will influence the fireman to improve his methods and to watch the fire more carefully than usual, why not use plain water and give it a trade name to conceal its identity? The results would be equivalent and the cost much less.

From an Engineer's Notebook

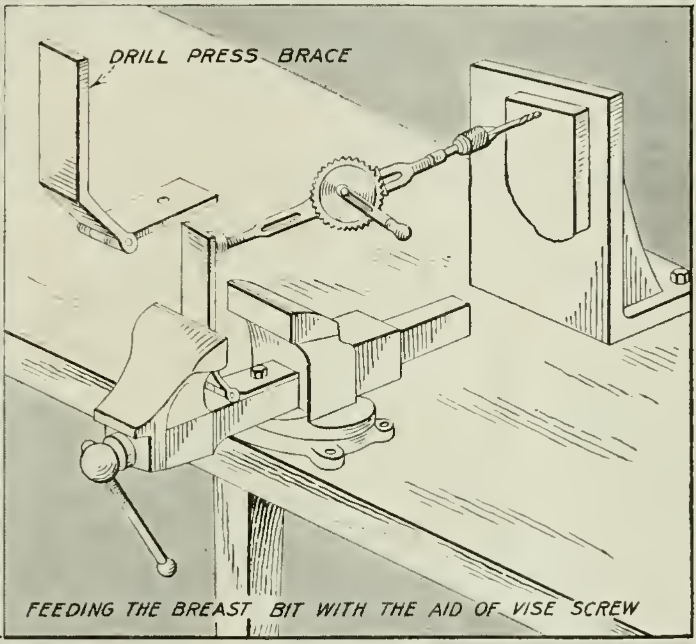
By M. P. Bertrande



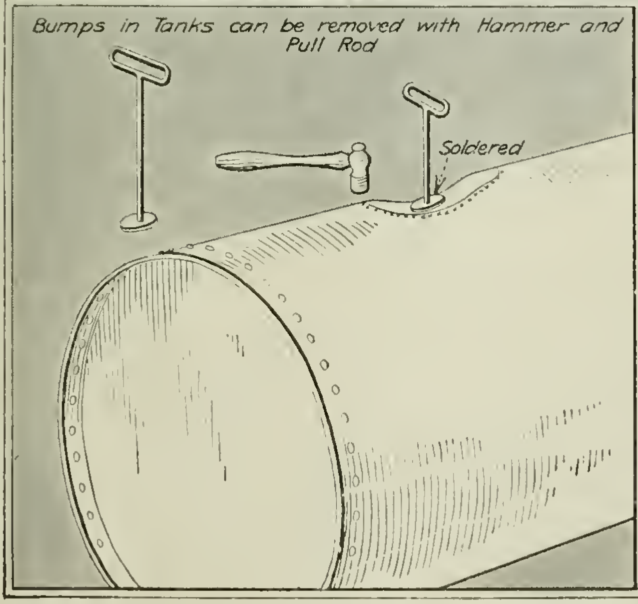
HANDY LADLE FOR POURING BABBITT



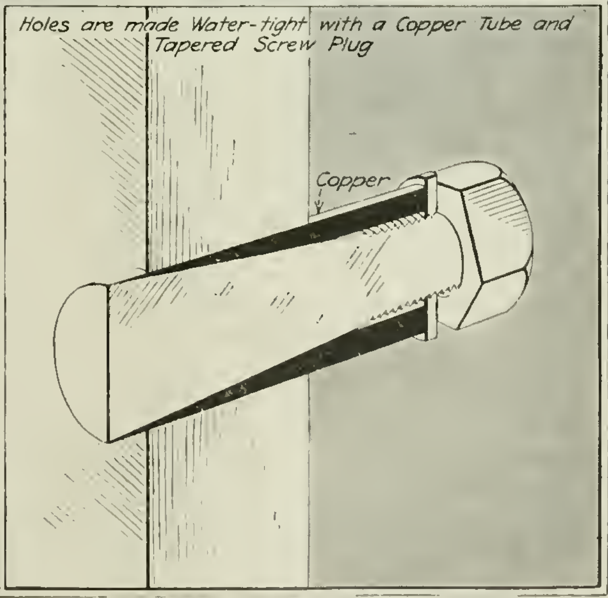
AN EMERGENCY DRILLING MACHINE



FEEDING THE BREAST BIT WITH THE AID OF VISE SCREW



Bumps in Tanks can be removed with Hammer and Pull Rod



Holes are made Water-tight with a Copper Tube and Tapered Screw Plug

The Electrical Study Course—Commutation

The process involved in the armature coils under commutation is explained, and one of the methods that may be used to assist in commutating the current is pointed out.

IN FIG. 1 the lines of force pass from the N pole into the armature core between points *B* and *D*; likewise under the S pole the magnetic flux passes from the armature core into the S pole between points *A* and *C*. It is only between these points that the armature conductors will be cutting the lines of force and therefore generating voltage, when the armature is revolved. Between points *A* and *B* on the left-hand side of the armature and *C* and *D* on the right-hand side, the conductors are outside of the magnetic field and are not cutting the latter; therefore do not produce any voltage. The space between the polepieces where the conductors do not cut any line of force is called the neutral point or neutral zone. It is always at this point that the brushes must be located on the commutator, because if they are very far off the neutral, serious sparking will result.

In general it is possible to shift the brushes slightly ahead of the neutral, that is, in the direction that the armature is turning, or to shift them slightly back of the neutral, against the direction of rotation, without seriously interfering with the operation of the machine. In some cases the brushes can be shifted slightly ahead or back of the neutral with beneficial effect upon the operation of the machine. However, this is a subject to be considered in a later lesson.

We have already seen in a previous lesson how a ring divided into two parts acts to cause an alternating current generated in a coil revolving between the poles of a magnet to flow in one direction in the external circuit. It will be recalled that, although the current was caused to flow in one direction, the current was of a pulsating nature; that is, flowed in waves. Where a number of coils are connected to a commutator, as in Fig. 1, the current not only flows in one direction in the external circuit, but also is maintained at a constant value. This will be seen by considering what takes place at the brushes as the armature revolves.

In Fig. 2 the armature is shown after it has been revolved one segment from the position shown in Fig. 1. In Fig. 2 coil *k*, which was under the N pole in Fig. 1, has moved out from under the pole and into the neutral zone, while coil *j*, which is in the neutral zone in Fig. 1, has moved in under the N pole, thus maintaining the same number of active conductors under this pole. The same thing has happened under the S pole, where coil *g*, which is under this pole in Fig. 1, has moved out into the neutral zone and coil *h* has come in under the pole, thus maintaining the number of active conductors under this pole constant and consequently maintaining the voltage at the brushes constant, which in turn will cause a current of constant value to flow in an external circuit *L* of constant resistance. This is the process that is going on all the time in the armature as long as it is revolved. As fast as one armature coil moves out from under a polepiece, another moves in to take its place, thus maintaining the number of active coils on the armature constant.

The process that takes place around the coils under commutation, that is, the coils in the neutral zone, is one of the most complicated operations in the machine. In Fig. 1 the current in coil *l* is flowing up through the plane of the paper and to the positive brush. At the negative brush the current is flowing from segment *c* to coil *m* and down through the plane of the paper. In Fig. 2 the current in coil *l* is flowing down through the plane of the paper and to segment *e* and then to the positive brush, and at the negative brush the current is flowing in through segment *b* and to coil *m*, up through the plane of the paper. From this it is seen that the direction of the current in coils *l* and *m* is reversed in Fig. 2 from that of Fig. 1. In other words, when the armature revolves through an arc equal to the width of a commutator segment, that is, causes one segment to move out from under a brush and another to move in, the current in a coil connected to the segments that the brushes rests on is reversed.

In changing from the condition in Fig. 1 to that in Fig. 2, there was a period when coils *l* and *m* were short-circuited; this is shown in Fig. 3. In this case the positive brush rests on segments *d* and *e* and the negative brush on segments *b* and *c*. When the brushes are in this position, as far as the circuits in the armature are concerned there need not be any current flowing in coils *l* and *m*, since as shown in the figure, the current to the positive brush can flow directly from coils *h* and *k* without flowing through coil *l*. Likewise at the negative brush, the current is from the brush to coils *g* and *j* without passing through coil *m*. In other words, coils *m* and *l* are shunted out of circuit, until the brushes move onto segments *b* and *e*, as in Fig. 2, where the current must flow in an opposite direction, in coils *l* and *m*, to that in Fig. 1.

The foregoing might be easily accomplished if it were not for the property of self-induction, which is present in every electrical circuit when the current is changing in value. It was shown in the lesson in the Dec. 4 issue, that when the current is increasing in value in a conductor, the conductors cut the line of force set up by the current and induce a voltage that tends to prevent the current from increasing in value, and when the current is decreasing in value, the conductors cut the line of force in a direction which creates a voltage that tends to keep the current flowing in the circuit. In other words, the effect of induction is to oppose any change in the value of the current in the circuit.

Let us see what the result of self-induction is upon the armature coils under commutation, such as coils *l* and *m* in the figures. Start with Fig. 1 and consider only the positive brush. The brush moves off segment *d* onto segment *e* bridging across the insulation between the two segments, as in Fig. 3. If it were not for the induction of the coil, there would be no reason for the current flowing in coil *l*, Fig. 3, but when the coil is short-circuited and the current starts to decrease, it is prevented from doing so by induction and for a short period must continue to flow through the coil into segment *d*. If this continues until segment *d* moves out from under the brush and segment *e* moves in, as in Fig. 2, then the current must not only cease flowing from coil *l* to segment *d*, but also reverse its direction and build up to full value in the opposite direction, as in Fig. 2. In the latter case induction again tends to prevent the current from building up in the opposite direction. The result of this is, if some means, which will be considered later, is not employed to make the current spark is produced in a make-and-break ignition system on a gas engine. Another thing is that as segment *d* moves out from under the brush, the contact between the brush is getting smaller all the time until the brush leaves the segment. If considerable current is kept flowing from the coil under commutation into the segment that the brush is leaving, such as coil *l* to segment *d*, Fig. 3, it may increase the temperature of the trailing corner of the brush to the point where it will glow.

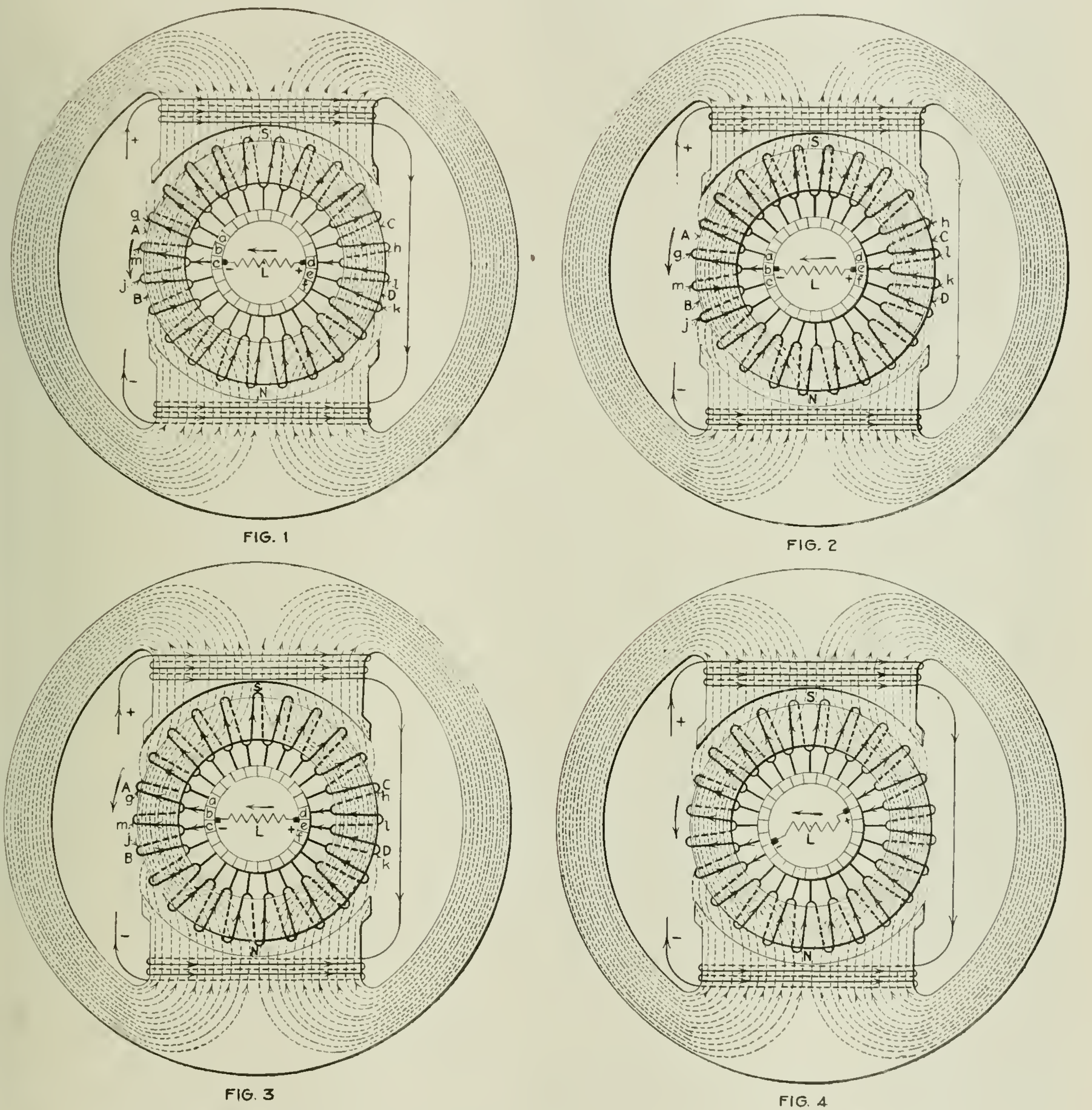


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIGS. 1 TO 4. DIAGRAMMATICAL REPRESENTATION OF A DIRECT-CURRENT GENERATOR

reverse in the coil under commutation in the time required for the brush to pass from one segment to another, severe sparking at the brushes will take place. This is caused by the current not being able to reverse in the coil, in the time that the brush passes from one segment to another, and follows the brush across the insulation between the segments, similar to the way the

The time during which the current must decrease from full value to zero and build up to full value in the opposite direction is very small. For example, assume that the armature in the figure is revolving at 1500 r.p.m., which is not an excessive speed. Since there are 24 segments in the commutator, 24 × 1500 = 36,000 segments pass each brush per minute, or 600 segments per second. We have just seen that each time a segment passes a brush, the current reverses in a coil. Therefore, when a two-pole armature having 24 segments revolves at 1500 r.p.m., the current must reverse in the coil under commutation in $\frac{1}{600}$ part of a second. From this it is evident that it may be a somewhat difficult proposition to make the current properly reverse in the coil in such a short period.

At the positive brush the current is flowing up through the coil under commutation and must be reversed and caused to flow down, each time that a segment moves out from under the brush and another one moves in. What would help to reverse the current would be an electromotive force induced in the coil opposite to the direction that the current is flowing in the coil under commutation; that is, if the current is up through the plane of the paper, the voltage will have to be downward to assist in changing the direction of the current. In the figure all the conductors under the S pole have an electromotive force induced in them down through the plane of the paper. Therefore, if the brushes are shifted so that the positive brush will come under the tip of the S pole, as in Fig. 4, the coil under commutation will have a voltage induced in it that is opposite to the flow of the current in the coil. When the brushes are properly located, they will be in a position where the voltage generated in the coil will be just sufficient to reverse the current during the period of commutation.

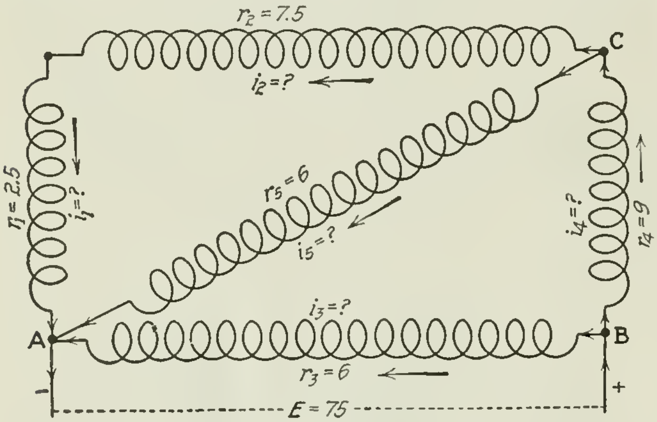


FIG. 5. COMPLEX CIRCUIT

The foregoing is one way to obtain sparkless commutation and was the one usually relied upon in the early type of machines, but by improvement in design it has become possible to build generators and motors that will operate over their entire range from no load to full load with the brushes located exactly between the pole-pieces without sparking. Further consideration will be given this subject in later lessons. It will be noted that the brushes are shifted in the direction in which the armature is revolving. However, this is true only of a generator.

When we consider the electric motor, it will be found that the brushes must be shifted against the direction of rotation, to assist in reversing the current in the coil under commutation.

In Fig. 5 is given the layout of the problem given in the last lesson, and it is worked out in a manner similar to the one solved in that lesson. Here we have two circuits, a simple one from B through $r_3 = 6$ ohms to A, and a second, a complex circuit, from B through $r_4 = 9$ ohms to C; at this point the circuit divides, one part going through $r_5 = 6$ ohms and the other through $r_2 = 7.5$ ohms in series with $r_1 = 2.5$ ohms to A. It is evident that the simple circuit r_3 is in parallel with the complex circuit just described. In the complex circuit r_5 is in parallel with r_1 and r_2 in series. Therefore, if we represent the joint resistance of this part of the circuit by R', then

$$R' = \frac{1}{\frac{1}{r_1 + r_2} + \frac{1}{r_5}} = \frac{1}{\frac{1}{2.5 + 7.5} + \frac{1}{6}} = \frac{1}{\frac{1}{10} + \frac{1}{6}} = \frac{1}{\frac{8}{30}} = \frac{30}{8} = 3.75 \textit{ ohms}$$

R' is in series with r_4, hence the resistance of the complex circuit is $R'' = R' + r_4 = 3.75 + 9 = 12.75$ ohms. Then the joint resistance of the total circuit is

$$R = \frac{1}{\frac{1}{R''} + \frac{1}{r_3}} = \frac{1}{\frac{1}{12.75} + \frac{1}{6}} = \frac{1}{\frac{18.75}{76.5}} = \frac{76.5}{18.75} = 4.08 \textit{ ohms}$$

Then the total current $I = \frac{E}{R} = \frac{75}{4.08} = 18.38$ amperes.

Since full pressure is applied across r_3, $i_3 = \frac{E}{r_3} = \frac{75}{6} = 12.5$ amperes. Full voltage is also applied across the complex circuit R'', hence, in this circuit the current $I' = \frac{E}{R''} = \frac{75}{12.75} = 5.88$ amperes. All this current flows through r_4, therefore, $i_4 = I' = 5.88$ amperes. After the current passes through r_4, it divides at C, part of it going through r_5 and part going through r_1 and r_2 in series. The voltage drop across r_4 is $e_4 = r_4, i_4 = 9 \times 5.88 = 52.92$ volts. $E' = E - e_4 = 75 - 52.92 = 22.08$ volts available between C and A, from which $i_5 = \frac{E'}{r_5} = \frac{22.08}{6} = 3.68$ amperes, and $i_1 = i_2 = \frac{E'}{r_1 + r_2} = \frac{22.08}{2.5 + 7.5} = 2.2$ amperes. The sum of i_5 and i_1 or i_2 is $3.68 + 2.2 = 5.88$ amperes, which checks up with i_4 the current flowing in r_4. This is as it should be.

In Fig. 1 if the resistance of each half of the armature winding from the positive brush around to the negative brush is 0.5 ohm, and there is connected between the brushes a resistance $L = 4.75$ ohms, what current will flow in the external circuit and in each half of the armature winding when 150 volts is being generated in the winding? Also, what will be the value of the volts across the brushes when the external circuit is connected?

An owner of land joining a stream above an existing dam loses all right to enjoin a raising of the dam, although that causes overflow of his lands, where no objection was made while the new structure was being constructed, and he maintained suits to collect damages for the injury done his property, without then seeking to enjoin further maintenance of the dam at its increased height. In addition to laying down this rule of law in the case of Holcomb vs. Alpena Power Co., 164 Northwestern Reporter, 470, lately, the Michigan Supreme Court also decided that where land is permanently flooded by a dam; the owner's damages should be computed in full in one suit on the basis of the excess of value of the land unflooded above its value as flooded.

Possible Saving in Avoiding Leaks in Boiler Setting

By J. M. Aarons

Some well-known truths are pointed out. Air leakage through boiler settings, due to cracked settings and porous bricks, can be reduced to a minimum by coating the brickwork. The present coal situation is bringing home the facts set forth.

SUPPOSE that 150,000,000 tons of coal could be deposited in the bunkers of the coal users of this country during the next twelve months without any effort on the part of either the mines or the railroads. This would mean that the fuel shortage would not only be overcome, but there would be a large surplus for export. This 150,000,000 tons is the estimated amount annually wasted by the coal users of this country, and the fuel shortage may therefore be charged directly to waste.

Engineers throughout the country have for years been pointing out the possibilities of increased efficiency in the boiler room. Generally speaking, little attention has been paid to them. The executive heads of manufacturing concerns do not, as a rule, make a study of their boiler-house conditions. This part of their operation is looked upon as a hot and dirty place. Combustion, as far as they are concerned, consists in starting a fire and shoveling on sufficient coal at intervals to keep up the steam pressure.

Coal Bills Considered Necessary Evils

Coal bills always touch the "sore spot," but they are looked upon more or less as necessary evils—something to kick about on the first of each month and then forget. Until recently, if the coal bill was 15 to 30 per cent. higher than it should be, it was nobody's business as long as the man who "paid the piper" was indifferent. Today things have changed and every pound of coal wasted is a black spot against the one who sanctions it.

How can coal be saved? When it is taken into consideration that a ton of good-grade coal delivered to the plant contains approximately 29,000,000 B.t.u. and that the average plant delivers to the point where power is used only about 555,000 B.t.u., it will be seen that an enormous waste is taking place somewhere. Part of this loss is unavoidable, but a large percentage of it is due to carelessness in operation and to neglect.

By far the greatest waste is caused by the large amount of excess air that is permitted to enter furnaces and boiler settings and to escape up the chimneys, carrying away heat that should be utilized to do useful work. This unnecessary excess air is admitted in two ways—first, through uneven fires which leave part of the grates bare and, second, through pores and cracks in the boiler settings. Loss due to uneven fires is chargeable directly to improper operation. Every fireman knows that to get the greatest capacity out of a boiler the entire grate surface must be covered with burning fuel and that there must be no holes or bare spots, but apparently many do not appreciate that an even fire is necessary if the fuel is to be burned efficiently. If a few simple instructions along this line were given and the firemen were required to follow them, a tremendous saving would be effected.

The loss due to leakage through boiler settings is even more important because it is less easily detected. If a fire is in improper condition, one look into the furnace reveals the fact, but leakage through settings is not so apparent. There is a certain amount of leakage around doors and boiler drums, but most of it filters through what appears to be a solid brick wall. The heating and cooling of the brickwork opens up a large number of small cracks which increase the leakage without giving a setting the appearance of being in bad condition. The leakage through boiler settings reaches greater proportions than is apparent from an inspection of the brickwork and may be as great as one-half of the amount of air supplied for combustion. This represents a large preventable loss, and one which may go on unnoticed because there is no outward indication that it actually exists. Moreover, the loss due to infiltration of air to the boiler settings is not intermittent but represents a continual source of fuel waste from the time the boiler is put in service until it is taken out. In fact, the condition is gradually aggravated, week after week, as the settings become more cracked and porous.

A large plant recently attempted to purchase two 500-hp. boilers. The delivery on this equipment was so far off that a serious problem faced them. The services of an experienced combustion engineer were engaged to see what improvement could be made in the existing plant. Analyses of the flue gas were taken, and readings as low as 2.4 per cent. CO_2 were secured on two of the boilers. This represented an excess air condition of about 800 per cent. Further investigation disclosed large openings in the settings, and open doors into the combustion chamber were admitting sufficient air to absorb practically all the heat liberated by the fuel burned in the furnaces.

Tight Settings Effect Large Coal Saving

With all settings made tight, which required but a few days' work, the new boilers were no longer necessary, and a large saving of coal was effected. Although this is an extreme case of waste, due to air infiltration, it serves to emphasize the necessity for tight settings. In fact, the heat units actually used in the average boiler room when compared to the heat units that can be obtained under proper operating conditions and with tight boiler settings, if put on a dollar and cents comparative basis, are equivalent to paying $5 for only $2.86 worth of coal.

Any handbook or treatise on boiler and furnace efficiency will point out the necessity of keeping the settings tight. The efficiency guarantee of any stoker company has a clause referring to tight boiler settings that qualifies their guarantee. In spite of all this the boiler settings in 95 per cent. of the plants leak air excessively.

Every crack and crevice represents waste, and every brick and mortar joint, no matter how good it may look, is passing a certain amount of air. Leaky boiler settings not only seriously affect the coal bill, but materially reduce the capacity of the plant. Many manufacturing concerns that are now crippled through lack of steam could sail merrily along with steam to spare, by simply coating the boiler settings.

The capacities of most chimneys are limited and can handle only so much air as they are not usually generously designed. The higher the temperature of the gases entering the chimney the greater the velocity through it. Its duty in all natural-draft installations is to pull the required amount of air through the fuel bed and to carry off the resultant gases of combustion. If cold air is allowed to leak into the settings, it lowers the temperature of the gases, slows up the velocity through the chimney, puts an unnecessary burden on it and cuts down the capacity of the plant.

There are usually two sides to a question, but there is positively but one side to this one. There can be no argument brought to bear against a tight boiler setting. The first step toward economy in the boiler house should be to cover all brick settings and stacks with a suitable air-tight coating. The material of this coating should have sufficient elasticity to expand and contract with the brickwork and also be capable of standing considerable heat and temperature changes and remain plastic for a long period. Above all, it should adhere firmly to the brickwork and not crack or peel off. There are several compounds that meet these requirements. They are cheap, easily applied and present one of the best investments that can be made.

No matter what improvements are contemplated in the boiler house, the settings should be coated. A fortune may be spent on instruments and boiler-house equipment, but the results striven for will still be missed if the boiler settings are leaky. Fuel represents 70 to 80 per cent. of the total cost of power. Is not 3 to 30 per cent. of this amount worth saving?

Unusual Design of Evaporator for Distilling Sea Water

Those who have to deal with the distilling of sea or other water or with evaporation problems of almost any kind will be interested in the design of the Lillie evaporator now being built by the Wheeler Condenser and Engineering Co., of Carteret, N. J. It is, as will be seen from the illustration, a modification of a regular Lillie sextuple-effect sea-water distilling apparatus. Two of these now under construction are to be operated by steam up to 60 lb. gage pressure or at any lower pressure.

The point that will catch the veteran's eye is the employment of four condensers, side by side, as shown in the illustration. This unusual arrangement of condensers permits seven different combinations of operation, as follows:

It may be operated as one single effect or more single effects; it may be operated as one or more double effects with vapors reversible in each; it is possible to operate it as a triple effect, or as two triple effects with vapors reversible in each; it is impossible, of course, to operate it as two quadruple effects, but every effect may be utilized by grouping as one quadruple effect and one double effect, in both of which the vapors are reversible; it may be operated as one vapor reversible quadruple effect with both end effects or either end pair of the section cut out; with one effect at either end cut out, it may be operated as a vapor reversible quintuple effect; lastly, it may be operated as a vapor reversible sextuple effect.

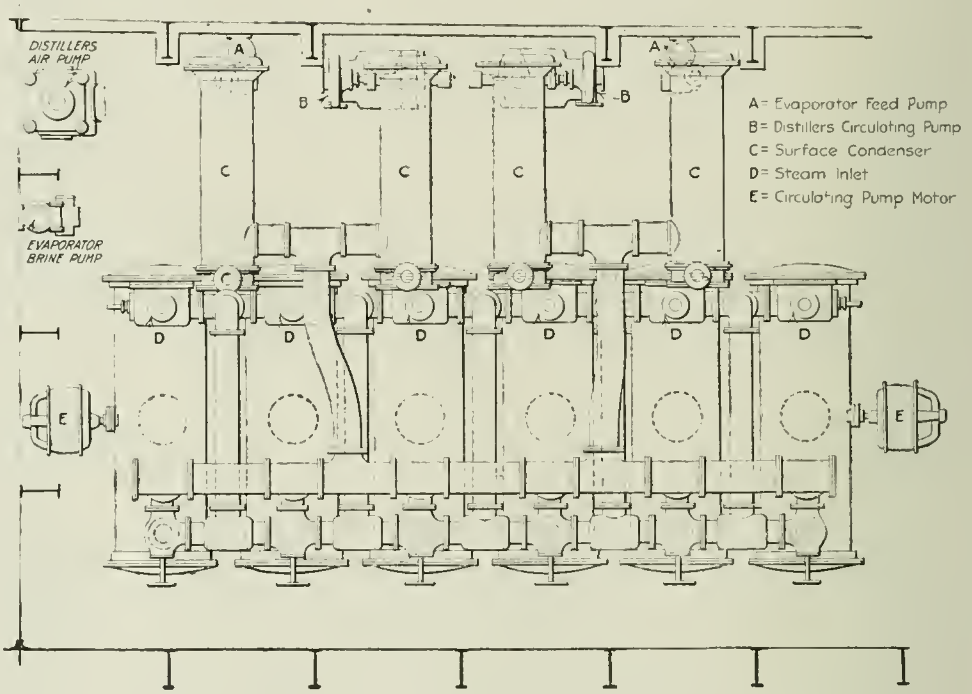


DIAGRAM OF THE LILLIE SEA-WATER EVAPORATOR

It is evident that should a mishap occur at either end, in the middle or anywhere else, there is little danger that this evaporator will be put out of commission entirely.

Useful Conversion Multipliers

	Multiply by		Multiply by
Inches to millimeters	25.4	Miles to kilometers	1.61
Millimeters to inches	0.0394	Grains to grams	0.065
Inches to centimeters...	2.54	Grams to grains	15.4
Centimeters to inches.....	0.394	Grams to ounces	0.35
Inches to meters	0.0254	Ounces to grams	28.35
Meters to inches	39.4	Pounds to grams	453.6
Feet to meters	0.3048	Pounds to kilograms	0.455
Meters to feet	3.281	Kilograms to pounds	2.2
Meters to yards	1.1	Kilograms to ounces	35.3
Yards to meters	0.9144	Kilograms to hundredweight	0.02
Yards to kilometers	0.0009	Hundredweight to kilograms	50.85
Kilometers to yards	1,093.6	Kilograms to tons	0.001
Kilometers to miles	0.62	Tons to kilograms	1,016

—*Graphite.*

Fuel Consumption of Low-Compression Oil Engines

By L. H. Morrison

THE builders of low-compression oil engines have quite generally adopted the following guarantees of fuel consumed per brake horsepower per hour at various loads: Full load, 0.100 gal.; three-fourths load, 0.110 gal.; half load, 0.125 gal. These performances can be attained in actual service, so long as the wear on the engine is not excessive.

All builders claim that their engines will operate on the heaviest of oils, as well as on other grades up to kerosene. Although any oil engine will work well with a crude oil that contains a considerable percentage of the lighter oils, the service will not be satisfactory if the crude has an asphaltum base. When such oil is used, deposits of carbon and asphaltum occur in the cylinder and cause rapid cutting. The same is true of any fuel oil having an asphaltum base. The wear on the cylinder is particularly heavy if the oil contains dirt and grit.

If a fuel oil is decided upon, it is advisable to purchase a filtered oil, usually sold as "Diesel fuel oil." This will probably cost from one to one and a half cents more per gallon than unfiltered fuel oil, or "boiler oil," but in lessening the wear on the cylinder, reducing the cutting of valves and seats and decreasing trouble in general, it is well worth the difference in cost.

The best all-round fuel is without question a distillate of about 32 deg. Baumé, because it is light enough to burn completely at all loads. Experience has proved that distillate is the proper fuel for any low-compression engine. These remarks apply specifically to asphaltum-base oil; with a paraffin-base oil it seems that any grade of fuel oil or crude may be used successfully.

Amount of Sulphur Should Be Limited

In the purchase of the fuel, limits should be placed on the amount of sulphur in the oil. While one-fifth of one per cent. of sulphur is as much as ought to be allowed, a greater percentage is usually found. One engine builder suggests the following requirements, which have been found satisfactory in connection with his own engines: Specific gravity, not below 26 deg. B.; sulphur, less than 0.5 per cent.; water, less than 0.5 per cent.; coke, not over 3 per cent.; fraction which will distill off below 360 deg. C., at least 60 per cent.; oil to have a heating value of at least 18,500 B.t.u. per lb., and to be free from grit or dirt.

On the basis of brake horsepower, the thermal efficiency at full load will be in the neighborhood of 19 per cent. On the basis of indicated horsepower, disregarding the friction and the power required to run the air compressor, the efficiency will be approximately 23 per cent. If efficiencies much greater than these are guaranteed, it will usually be found that the engine is not of the low-compression type, but belongs to the semi-Diesel class, in which the temperature range allows a greater efficiency to be obtained.

In case the engine drives an industrial load, the best method of drive is by means of a belt. Many engineers show a preference for a clutch coupling connecting the engine shaft to the driven shaft; but with this arrangement it is a hard matter to keep all the bearings in line, and the usual result is rapid wear of the bearings and the clutch friction blocks.

By using a friction belt pulley, the engine can be started under no load and brought up to speed before the load is thrown on. Driving by belt allows the shaft bearings to keep their alignment with greater ease. The wear on the engine and lineshaft bearings is less, and the drive is more flexible.

In an installation in which the engine drives an electric generator, the rotor should, if possible, be placed directly on the engine shaft. In the past it has been the general custom to use a waterwheel or gas-engine type of alternator with self-contained bearings and shaft. This shaft was connected to the engine shaft by a flexible coupling or a flange coupling. Such a method involved at least one extra bearing or was hard to keep aligned. In the later engines an extended shaft and an outboard bearing are generally used. The rotor can be pressed on the shaft extension. Such an installation is more attractive and easier to keep in good shape.

The question often arises as to the possibility of paralleling two alternators driven by low-compression engines. If the engines are of the single-cylinder type, the synchronizing will be more difficult than if multicylinder engines are used. This is due to the large angular variation in the speed of the single-cylinder engine, although, of course, the use of extra-heavy flywheels will eliminate part of this trouble. As a consequence, there are more installations in which paralleling of the units is accomplished by using multicylinder engines than by single-cylinder engines.

It is well to have the alternators equipped with squirrel-cage windings on the rotor to reduce the cross-currents. Another good plan is to use exciters large enough so that one of them will be able to furnish sufficient current for both generators.

Low-Compression Type Suited to Small Plants

The low-compression engine has its field of usefulness. In industrial plants using less than a hundred horsepower, this type is quite suitable. While the history of the usual installation is one of expensive repairs and shutdowns, this is not really the fault of the engine. It has been customary for builders to claim that experienced attendance was not necessary; but many purchasers who have acted on this statement have learned how little truth there is in it. Given the care that a Diesel engine or a Corliss steam engine receives, the low-compression engine will operate satisfactorily.

While fuel oil was cheap, the saving of the Diesel engine over the low-compression engine was not great in the smaller sizes; as a result, the low first cost of the low-compression engine was the motive that caused many to be installed. With oil costing about five cents a gallon, the Diesel engine will undoubtedly be favored over the former type even in sizes less than one hundred horsepower.

Falling Chimney Wrecks Part of New England Factory

A part of the three-story frame building of the Sprague Box Co., at Lynn, Mass., was wrecked by a falling chimney recently, causing four fatalities and injuring a number of employees. The chimney failed during a gale estimated at 60 miles per hour, and had the accident occurred later in the day, the loss of life would unquestionably have been much greater. The chimney was a brick stack of rectangular horizontal cross-section, about 3 x 5 ft. inside dimensions and approximately 70 ft. high. As shown in Fig. 1, the original of which was made on the spot by a representative of *Power*, the chimney was carried upward from the boiler house of the factory along the outer wall, to which it was attached by iron straps about half-way up and also at the roof level. It extended above the roof for about 35 ft. The original chimney was built eight years ago, and twelve months ago about 8 ft. was added to its height, the stack being guyed to two parts of the factory building.

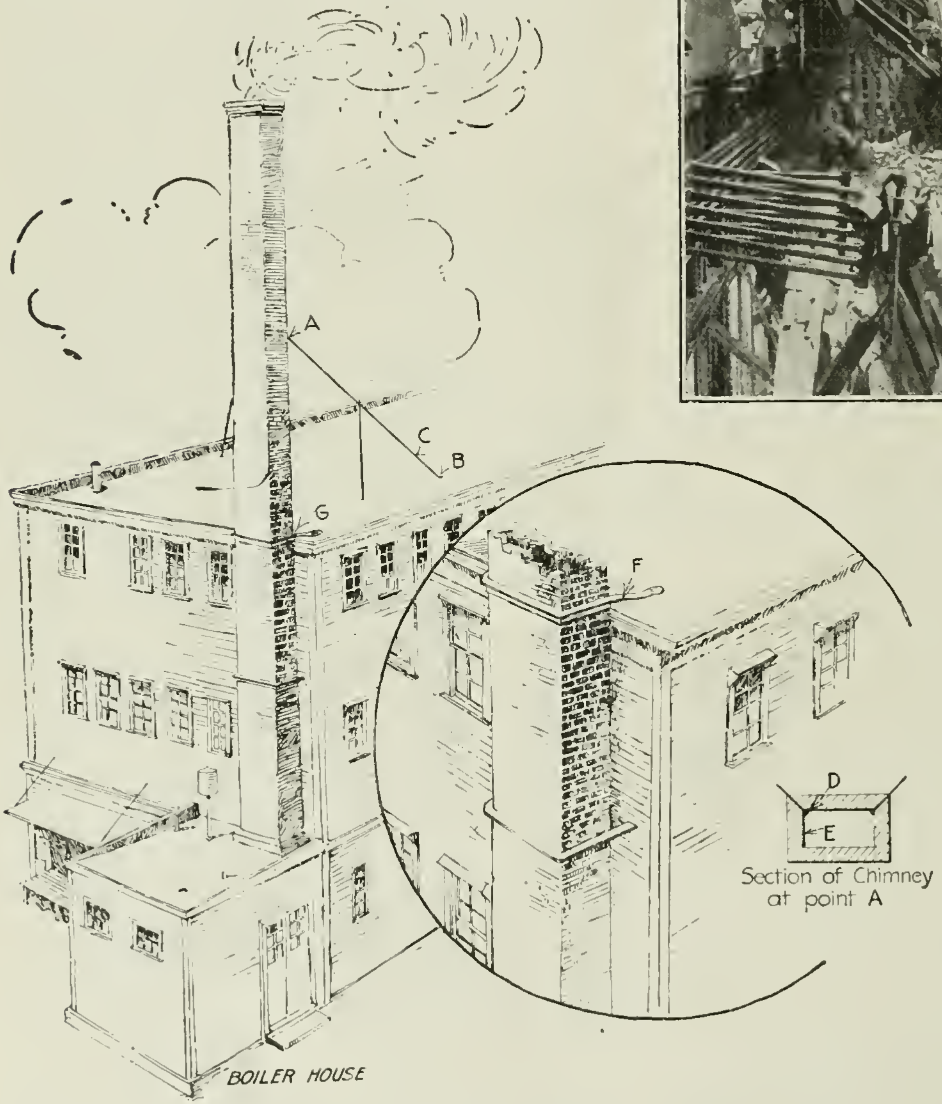


FIG. 1. DETAILS OF THE CHIMNEY, METHOD OF BRACING AND POINT OF FAILURE

In Fig. 1 *A* represents the two anchorages to the chimney and *B* the anchorages to the roof; the rods *C* are 1 in. in diameter and about 30 ft. long; *D* is an angle iron on the inside of the chimney; *E* represents the thickness of the chimney, 8 in.; *F* is an iron strap at the roof level, and *G* represents the point where the chimney broke off.

FIG. 2. THREE FLOORS WERE DEMOLISHED

In giving way under the gale, the stack broke off at the roof level. It fell intact into the factory, demolishing three floors covering a panel or bay about 16 ft. wide and 40 ft. long, Fig. 2. The anchorages of the brace rods in the stack held. The wooden anchorages of the rods in the building structure were carried away with the rods, and the only bracing support of the stack was the stiffness of these rods. Foundation and straps were in good condition when inspected. It appears that the chimney was ill-proportioned for the height to which it was carried and that its anchorages to the roof were inadequate in size and number, guying being on one side only. All possible aid was extended to the victims of the disaster by the local branch of the Red Cross, the Lynn works of the General Electric Co., the Lynn Gas and Electric Co., J. B. Blood Co., and others, and fortunately no fire occurred.

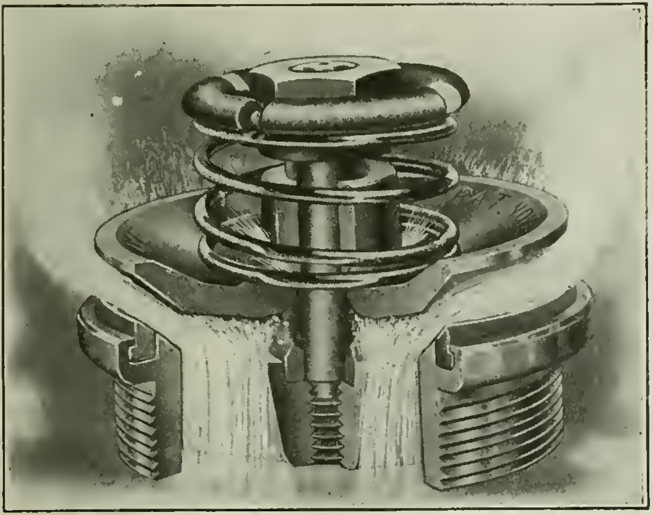
The accident occurred at 7:45 a.m., and at 5 p.m.

on the same day the débris had been removed, a new roof erected, and the chimney replaced by a 2.5-ft. steel stack 30 ft. long, erected upon the remaining portion of the brick stack. The plant resumed operation on war orders the morning after the accident. About 5 ft. of new brickwork was built upon the upper end of the old stack in adding the new section. Two courses of bricks formed the stack proper, the walls being 8 in. thick.

Scoville Pump Valve

A metal-to-metal pump valve sealed by compressible composition rings of special form is being made by the Scoville Pump Valve Co., Chicago, Ill. As shown in the illustration, the valve disk is beveled on its outer circumference and also around the hole for the stem. In grooves around the stem and in the seat of the valve the composition sealing rings are inserted. The pressure of the fluid forces the rings against the beveled edges of the valve, making the metal-to-metal joint tight, and as the rings come in contact with the valve before it is fully seated, there is little opportunity for slippage.

Wear upon the seals is small as the valve does not seat directly upon them, and renewal is comparatively simple and inexpensive. Another advantage claimed for the beveled valve is a reduction in friction and loss from eddy currents over a flat disk in which the fluid flow is at right angles to the plane of the valve. Standard and pot types of valve are made.

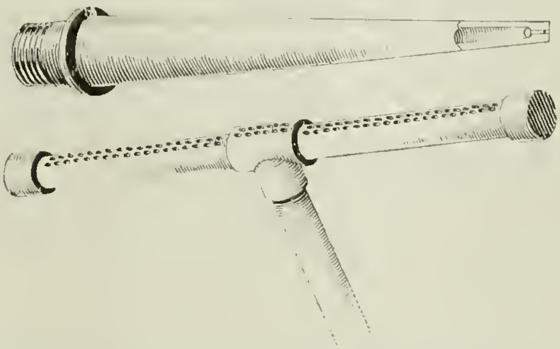

SCOVILLE METAL-TO-METAL PUMP VALVE

Compressed Air for Cleaning Motors

By D. R. Shearer

In a great many manufacturing plants, especially those working in wood or a similar material, the driving motors have a tendency to become clogged with dust in a short time. Such accumulation of dust is a fire hazard, particularly if the motors are overloaded and liable to have coils burn out; and if a motor is not overloaded, it may heat if the air ducts are filled with dust. Moreover, the motor is not able to carry the peaks when called upon, for the reason that the additional heat cannot be dissipated. Motors should be cleaned frequently, but such cleaning with the means ordinarily at hand is a rather difficult procedure since the air ducts are usually small and difficult to clear with a brush. The windings may be brushed off externally, but such cleaning does not reach the real seat of the trouble.

One of the best methods is compressed air under considerable pressure. If the air is not available from some source already in use, it is advantageous to use a small motor-driven compressor and a storage tank. The compressor should have a capacity of from 4 to 10 cu.ft. of air per minute at a pressure of 100 lb. per sq.in., and the tank should hold from 40 to 100 cu.ft. This size will take care of the average plant.


NOZZLES OR TOOLS FOR CLEANING WITH AIR

In piping a factory the air line can be 1-in., $\frac{3}{4}$-in. and $\frac{1}{2}$-in pipe. Since the amount of air used in cleaning any one motor is small, a large pipe is not necessary. An outlet with a valve should be placed near each motor, or if they are grouped, several motors can be reached from one outlet with $\frac{1}{2}$- or $\frac{3}{8}$-in. hose; the smaller size is more easily handled. The nozzles can be made up of brass rod of suitable sizes and shapes, one of which is shown in the illustration. It is necessary, however, to use nozzles with small openings as a large nozzle opening would consume too much air. Probably the most useful sizes would be $\frac{3}{32}$-, $\frac{1}{16}$- and $\frac{3}{64}$-inch, and these three nozzles will meet most conditions.

Sometimes it becomes desirable to clean surfaces with air; for instance, the walls or ceilings of the buildings. This may be done with a tool made from $\frac{3}{8}$- or $\frac{1}{2}$-in. pipe in which there are a number of holes, as shown, to form a "brush" of escaping air. For ordinary purposes holes of about $\frac{1}{32}$ to $\frac{1}{64}$ in. can be used.

These small nozzles do not clog readily if all the scale and dirt is blown out of the piping. As an investment such a cleaning system will be found to pay for itself in the reduction of motor troubles and the decrease in fire hazard.

Carbon in Steel

There is more or less uncertainty in the mind of the average reader in regard to carbon in steel and how it can be got there. While there are many ways of introducing carbon into iron, one of the most direct is to throw charcoal into a ladle being filled with molten iron—simple as sprinkling salt in soup and the determination of the proper amount is the same; that is by sampling.

Centralized Mine Plant

By C. C. Muldner

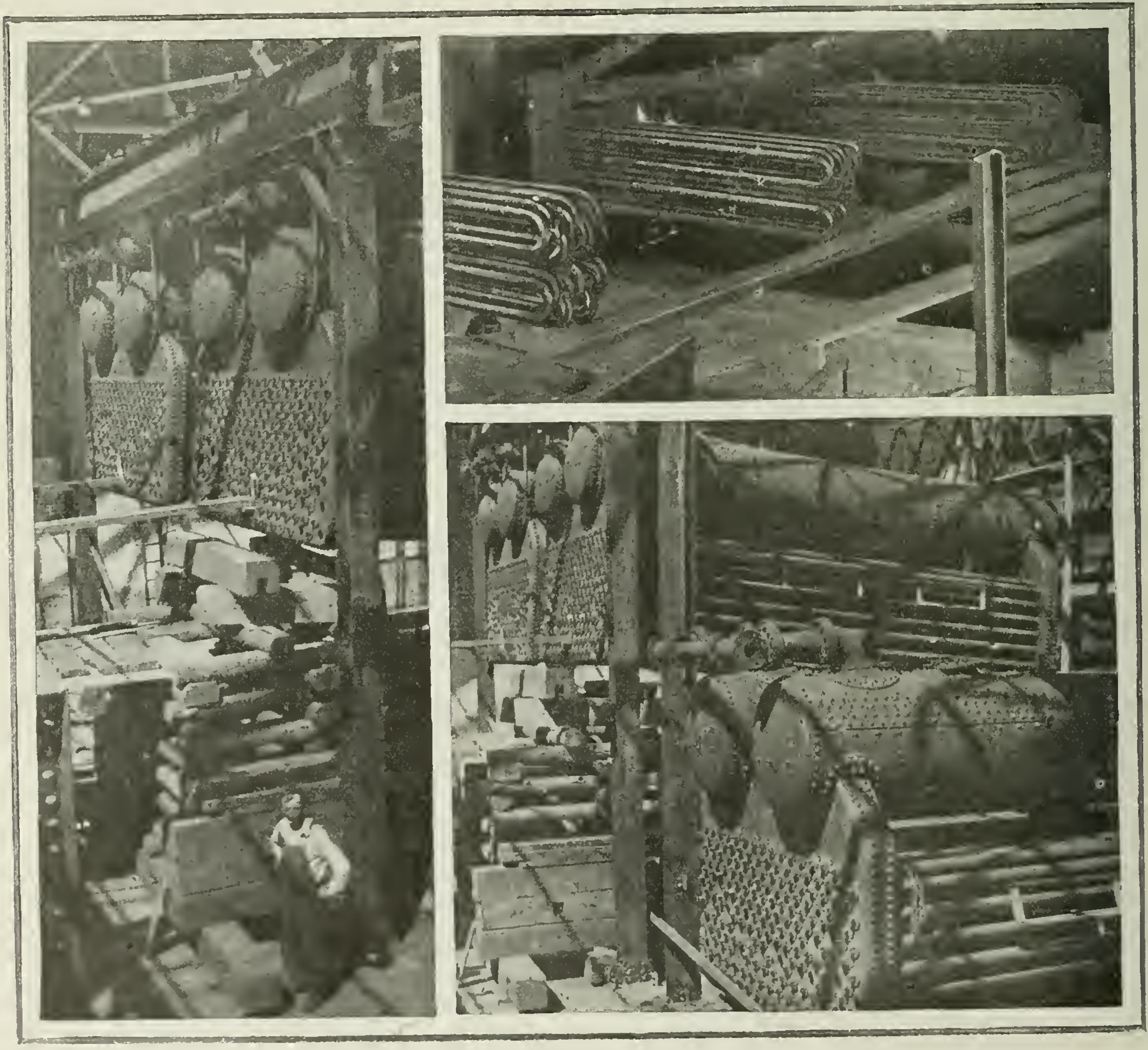
The illustrations show the boilers in course of erection in the new addition to the power plant of the Oliver Iron Mining Co., at Ironwood, Mich.

The chief feature in this setting is that two 25-ton (450-hp.) Heine boilers are hung on one gallows, there being no supporting column in the division wall between them. The overhead support consists of two 24-in. I-beams 27 ft. long, supported by two 10-in. H-beams, eliminating the usual column in the division wall, which, being completely bricked in, deteriorates rapidly, causing serious trouble. The height of the setting can be judged from the height of the man standing on the floor level and the tops of two return-tubular boilers in the background, by means of which it is expected to eliminate smoke and greatly increase the furnace efficiency and pay for the extra first cost in a short time. The temperature control connected with the superheaters maintains any desired superheat within five degrees.

This plant will be used as a central station for all the mines in the vicinity belonging to the Oliver Iron Mining Co., of which there are about thirty, to be linked together with about 14 miles of tunnels. Cables and steam pipes will transmit power, light and heat to each mine. Eventually, the mines will be electrified, thus doing away with the numerous individual boiler plants.

This is an example of the present tendency to centralize mine power plants and, in the case of coal mines, to produce electric current for distribution and sale at the pit mouth, where low-grade fuel can be profitably utilized by combining high boiler setting and superheaters in large units; and with stokers and coal- and ash-handling machinery, the cost of producing steam should be reduced to the minimum.

The transfer of electric current long distances involves a loss, of course, but it often costs much less than the hauling and handling of coal from the mine to the market. Time was when crude oil was hauled from the wells to the refineries; nowadays it is pumped for distances of several hundred miles.



TWO BOILERS SUSPENDED FROM A SINGLE GALLOWS FRAME; HIGH SETTING AND SUPERHEATERS

Editorials

Putting Their Houses in Order

THE employers have begun to set their houses in order. Some employers, not all. Careful study is beginning to replace indifferent handling of the labor problem. Necessity is forcing a modification of the autocratic policy. The worker will no longer be a chattel. He demands to be treated as a human being. His aspirations must be consulted.

There was plenty of reason in the past for the employer changing his attitude. Where he did not have strikes, he found at least indifferent and consequently wasteful labor interest. His dominant thought, though, was to hold all power. He feared that any injection of the milk of human kindness would lead the men to believe that he was weakening, that kindness was the resort of waning strength.

Yet around him there were plants that continued successful even though the men were treated like humans; aye, that increased their profits through greater efficiency and greater labor stability. Gradually the public, learning faster than the owner, forced upon him shorter hours, accident-prevention measures, proper sanitation, workmen's compensation. And lo, the industry was the gainer. There was physical response to the improved conditions; and just as surely, response in spirit, even if unconscious.

Still, the absolutism in management remained. The changes were forced, not voluntary.

Then came the war. Labor, from receiving an indifferent interest from the employer, began to get his chief attention. The supply was ostensibly short.

For a decade those who thought deeply on management problems have urged a closer study of the human element. Management inefficiency, as affecting the worker, had been berated. The value of intelligent employment and promotion systems, involving a close study of the aptitudes, ability and ambition of each employee, had been emphasized. All to no avail—until the war came.

Now the demand for skilled employment managers is far greater than the supply. With an apparent labor shortage the wisdom of putting each man in his best place, of giving him the highest type of work he is capable of doing, of encouraging him to improve himself, has been apparent.

Intelligent employment methods must become universal. They are necessary for the development of the highest efficiency of the individual as an individual and as a member of an industrial organization. Moreover, they bring employee and employer into close, sympathetic touch. Each will profit from the experience of the other.

Such contact, too, is a necessary preparation for the inevitable—coöperative management. Any scheme that is not based on confidence and sympathy will fail. If coöperative management is accepted grudgingly, if an artificial structure of labor participation in plant control is nullified by an unjust employment system, there is sure to be strife. The insincerity will prevent effective coöperative work.

And since coöperative management is to be expected as a war product, it behooves industrial leaders to prepare for the day, to put their houses in order. There must be in each plant someone whose duty is to know the worker, whose seat at the council table is that of the employee's advocate.

Such is the way that progressive employers are preparing for the industrial change that will inevitably follow the war.

Shutting Down the Isolated Plant

THERE are two sides to every question, and this applies to the methods of supplying power to manufacturing plants. Most manufacturers who operate their individual power stations do so because they find that power can be produced cheaper than it can be purchased. To be sure, the coal shortage has caused annoyance and in certain cases some losses, but it is not evident that the situation has been such as to warrant eliminating these isolated steam plants as advocated by the following extract from a recent editorial appearing in *The Central Station:*

> Never was the time more ripe for urging the shutting down, if not eliminating entirely, for business as well as for National reasons, the isolated plants which could and should be served by the central station. The stubborn owners and operators of isolated plants, and the word stubborn fits the majority of these cases, have certainly had their full measure of worry and loss during the past two months, due to the coal situation. Yet no amount of accurate operating figures submitted to them, previous to the present conditions, by central-station engineers, could move them to action.

As has been stated many times in *Power*, there are some types of isolated steam plants that should either put in new equipment or purchase power. There are others that should use purchased power part of the time, as for instance, night runs during the months when no heating is required and the load is light, but should use their own power during the yearly day run with a heavy load, and heating during the winter months. Other plants should never purchase power, but should produce their own at all times.

We agree that the isolated-plant owners are "stubborn," when it comes to discarding their power plant and substituting purchased power, but if their plants are run in an economical manner, there should be no cause for surprise as to the admission made in the editorial mentioned that "no amount of accurate operating figures submitted to them, previous to the present conditions, by central-station engineers, could move them to action."

We very much doubt that the same "accurate figures" will move them even now after the period of "worry and loss." Most isolated-plant owners have an ear to the ground when it comes to dependability and economical service, and the plight that many manufacturers have found themselves in during the last two months can hardly be an incentive for them to continue central-station service or to induce isolated-plant owners to abandon an expensive and dependable plant equipment for a service that is not as dependable and does not always serve.

Some of the recent newspaper headlines relating to this matter tell the story, but they can hardly be considered as evidence favorable to the wiping out of the isolated power plant. A Nashville, Tenn., paper has this headline: "ELECTRIC POWER CANNOT BE USED. INDUSTRY IN NASHVILLE WILL ALMOST WHOLLY CEASE TOMORROW." A New Jersey paper came out with the heading: "ALL DEPENDENTS UPON P. S. SERVICE ARE TIED UP. OFFICIALS OF THE PUBLIC SERVICE ELECTRIC COMPANY TODAY ESTIMATE THAT 2500 PLACES OF BUSINESS ARE SHUT DOWN IN HUDSON COUNTY." Another heading reads, "POWER OFF SEVERAL DAYS," and still another: "POWER OFF ALL THIS WEEK. INDUSTRIES PRACTICALLY AT A STANDSTILL. 15,000 IDLE HERE." These are only a few of the many that could be cited.

Many manufacturing plants are engaged in making war materials, and the sudden expansion of power requirements has forced them to purchase power to meet the additional demands upon their steam plants. Although big and little factories engaged in war materials have been hit by the failure of the central station to provide power, it is significant to note, according to newspaper articles, that "the —— factory operated in part, however, because it has a plant of its own. The plants of the —— Co., the —— Co. and the —— Co. are operating today because these concerns can generate their own electricity. Practically everything else in the city is at a standstill."

Central-station representatives are undoubtedly using the past and present fuel difficulties as a lever to pry isolated plants into taking their current. In fact one such gentleman stated in this office that this was the time to cover the isolated-plant field in a central-station canvass. Some will fall for it, but with the most of them no amount of "accurate operating figures" submitted to them by central-station engineers will "move them to action" that is against their own interest.

Government Coal-Price Regulation

THE regulation of coal prices by the Fuel Administration is the first attempt ever made, at least on a large scale, by the United States Government to fix and establish prices for any of the great industries. It is very important to both the public and the coal industry that the prices so fixed should be based on accurate information as to the conditions prevailing in different fields, and that, when once this information has been received, the right principles should be employed in making use of this information.

The Fuel Administration believes that it has devised a speedy and accurate method for using the cost information which it has in hand, and that it has worked out the fundamental principles which should guide it in considering applications for modifications of coal prices. It is the purpose of the Administration to announce decisions on all applications for the price revisions now before it, prior to April 1, 1918, and, prior to that time, to make such changes in the classification as seem to be necessary, in order to relieve uncertainty on this score as far as possible before the beginning of the new coal year.

By this statement, the Fuel Administration does not wish to be understood as stating that the examination of the prices now being made will complete its price work. On the contrary, it will continue to collect and study facts relating to the cost of production of coal and the prices at which it is sold. It will make such further readjustments from time to time as are necessary to keep the price on a scale fair to the public, fair to the coal industry and sufficiently high to encourage production. It hopes, also, to take measures in the very near future to encourage and insist upon the use of less wasteful methods of mining, the sale of clean coal and the more definite recognition of the different qualities of coal in the Government prices.

Rate Fixing

THE Supreme Court has decreed that a public-utilities corporation is entitled to a profit on a "fair value" of its property. Several public-service commissions consider a fair value the cost of reproduction at present prices, less depreciation.

Public-utilities corporations are actually going before public-utilities commissions and pleading for raises in rates which will enable them to pay a profit on values of their property based upon the inflated war prices of last year.

And they do this in all apparent seriousness and with the evident expectation of getting away with it. Allowable profit should be based upon the cost of the service rendered and not upon an indeterminable value of the plant required to produce it.

Frank Baackes, vice president of the American Steel and Wire Company, in criticizing the Fuel Administration, says: "You cannot expect a tailor to operate a blacksmith shop successfully, nor can we expect too much of an administrator who was nothing more than a professor of economics."

Probably a representative of the coal producers could have induced his associates to produce more and cleaner coal at a less price; and could have made a crippled railway system distribute it to better advantage. Eh?

The Toronto *Call* announces that Patrick K. Gallagher, of Nelson, B. C., has developed an internal-combustion engine in which oxygen will take the place of gas or oil. It won't do, Patrick. Oxygen is working now in every kind of combustion engine, internal and otherwise, even in the mysterious motor processes of the animal organism; but it needs fuel or food to work with. If you want to make a real fuss with your idea, keep people guessing about it, like Garabed.

The essentials—Students of Divinity and Dentistry are exempt from the draft; students of engineering are not.

Correspondence

Grate Area and the Underfeed Stoker

With hand-fired grates or overfeed stokers operating on natural or induced draft, the question of grate area is an important one. With natural draft the furnace suction that can be obtained is limited by the height of the stack it is feasible to build. In the case of induced draft, infiltration losses through the boiler setting and grates, which become prohibitive at high negative pressures, limit the possible furnace suction. The amount of coal that can be burned per square foot of grate is limited by the available furnace suction, and consequently, if it is desired to double the capacity of a boiler, it is necessary to double the amount of grate surface.

In the case of the underfeed stoker, grate area is not of so much importance. The capacity that can be obtained from the stoker is dependent only to a small degree upon the grate area. The amount of coal that can be fed by the stoker is limited only by the mechanical strength of the stoker parts. To burn this coal, it is only necessary to provide a sufficient blast pressure under the grates, sufficient openings through the grates and means for keeping the fuel bed broken so that the air may find a passage up through it. The draft suction in the furnace of an underfeed stoker should be kept as nearly equal to the atmosphere as possible at all ratings to prevent infiltration and also to stop gases escaping from the furnace into the boiler room. The resistance of the fuel bed is taken care of by the forced-draft pressure under the grates. To a certain extent, the resistance of the fuel bed is inversely proportional to the percentage of volatile in the fuel. The higher the volatile the less draft pressure under the grates necessary for burning a given amount of fuel. Infiltration losses actually decrease at high ratings. The reason for this is that the limit to capacity with an underfeed stoker is usually set by the ability of the chimney or induced-draft fans to get the gases away from the furnace without permitting a pressure in the furnace. The capacity limit is usually not due to inability to burn sufficient coal.

With the underfeed stoker combustion efficiency does not depend to any great extent on the grate surface, but is dependent more upon distillation or retort volume and total volume of coal in the furnace. To show this the underfeed stoker may be compared to a continuous gas producer. It is well known that the highest efficiency of combustion would be obtained from a gas producer with a fire bed several feet thick. The underfeed stoker and the gas producer are similar in the following functions: (a) Distillation of gas by approach to hot zone; (b) mixture of gas and air in the fire, using the tortuous passage between lumps as a means of thoroughly mixing volatile matter and air; (c) heating of the mixture to a high temperature as it passes through the topmost layer of the fire.

The great difference between the underfeed stoker and the producer is that the producer is not intended to complete combustion but only to produce a combustible gas, whereas the stoker must not only produce the gas but burn it and the resulting coke. The temperature of the fire of the underfeed stoker is much higher than the producer, and this sets a limitation to pursuing the analogy too far. The high temperature with the underfeed stoker causes the formation of masses of clinker, and if a great depth of fuel bed were used with the stoker, it would be impossible to keep it broken up and free from clinker by any practical method of stoking or mechanical poking. Within the limits of the clinker problem, that stoker having the greatest distilling volume will have the highest combustion efficiency. The higher the percentage of volatile in the coal, the greater the necessity for large retort volumes in order to get high capacity and efficiency.

The difficult feature of coal combustion is not the burning of fixed carbon, but of volatile matter. The burning of volatile matter is a function of the relative thoroughness of mixing air and gas and of temperature. The temperature must be kept above the ignition point or the flames will be extinguished. The thoroughness of mixing introduces the element of time. If mixing is done in the fuel bed, the thoroughness will depend upon the length of the mixing passages; that is, the depth of the bed. If mixing were perfect in the fire bed, which might occur with a deep producer fire, there would be little or no flame, and surface combustion would practically result with a bed of hot coke as refractory material. If the depth of bed is insufficient for perfect mixing, flame occurs and furnace volume is then required to provide the length of path to complete the mixing. For the highest efficiency, combustion must be completed and flames disappear before contact with any heat-absorbing surface, otherwise extinction of the partly burned material occurs, usually with soot deposit, and part of the gases must escape unburned, unless secondary combustion can be established, as for instance, at the top of the first boiler pass.

In general the problem of combustion is that of carburetion, and the stoker might well be compared to a carburetor. The dictionary defines a carburetor as an "apparatus used to charge air or gas with volatilized hydrocarbons." The verb to carburize means "to combine or impregnate with carbon." A stoker fire, or the fire in any furnace, is a device for carburetting the air passing through the fuel bed. The hydrocarbons and carbon are volatilized by the heat, and then they impregnate the air so that it becomes a combustible gas. Combustion efficiency depends on the accuracy of the mixture. The capacity varies with the volume of air passed through the fuel bed and impregnated. Grate area is of some importance, but depth of fuel bed is the essential feature, for depth is what promotes better mixture of gas and air. Any carburetor device is efficient as it secures mixture in right proportions. Thus the tortuous passages through a deep fuel bed of small area are more effective than the relatively direct passages through a thin fuel bed of large area.

As an index of the value of an underfeed stoker, the relation between distillation or retort volume and total volume of coal is most important. By distillation or retort volume is meant the volume of coal in the retorts below the tips of the tuyeres or grates, including the throat under the front wall in front of the feeding plunger. By total volume of coal is meant the retort volume plus a one-foot thickness of fuel over the entire surface of the stoker. This one foot will allow for the usual thickness of 18 to 24 in. in the thickest part of the fire down to 6 or 8 in. on the overfeed section and the dump grates. This same comparison might be made by obtaining the ratio between retort volume and grate surface. Distillation and mixing of the volatile matter occurs clear to the surface of the fire so that the relation between total volume of coal and the square feet of grate is also important. Combustion of fixed carbon of course predominates near the surface of the fire, while in the retorts proper distillation and mixing is the sole function.

The most important function of the underfeed stoker consists in the burning of volatile matter. For this reason the best comparison of an underfeed stoker consists in getting either the ratio between retort volume and total volume or between retort volume and grate surface. The usual practice in figuring square feet of grate surface is to use the projected area of the stoker including dump. Combustion actually takes place with the underfeed stoker from the front wall clear back to the bridge-wall. The path of least resistance for the air through the fuel bed is generally toward the bridge-wall. Consequently, even if there is no definite air supply at the rear end of the stoker, there is still ample air coming through from the fuel bed above to maintain active combustion. For this reason it is perfectly legitimate to include dump-grate area when figuring the grate surface of an underfeed stoker. **F. H. Daniels,**

Worcester, Mass. Sanford Riley Stoker Co.

Turbine Accidents

The list of turbine accidents by C. H. Camp, in the Nov. 20 issue of *Power*, covering a period of seven years, justifies the present writer's claims for overspeed tests notwithstanding the small number of accidents due purely to explosions of the turbines. When one considers that in a period covering seven years the casualty companies, as the author states, can record only 19 accidents due to explosions, it is apparent that "turbines which have exploded due to overspeed or overpressure in the low-pressure stages have been very few."

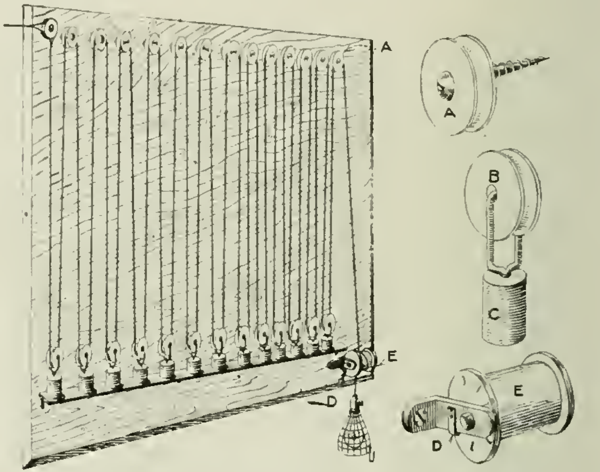
In most cases the explosions or accidents were due not to inherent faultiness of the turbines themselves, but to causes separate from the turbines and mostly due to carelessness on the part of the operators or to improper electrical protection. It is not proposed nor intended to be understood that a 100 per cent. overspeed test on the turbine will make it safe against explosions. It will not be required if the trips and governors work properly; but if the governors should refuse to act, the additional factor of safety of a machine tested to a 100 per cent. overspeed would give the attendant, or watch engineer, an opportunity to trip the throttle by hand before the turbine rotor reached the breaking point.

From careful examination of the list of accidents submitted I am of the opinion that most of them were due to faulty and careless operation or attendance, as in well-conducted plants the engineer in charge makes it his business to ascertain that the governor does not stick and that the relief valve will relieve the pressure if need be. Relief valves, however, should always be fitted with safety measures, such as auxiliary tripping devices actuated by the governor of the turbines.

New York City. **W. F. Schaphorst.**

Adjustable Extension Lamp

Anyone who has worked in a shop, power plant or any place where a portable electric lamp is used, will quickly become impressed with the annoyance that the loose extension cord causes when thrown promiscuously about the floor. An efficient method of avoiding much of this annoyance is shown in the accompanying illustration. The extension cord passes alternately over a series of fixed and movable pulleys as shown. The fixed pulleys *A* are ordinary porcelain insulators mounted on round-head screws, at the upper end of a panel which should be made of slate or asbestos board. The panel can be attached to the wall in any convenient place. Small cast-lead weights *C* are attached to the movable pulleys *B* to keep the cord taut. The movable pulleys are also made of porcelain insulators, and the connection between the pulley and weight is made from a piece of wire bent to the proper shape.



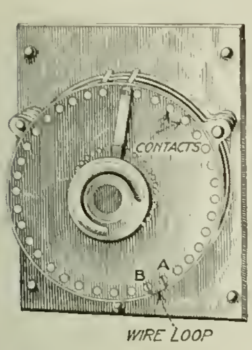
PARTS AND ASSEMBLY OF ADJUSTABLE EXTENSION LAMP

The lamp cord makes one and a half turns around roller *E* at the bottom of the board and passes out to the lamp. A small spring catch *D* allows the cord to be easily pulled out to the desired length, but prevents it from slipping back. It is obvious that upon pulling out the extension cord the movable pulleys will be lifted, shortening the distance between them and the fixed pulleys. By releasing the catch *D* the cord is allowed to return slowly to its normal position, as shown in the diagram. **M. P. Bertrande.**

Ozone Park, N. Y.

Repairing an Open-Circuit in a Field Rheostat

Repairing open-circuits in field rheostats having the resistance encased in porcelain or other insulating compounds can be accomplished as follows: Assuming that the open-circuit has been located between contacts *A* and *B* in the figure. A radial slot is cut with a hacksaw in the center of each of the two contacts between which the open-circuit is located. Cut these slots about $\frac{1}{16}$ in. deep. Then make a loop of No. 20 B. & S. gage copper wire, as in the figure, and drive it down in the slots. The edges of the slots are slightly upset by a small cape chisel to hold the wire firmly in place, and then soldered to the contacts. All excess of solder is removed so as not to interfere with the contact-arm travel.



FIELD RHEOSTAT

Brooklyn, N. Y. SAMUEL SPAGNOLA.

Starting Diesel Engines Under Difficulties

As all Diesel-engine operators know, it is difficult to start these engines when they are cold—that is, below a temperature of 40 deg.—and especially so when they have been exposed to freezing weather for a day or two. The builders usually recommend that they be installed where they can be kept from getting so cold. About the first of November, 1917, I took charge of a plant having two Diesels, in which the engines are under the shelter of a corrugated-iron structure that has been through the vicissitudes of fire and reconstruction and is more of a refrigerating room in winter than anything else.

In addition to the foregoing, the starting-air tanks are a long distance from the engines, and there are ten elbows and bends in the starting-air line. This line is also too small for efficient starting, being of 1-in. double-extra-heavy pipe. The engine is belted to a lineshaft carrying several pulleys and belts, driving the air compressor and circulating pumps and two generators, as well as several other belts that usually are running on loose pulleys, but altogether producing a considerable friction load. And then the engines are old and badly worn in the cylinders so that compression is poor. In fact they were in such shape that the employees of this plant who had been handling them had not been able to start them since last June.

After overhauling and repairing these units as best I could, so that we could get some service out of them before the final shutdown for rebuilding, I started up one without much trouble and continued to do so every day for a week; then the temperature dropped to 19 or 20 deg. above zero and stayed there for several days. On Monday morning I attempted to start up and before quitting had lost all the air that we had stored without getting the engines running. It was then necessary to connect up the steam engine of an ammonia compressor that was belted to the lineshaft and take the belt off the Diesel's pulley so as to drive the air compressor, and pump up the starting tanks again before we got started.

When it was convenient to shut down for a day or two, I cut into the steam line running through the building and connected it into the circulating-water system as near to the cylinder jackets as possible. Now, when it is too cold to start easily, I turn live steam through the water jackets and in ten to fifteen minutes the cylinders are warm enough to start on the first attempt.

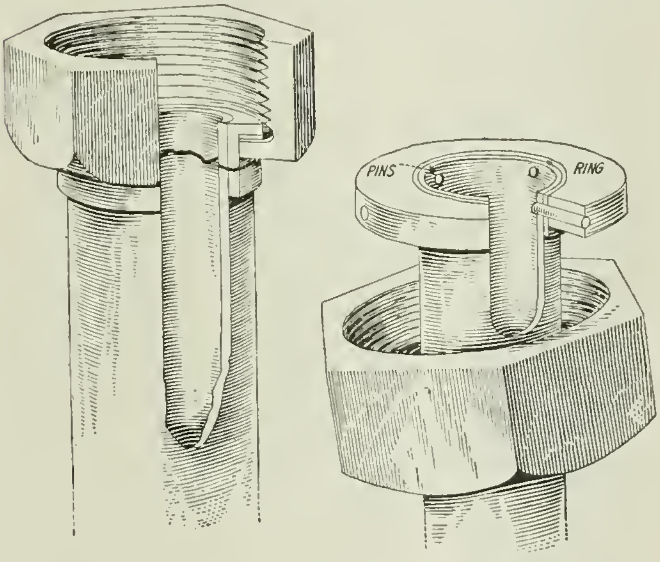
Of course not all Diesel plants are so arranged that they can have steam, and many are so housed that they do not need any external means of warming up, but doubtless there are a good many who might be able to use this method and so get around a serious difficulty.

Austin, Texas. F. C. WILLIAMS.

Repair to Copper Circulating Pipe

The copper pipe connecting the jacket of an oil engine with the radiator broke near a union, as shown by the irregular line in the illustration. It was repaired by the engineer in a short time as follows:

The coupling was separated and a ring was shrunk on the end of the broken pipe and pinned, after which the pipe end was peened, smoothed off and the union put together as before. The pipe when joined was about an inch shorter than originally, but fortunately the radiator could be moved that amount without difficulty. This job seems all the more creditable when it is considered that only a few hand tools were available.



BROKEN UNION REPAIRED

West New York, N. J. LUDWIG V. LAUTHER.

Distinguishing Iron from Steel Pipe

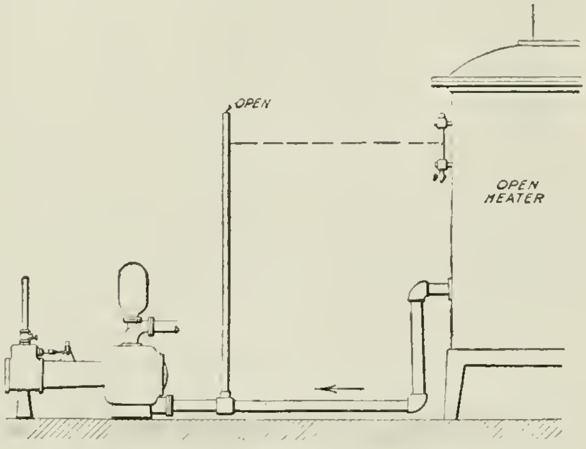
I have noticed several articles in *Power* relating to methods of distinguishing iron pipe from steel, and I herewith present my method, which is very simple.

Aqua fortis (weak nitric acid) applied to the surface of steel produces a black spot; on iron the metal remains clean. By this method the slightest vein of iron or steel can be readily detected. J. W. STANLEY.

Braemar, Tenn.

Vapor Relief on Pump Suction

A feed pump which got water from an open heater situated about four feet above the pump gave trouble by pounding—not only at the pump, but in the discharge line. Various remedies were tried with no success until an air pipe was connected to the suction line with the open end extending above the water level of the heater, as shown in the illustration, after which the trouble ended. **N. C. Gleason.**



OPEN END PIPE CONNECTED TO PUMP SUCTION

Northport, Wash.

Piston Packing Burns Out—No More

My S.O.S. regarding piston packing burning out in the issue of Jan. 22, page 129, brought several fine answers by mail from widely separated places—Staunton, Ill.; Denver, Colo.; Port Huron, Mich.; Trenton, N. J.; and Milford, Mass. I have, of course, replied to these letters, thanking the writers for their interest. Is there any other group of mechanics except engineers who would use their time, stationery and stamps simply to help out a brother engineer who is a perfect stranger to them? One thing that is noticeable about engineers is their unselfish willingness to help others.

Some of the suggestions given me are peculiar, and probably I never would have thought of them. Following, in part, the advice given by two of my correspondents, one suggesting metallic packing and another a certain brand of steam packing, I compromised and used both. Instead of a concave ring in the back of the packing box, I now use a flat one and have made the end of the follower, or gland, flat and use alternate rings of a good high-pressure asbestos rubber packing and rings of plastic metallic packing. Some, no doubt, will raise their hands in horror at such an idea, but the proof of the thing is in the satisfactory results gained.

Another peculiar thing I noticed in the replies received is that the electric men are so certain the fault can be traced to defects in the electric end of the work, while the steam men are just as certain that the trouble is in the steam machinery. However, the steam men were right in this case, so far as I can see in the short time since I made the change. I have tried it severely by drawing the packing tight and also by leaving it loose, but it does not get hot. **James E. Noble.**

Portsmouth, Ont., Canada.

Starting Synchronous Motors

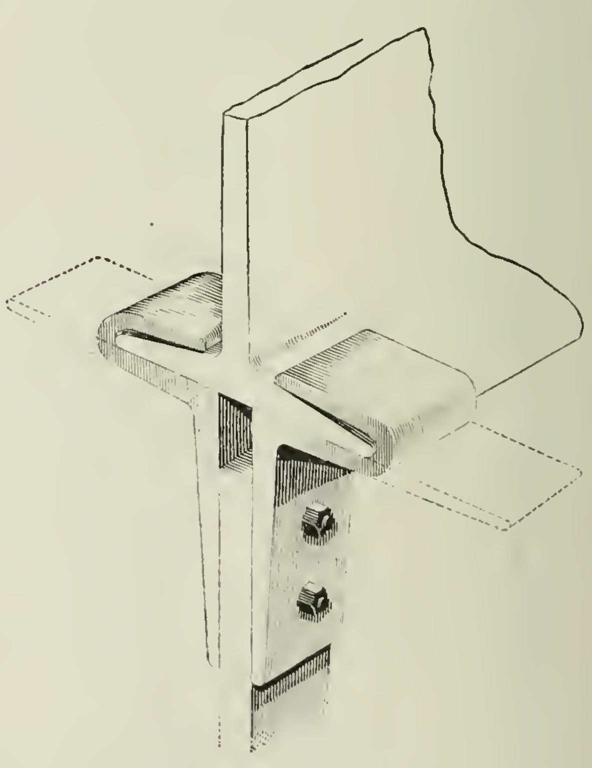
In starting up the synchronous motor in our plant, there is usually one man at the switchboard and another, generally the fireman, at the compensator for starting the motor. At starting, the man at the switchboard closes the oil switch and the attendant at the starting compensator throws the lever to the starting position. When the motor comes up to speed, the man at the switchboard closes the field switch and the attendant at the compensator throws the lever to the running position.

There are times when it is not convenient for the fireman to leave the boiler room in order to help out. It is a case of either waiting or getting someone else. This, again, is often out of the question. To start the motor without an assistant, I first tie the lever on the starting compensator to the starting position, then I go to the switchboard and close the oil switch; when the motor gets up to speed, the field switch is closed; after this I go to the compensator, release the starting lever and throw it to the running position; then I return to the switchboard and make the necessary adjustments. In this way I am able to satisfactorily put the motor into service without the help of an assistant.

Middletown, N. Y. **Thomas M. Gray.**

Hanger-Clamp for I-Beam

The best and strongest kind of an I-beam hanger clamp I know of, can be made from two pieces of 3-in. angle iron sawed off about two inches wide, heated and one end or flange bent back and the other drilled for the strap, as shown. The thickness of the angle is where it is most needed. **W. H. H. Plowman.**



HANGER-CLAMP MADE OF ANGLE IRON

Philadelphia, Penn.

Inquiries of General Interest

Flow of Steam Through 6-In. Pipe—What weight of steam at 150 lb. gage would be delivered per hour by a 6-in. steam pipe 100 ft. long? B. C. W.

The rate of flow would depend on the drop of pressure; that is, the number of pounds per square inch the steam pressure would be reduced in traversing the full length of the pipe. A simple form of diagram for computing the flow of steam in pipes, based on the Babcock formula, with examples, is given on pages 836-7, June 13, 1916, issue of *Power*. For a continuous flow and pressure drop of 5 lb. per sq.in. the discharge would amount to about 9000 lb. of steam per hour.

Diameters of Fire Tubes of Boilers—What is the rule for the diameter of fire tubes of return-tubular and vertical fire-tube boilers? C. H. S.

For natural draft the usual rule is to allow one inch of nominal or outside tube diameter for each 4 ft. of tube length for use with bituminous coal, and for use with anthracite, 1 in. of nominal diameter for each 5 ft. of tube length. For artificial draft the size of tubes may be considerably smaller, according to the force of draft and tendency of the fuel to clog the tubes with soot. For vertical fire-tube boilers, where the course of the heated gases is short and direct, the ratio of tube diameter to length is usually about 1 to 70.

Reason for Lap on Corliss Steam Valves—Why is lap given to the steam valves of single-eccentric Corliss engines? W. R. S.

For obtaining compression of the exhaust the exhaust port must be closed before the piston reaches the end of the stroke. It is not permissible to obtain earlier closing of the exhaust valves by lengthening the exhaust-valve rods, as that would make the valves later in opening and the steam would not be released until after the piston had completed its stroke. Therefore to obtain earlier compression and release, the eccentric is advanced; that is, set ahead of the 90-deg. position. All valve events are thus made earlier, and to delay uncovering of the steam ports by their valves until the beginning of the stroke, it becomes necessary to add lap to the steam valves.

Cushioning of Duplex Pump—How can a duplex pump be given more cushion? H. D. W.

In the ordinary duplex pump, the ports and passages for admission of steam are at the ends of the cylinder, and those for discharge of the exhaust are nearer the middle of the cylinder. The piston in approaching the head covers the exhaust port, while the exhaust edge of the valve is still open and the steam end of the valve covers its port. The volume of steam thus entrapped in the end of the cylinder and steam passage is constant, and there is no convenient means of covering the exhaust port earlier so as to obtain more cushion, excepting to provide a wider piston ring. On pumps of over 10-in. stroke, for regulating the cushion an opening is provided through the partition between the steam and the exhaust passages with a valve inserted for relieving the piston of too much cushion, but cushioning cannot be adjusted to more than the amount obtainable with this valve closed.

Noise in Ends of Cylinder—What causes a noise in a steam-engine cylinder at each reversal of the stroke of the piston? W. E. B.

With a noncondensing Corliss engine, a rattling noise may be due to the exhaust valves being raised from their seats when the steam expands to such a low pressure that the valves are raised from their seats by pressure of the atmosphere. If the noise from this cause continues when the engine is running at regular speed, it can be stopped by throttling or reducing the initial steam pressure, or by joining together the indicator connections of opposite ends of the cylinder with a very small opening. A slapping noise may result from loose-fitting piston rings driven against the sides of the grooves by sudden change in difference of cylinder pressures on opposite sides of the piston, or from frictional resistance to being dragged at each reversal of the stroke. A rattling noise may be due to a broken piston ring or some material out of place, and when it occurs the engine should be stopped as soon as possible and inspected to discover loose or broken parts that might score the cylinder.

Ventilation of Paper-Machine Room—How can a paper-machine room be ventilated to prevent deposit and dripping of condensation from the roof or ceiling? W. H. D.

To retard the condensation it is necessary to keep the roof or ceiling warm. This is best accomplished by sheathing under the roof or ceiling to form a dead-air space and liberally warming the sheathing with steam pipes hung close to its under side and evenly distributed. The space over the machine where vapor rises should be covered with a hood kept clear of vapor by an exhaust fan discharged outside of the room, and for general ventilation of the room to remove moisture, there should be exhaust fans or suction ducts in the side walls, placed at intervals near the roof or ceiling.

Equivalent Evaporation from and at 212 Deg. F.—With an evaporation per pound of coal of 8¼ lb. of feed water at 208 deg. F. into steam at 140 lb. boiler pressure and 96 per cent. dry, what is the equivalent evaporation from and at 212 deg. F.? J. W. N.

Each pound of the feed water contained 208 — 32 = 176 B.t.u. above 32 deg. F. According to Marks and Davis' Steam Tables, a pound of steam at 140 lb. per sq.in. gage, or 155 lb. absolute, contains 332.9 B.t.u. in the water and 861 B.t.u. latent heat; hence with the steam 96 per cent. dry each pound contained 332.9 + (861 × 0.96) = 1159.46 B.t.u. and each pound of the feed water must have received 1159.46 — 176 = 983.46 B.t.u. The evaporation of a pound of feed water from and at 212 deg. F. requires the latent heat of evaporation, or 970.4 B.t.u.; hence the factor of evaporation was 983.46 ÷ 970.4 = 1.0134, and the evaporation was equivalent to 8¼ × 1.0134 = 8.36 lb. of water from and at 212 deg. F. per pound of coal.

Thickness and Weight of Lead Pipe—What is the rule for finding the proper thickness and weight of lead pipe? P. F.

The thickness of lead pipe required to withstand a given pressure may be calculated by the formula,

$$T = \frac{0.433 \times H \times R}{2745}$$

in which

T = Thickness of pipe in fractions of an inch;
H = Head of pressure in feet; (water)
R = Radius of pipe in inches;

from which

$$T = 0.0001578 \times H \times R.$$

For lead a factor of safety of 10 is required, hence for practical application $T = 0.001578 \times H \times R$, or if we take D = the diameter of pipe in inches, instead of the radius, $T = 0.000789 \times H \times D$.

The formula for the weight of lead pipe is:

$$W = 3.86\ (D^2 - d^2)\text{; or } 3.86\ (D + d) \times (D - d)$$

in which

W = Weight of pipe per lineal foot in pounds;
D = External diameter of pipe in inches;
d = Internal diameter of pipe in inches;
3.86 = A constant.

The Coal Problem*

By E. G. BAILEY

THE biggest and most important question before the American people today is the coal problem. Some may disagree and claim that it is transportation. But sift the present situation to the bottom, and you will find that the coal problem, or rather the abnormally high percentage of ash and impurities in the coal, is like sand in the bearings of transportation, of ocean shipping and of practically all industries, causing them to slow down at the most critical time in our history.

Coal is bought solely for the combustible elements it contains. The less ash and impurities in the coal the less number of tons you need. The greater the demand for coal the higher the price and, under present conditions, the poorer its quality. The price has been regulated, but the quality has run riot.

Why have we allowed this to happen just at the time when we need *heat units* in their most concentrated form? Why are the railroads burdened today with hauling millions of tons of utterly worthless dirt? To say that this excess of impurities in the coal coming on the market today is worthless does not describe the situation. The price paid for this dirt is only a small fraction of the damage. The rest of its cost is in the decreased efficiency, the lowered capacity, the increased labor and the excessive repair bills involved in the combustion of this coal—and in the necessity of closing down industries because of the lack of coal which might have been shipped in place of these so-called "worthless," but really exceedingly costly, impurities.

Impurities in Coal

Through the past winter we have heard a great deal of talk about the deterioration in the quality of coal, the increase of ash, slate, sulphur and other impurities. We know this has occurred, but let us see how much it has amounted to, how much it has cost, and we can decide better what efforts should be put forth to remedy this difficulty.

We find from reliable sources that the coal received in many of the largest power plants in the country has increased by 5 per cent. to 10 per cent. in ash and has decreased in heating value by 8 per cent. to 12 per cent. Many good authorities state that the amount of coal consumed in their plants has increased 10 per cent., entirely owing to the inferior quality of coal received today as compared with that received previous to 1916. Figures from a prominent manufacturer who has received coal from the same district during the past seven years and has followed its quality closely by analysis and other means show a decrease of 9 per cent. in B.t.u. during the calendar year 1917 as compared with the average of five years, 1911 to 1915 inclusive.

War conditions should be borne in mind in this connection. We should not assume that the quality of all coal mined has decreased in this same ratio, for the Navy and other Government requirements have increased by several million tons, and they rightfully are getting the better coal. Hence, some of the decrease in the quality of coal going to industrial plants and locomotives has been due to confining their supply to the mines of inferior quality. But evidence is at hand to show that coal coming from the same mines carries a much higher percentage of bone, slate and free impurities than it formerly did, and as a conservative estimate I am confident that the increased coal consumption of this country during the year 1917 due to the inferior quality resulting from neglect of preparation at the mines, tipples and breakers amounted to at least 5 per cent. In other words, of the approximately 600,000,000 tons of coal produced and shipped to market during the last year 30,000,000 tons was worthless dirt, slate and rock.

How much has this increase in impurities in coal cost the United States during the last year? In the first place coal has been worth on an average, counting contracts and all, about $2.50 at the mines. The average freight, including both rail and vessel, paid on all coal produced is probably in the neighborhood of $1.50 per ton. So that the 30,000,000 tons of dirt which has been delivered to the consumer has cost about $120,000,000 during the past year.

But this only takes into consideration the cost of the coal delivered to his plant. He then has the additional cost of firing this inferior coal, repairing furnaces, stokers, locomotives and the cost of handling the ashes. These items would add a few million dollars more, but that is a mere bagatelle compared with the cost due to the shortage of coal, the closing of plants and our heatless holidays. Estimates by various authorities on the cost of the heatless holidays range from one billion dollars on up, and that was probably, for the time being, the best and cheapest way out of the difficulty.

Coal Shortage or Dirt

We have been talking about the coal shortage, while in reality we have been loading our cars and locomotives with slate and impurities instead of coal, and had coal of the former quality been shipped to market, we would have had 30,000,000 tons more real coal than we did get.

The effect of this increase in the percentage of ash has been cumulative. Storage piles have been gradually exhausted, and the supply to consumers has diminished to absolutely nothing in many cases, due to each day's coal consumption requiring 5 per cent. more than it otherwise would, because of the high percentage of ash alone, regardless of weather conditions or increased load. Suppose that all of the slate and impurities corresponding to this 5 per cent. increase had been concentrated into two or three weeks of normal shipments during the middle of the winter and this 30,000,000 tons of pure slate and rock were loaded into 1,000,000 railroad cars without any coal mixed with it. Every American citizen would have been up in arms in a minute, and indignation societies and vigilance committees would have emptied the slate out along the railroad tracks and started the empty cars back to the mines to be loaded with coal instead of impurities. But the final result has been the same.

We should also remember that the inferior quality of coal, in addition to tying up 1,000,000 railroad cars and requiring the use of thousands of locomotives, has also seriously affected the operation of the locomotive itself. The locomotive is a complete power plant, with grate area, size of nozzle, draft, steam consumption, etc., very nicely balanced. If either the quality or character of coal is changed on a locomotive, its efficiency and capacity are affected. Today locomotives are receiving, not only the poorer quality of fuel, but coal of widely varying character due to the allotment of railroad fuel to all mines. This has resulted in greatly reducing the hauling capacity of the locomotives.

In buying coal we have been so accustomed to expect the quality to decrease when the price went up that we considered it inevitable. We thought there was no remedy. The coal operator has not been wholly to blame, because he could not control the preparation of coal at the mines of his competitors. If he was conscientious and prepared his coal, he was the loser and the man who shipped dirty coal to the market obtained his profits.

The cause for this condition is well known to anyone at all familiar with the mining of coal; the reason is that the technically trained men of this country have failed to master a difficult problem they tackled several years ago and would have mastered by this time, had they had the courage of their convictions and the ability to handle human-nature problems as well as engineering.

In mining coal we find the ash occurs in two general forms, intrinsic ash and extraneous or free impurities. The intrinsic ash is locked up in the coal, so to speak, and is inseparable from it. The purest lump of coal contains a percentage of ash that is thoroughly mixed through it, much like the ash in wood. From any one coal seam in a district this intrinsic ash usually runs fairly uniform, although it may vary widely in different coal seams, in different districts, or even in different strata of the same seam.

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*Lecture (somewhat condensed) delivered at the Johns Hopkins University, Baltimore, Md., Feb. 27, 1918, as one of the J. E. Aldred Lectures on Engineering Practice.

The extraneous or free impurities usually consist of slate, shale or sand rock from the roof of the mine, and clay from the floor, and sometimes slate, shale and sulphur balls are sandwiched between the coal strata. The slate and shale strata in the coal seam itself are the most difficult to eliminate because they are more or less broken and intermingled with the coal when it is shot down and require extra labor and special care on the part of the miner to throw back these impurities or load them separately into mine cars for the dump. Small sulphur balls are still harder to detect because they are usually covered with coal. Large ones should be detected by their weight. The amount of free impurities likely to come from the roof varies widely with its character. Some mines have a very firm roof that seldom breaks, while in others it crumbles and falls badly, mixing in with the freshly mined coal much like the strata of slate running through the seam. There is little excuse for loading dirt from the floor of any mine. Sometimes the fireclay bottom is very soft, making it difficult to prevent its being shoveled up with the coal, and again the mining-machine operators may carelessly permit some of the bottom to become mixed with the slack or fine coal.

There is another form of impurity generally known as "bone." This is really a stratum of coal containing an abnormally high percentage of intrinsic ash. The ash in bone coal usually runs about 30 per cent., although it may be much higher or even lower. As there is no distinct division between coal and bone, there is often a difference of opinion as to what should be loaded as marketable coal.

How Coal Is Usually Cleaned

In normal times there is a great deal of real competition between different mine operators, in selling soft coal, at least. In meeting this competition the operator is forced either to sell at a lower price or produce a superior quality of coal. He, therefore, puts forth considerable effort and goes to extra expense to produce as low-ash coal as possible. This preparation of the coal is accomplished by compelling the miner to throw out all free slate, bone and other impurities previously mentioned. Inspectors examine the conditions of the mine—which, by the way, may vary a great deal in different parts of the mine as it develops—and they instruct the miner just what to load out as coal and what to throw back in the gob as refuse or load out separately for the slate dump. Additional cleaning of the coal is done on the railroad cars as each mine car is dumped, and during the last ten years many mines have been equipped with picking tables. In many districts the slack and smaller sizes of coal have the extraneous or free impurities removed by washing. At anthracite mines the slate and bone are picked out of the larger sizes in the breakers and removed from the smaller sizes by washing.

In all cases the preparation and cleaning of coal increases the cost to the operator, both for labor and equipment as well as the actual tonnage of impurities and some accompanying coal that is removed. The customer has been glad to pay more for the cleaner coal because it saved his paying the freight on slate and impurities.

In times of normal condition in the coal trade, which existed between the years of 1903 and 1916, competition carried the preparation of coal so far that a great deal of really marketable coal was thrown aside or left in the roof or floor of the mine, merely because it contained a slightly higher intrinsic ash than the remainder of the seam. Oftentimes this amounted to as much as 10 to 20 per cent. of the total coal in the seam, while its elimination reduced the ash content in the coal as shipped by only 1 or 2 per cent. This is one of the extravagant wastes which has taken place, and which has been so frequently referred to by the Bureau of Mines in support of its estimate that 50 per cent. of our coal resources was wasted beyond recovery in the mining. Another big waste of our coal supply has been due to mutilation of the thinner seams or those having a higher ash content, by first mining the thicker and better seams underneath.

There was an increased demand for coal in 1916. Naturally, prices began to soar, and many consumers foresaw what was coming and were glad to pay any price in order to get coal and fill up their storage space. This condition continued through the winter of 1916-17 until it was of common occurrence to pay as high as $5 and $6 per ton for bituminous coal at the mines. Most of the purchasers were so anxious to get coal that they forgot all about quality and were willing to take anything at any price, in order to keep their plants in operation.

It is only logical, under such conditions, for the mine operator to ease up on the preparation of coal at the mines. He has ample market at a high price for every ton of coal that he can load.

Some may think that the price of coal at the mines as fixed by the Government in August, 1917, being lower than the operators considered justifiable, had something to do with the decrease in quality. It may possibly have affected the preparation of coal in a few instances where the operator was forced to reduce his costs as much as possible, but if the Government price were advanced on the present basis of control to $5 per ton at the mines, it would not reduce the percentage of impurities in the coal one iota.

At the time when we should have given attention to conservation of our natural resources, we were wasting large quantities of really marketable coal. But in a crisis like the present war, when we need large quantities of coal in its purest form with the most concentrated heat units, we find the miners are loading all of the high-ash coal, bone and in many cases, slate, rock and sulphur balls with practically no effort on the part of the operator to stop them. In fact, most of the picking tables and coal washers have been discontinued and the entire product of coal with its impurities goes to market unchecked. In some cases the operator is loading the gob pile, the culm bank, coal from the poorer parts of his mine, or is concentrating his production on the mines of poorest quality, for he knows that under present conditions anything will go, and he is reserving the better quality of coal for future needs when strong competition is resumed.

There has been a time, and there will again come a time, when conservation of our coal supply should be carefully considered in connection with the preparation of coal for a competing market, but now is not the time to conserve our national resources. Today, when every ounce of heat energy, every railroad car and every locomotive should be producing maximum results, one thing above all others should claim the attention of the men of this country, and that is to distribute coal in its purest form to the consumer and obtain maximum efficiency in its combustion. Instead of doing that, we are clogging our railroads and furnaces with the dirtiest and poorest quality of coal ever produced.

What Is the Remedy?

To simply appeal to the coal operators and miners on the grounds of patriotism will not accomplish the results. We must go to the very root of the matter, and during the present crisis eliminate every possible pound of slate and impurity from the coal as it is loaded into the railroad cars at the mines. This will be equivalent to increasing the motive power, the car supply and terminal facilities of our railroads to the extent of 30,000,000 tons carrying capacity per year. It is possible; it can be done; and it *must* be done. The question remains how to do it most quickly and at least expense.

You must bear in mind that increasing the price alone will *not* improve the quality, and without the quality being improved the railroads cannot haul the necessary heat units. There is enough labor available at the mines to clean the coal; our trouble is due to lack of railroad facilities to haul the excessive amount of impurities it contains. It seems so perfectly self-evident that we must put forth every effort to concentrate as many heat units in each ton of coal which our railroads can handle, that in the face of these figures we can go to any end in carrying out the remedy. This question is important enough to do the job right and anything which is worth while *can be done*.

Pay Price in Proportion to Quality

I would recommend that the Government establish coal-sampling stations at certain points where large numbers of railroad cars are unloaded to vessels or power houses. These sampling stations should be equipped with the necessary machinery for handling samples of one thousand pounds or more so that the sample will be thoroughly representative of the individual car from which it is taken. From this sample determine the percentage of total ash as well as the free impurities (slate, rock, etc.) so that a positive check will be obtained on each mine as to the quality of coal being produced, and the effectiveness of its preparation.

By locating these sampling plants at such points as New York, Philadelphia, Baltimore, Hampton Roads, Cincinnati, Lorain, Buffalo and other lake loading ports, adding Chicago, St. Louis, Indianapolis, Birmingham and other cities throughout the United States later on as the work is extended, coal from every mine in the adjacent districts can be consigned or reconsigned by the Fuel Administration to these cities and to these particular piers and power plants so that at least one sample each month will be obtained from every mine shipping coal. Later on as the system is perfected it could be increased to the sampling of one car out of every ten shipped, so that a very fair average of the quality of coal loaded from each mine would be obtained. Even though not enough cars could be sampled to get an average that would be scientifically accurate to a fraction of one per cent., the influence on the operator and miner would be effective.

To give the coal operator a real incentive to clean his coal as he should, the price he receives should be materially affected by the quality of coal produced. It would be advisable to go a step farther and base the distribution of cars to the mines on quality also. The quality as shown by the results of one month should form the basis of price and car distribution for the subsequent month, so that no confusion resulting from back charges and adjustments need interfere with the plan.

The adjustment of price for variations in intrinsic ash should be nominal, say 5 or 10c. per ton, but for extraneous ash it must be severe, such as 25 to 50c. per ton for each 1 per cent. ash.

The base price for standard quality of coal should be established by the Government as at present, with possibly different base prices and different quality standards for the several districts, taking into account the character of coal, height of seam and other mining conditions, but the main thing to strive for is to obtain the highest quality of coal and the most concentrated form of heat units in order to tide us over the coming year, which is going to be much more critical than that just past, unless some radical step is taken to apply a remedy for the basic cause of the present situation.

This work of sampling and accurate quality determination should be supplemented with Government inspection at the mines to prevent the loading of bad crop coal and to keep in first-hand touch with the mining conditions as a supplemental check upon the preparation of coal and to instill a spirit of coöperation.

Real knowledge of the quality of coal being produced will also be of great benefit in classifying coal from various mines into the different pools so the consumer, and particularly the railroads, will receive coal of uniform quality, thereby enabling them to obtain maximum capacity and efficiency from the coal they use.

The Remedy Is Feasible

There may be some people pessimistic enough to say that this scheme cannot be carried out, it would cost too much money or we cannot get the men to do it; but this question is of such basic importance today that some remedy is absolutely necessary. We have our choice of either building thousands of locomotives, a hundred thousand railroad cars and adding to the terminal facilities of our railroads within the next few months to haul this 30,000,000 or more tons of dirt, or asking the railroads to ship only the most concentrated form of heat units in coal of highest quality.

The latter can be done, the remedy is feasible and practical, it can be started immediately and put into effective operation within a few months at a trivial cost as compared with any other remedy available. The Government already has departments familiar with every problem which enters into the carrying out of this scheme. It would require many competent technical men to carry it out, such men as you, who are being turned out of our colleges and universities today, and those who have preceded you during the past few years.

In normal times, when competition was strong, the consumer could get about what he wanted at a very low price, but now in his anxiety to get coal he has catered to the coal man, forgotten quality, paid any price, and has been satisfied to take whatever the coal man gave. Today we hear more talk of quality from the coal operators, who want the quality considered as a basis of price, as a basis of car distribution, as a basis of classifying coal into different pools, than we have heard from the consumer. But the operators seem to think that it is sufficient to classify the coal very roughly, using quality data obtained prior to present conditions. This would help some, but it is not the real remedy that must be put into effect today, for it must be based on the quality of coal *now* being produced.

The engineers of this country, who are responsible for efficiency in the combustion of coal, should also make a very thorough search into the actual conditions which exist in the plants under their care. One of the difficulties is that combustion has been discussed and rehashed so many times and they have been warned about excess air, unburned gas, CO_2 and various other things until it is a good deal like the boy and the wolf. They know so well what ought to be done that they begin to think they are actually doing it. Others know they have done it once and assume that the men in their plant are continuing to do it without constant supervision or checking up, but everyone who is at all familiar with the combustion of coal knows that there is room for decided improvement along this line in a majority of power plants, including many of the larger central stations in operation today.

One of the basic difficulties is, the person responsible for the operation of the plant does not always know exactly what results he is getting. If he is basing the results on coal per kilowatt, coal per unit product, such as steel, paper, cloth, etc., or even pounds of water evaporated per pound of coal, he does not have as close a check upon his efficiency as he should have, because he is likely to blame poor results to the inferior quality and varying character of the coal he has received. To a large extent the coal has been responsible. The decrease in quality has taken his heart out of his work so far as striving for high efficiency is concerned, and I have even heard some prominent engineers make the remark that they did not care a rap about efficiency—what they wanted was coal that would give them capacity. They apparently forgot that when they are getting efficiency they are also getting capacity, for wasted heat units can accomplish nothing. Efficiency and total plant capacity go hand in hand. We must stretch every ton of coal out to last as long as possible.

Let us forget for a minute much of the detailed theory and ideas of combustion and come down to a few basic facts. Coal is fired to the boiler furnaces to produce heat. Whatever the heating value of this coal may be, whether it is 10,000 or 14,000 B.t.u. per pound, that figure represents 100 per cent. of the heat units available for making steam in that boiler. The problem is to transfer as many heat units as possible from the coal to the steam. All of this heat cannot be utilized, but it does all show up some place, and the channels through which this heat passes may be divided into three general classes:

		Best Practice, Per Cent.	Probable Average, Per Cent.
1	Incomplete combustion (loss)	2	7
2	Heating up flue gases and other things beside water in in boiler (loss)	18	28
3	Evaporating water in the boiler (useful)	80	65
	Total heat in coal as fired.	100	100

The entire 100 per cent. of heat, no more and no less, always shows up in these three main items, which may be called a heat balance.

The amount of heat in the third item represents boiler efficiency, and it must be low if the other two items are high and it can be high only by keeping the other items low. These two loss items are such that they get first chance, so to speak, at the heat units in the coal, and high boiler efficiency can be assured only by knowing what are these controllable losses and how to keep them at a minimum.

The first item, incomplete combustion, covers unburned coal and coke carried away in the ashes. This is a loss that can readily be observed by inspection and checked up by sampling the ashes and determining the percentage of combustible. The other loss under this item is unburned gas, principally carbon monoxide (CO), which is due to carrying too thick a fire and operating the furnace like a gas producer. This loss can be obviated by carrying a thinner fire and providing a greater supply of air per pound of combustible. If this is carried to an extreme, too much air passes through the furnace and carries away large quantities of heat at flue-gas temperature, thereby increasing a loss which would come under the second item. It is, therefore, necessary for the fireman to have some guide in maintaining the fuel bed in the proper condition so as to obviate the unburned-gas loss on the one hand and the excess-air loss on the other.

The most usual means of checking up this condition has been flue-gas analysis, and engineers should apply their knowledge of this subject to actual practice today as never before. There are other means that serve as a very valuable guide, such as the relation between the rate at which air is supplied for combustion and the rate at which steam is generated from this combustion. This is based on the fact that air is a fuel just as much as coal, and a certain evaporation should be obtained per pound of air. This is practically independent of the quality or character of fuel.

WATCH THE APPEARANCE OF THE FLAME

Another method, which is within the reach of every fireman and every engineer in the country without buying a cent's worth of equipment, is to watch the appearance of the flame from the furnace. The critical points to watch are the top of the first pass in a cross-baffled water-tube boiler; the point where the gases enter the tubes at the rear of a return-tubular boiler, or the corresponding location in boilers of other types. When there is too little air for complete combustion a flame of burning CO gas is visible at these points. Oftentimes it reaches entirely through the boiler and escapes before combustion is complete. A large loss due to unburned gas may result even though this flame may extend only part way through the tubes of a return-tubular boiler, or only start down through the second pass of a water-tube boiler, for the gases are cooled below their ignition temperature before combustion is complete. On the other hand, if too much air is supplied to the furnace, observations at these points will show no flame at all. The most efficient conditions exist when there is a good mellow flame ending at about these points in the gas passage. This shows that there is air enough for complete combustion, but not much loss due to excess air. The latter loss may be very great when the flame is too short. In many metallurgical furnaces the appearance of the flame is the principal guide in controlling combustion.

At the same time that the engineer and fireman are looking into the gas passages of their boiler, studying the appearance of the flame, many of them will be surprised to find how dirty are the tubes and how many holes there are in the baffles of their water-tube boilers. These conditions are much more prevalent, even in the largest power plants, than is generally supposed or admitted. Both conditions result in a high temperature of gases escaping from the boiler and materially increase the loss in the second item previously mentioned. It pays big to keep boiler tubes clean and maintain baffles in good repair, even when coal is at normal price and there is plenty to be had; but now it is a crime to overlook conditions that can be so easily remedied and produce returns of such magnitude and importance.

KNOWLEDGE AND ETERNAL VIGILANCE

In connection with the operation of power plants there are two old quotations that exactly fit, and I urge everyone to bear them in mind in connection with their own plant. The first one, "Knowledge is power," is certainly applicable. You *must know* what your plant is doing, you must know what is the efficiency of your boilers and furnaces, what and how much your losses are before intelligent steps can be taken to apply remedies. If you simply know that the efficiency is poor, you cannot improve it until you know why it is poor. If there are big losses in the first item of the heat balance mentioned, you should do one thing. If they are in the second item, you should apply some other remedy.

The other quotation, "Eternal vigilance is the price of economy," is equally pertinent. Many people have spent much time and money making an extensive series of tests in their power plants, and by means of such tests obtained very good evaporation and high efficiencies which pleased them greatly. The results were tabulated for blueprints or framed in their office, and many of them are foolish enough to think that their plant is still producing this kind of results. Some of them are, and some of them are getting even better results today than they were during such tests, but this applies only to those who are using eternal vigilance and checking up their efficiencies as well as their losses from day to day and hour to hour. As George Diman says, "A boiler test is a good deal like a horse race—you can get most anything you want out of it, but you keep on burning coal 365 days of the year."

IMPORTANCE OF THE COAL INDUSTRY

The things which have happened during the last year in connection with the coal industry have served to waken the engineers as well as the general public to the importance and magnitude of the coal problem. It not only needs the most careful attention and the most diligent study today, but it needs the continued service of the technically trained men of this country to follow it up in the future, for it always will be a problem of the greatest magnitude in the United States. We have been bountifully supplied with hundreds of thousands of acres of coal of good quality; we have been mining it so cheaply and thinking so little of the future that most people have not realized what tremendous problems were involved and how important they were to the industrial and physical welfare of the country.

One of the most important problems is the relation between the price and value of coal. This has not yet been satisfactorily or equitably determined, for it involves a third factor—conservation of our natural resources which should enter into this relation, and the working out of this phase of the coal problem alone will require a great deal of attention by the best brains of the country.

Another illustration of a single phase of the coal problem which is deserving of further attention is the simple question of storage. This always has been a serious problem, especially for certain coals when stored in certain parts of the country. Following the war it is going to be more so, because people who have been handicapped now are going to store larger quantities of coal as soon as they are able to get coal to store, but what is the use of storing if they are unable to prevent expensive losses due to spontaneous combustion?

I therefore urge you students of the Johns Hopkins University and young men from other schools to give the coal problem in its various phases your most earnest consideration in selecting your life work or at least your first job, because there is no more important problem today, and there is no richer field for the future, than to tackle some phase of this important industry and bring to light and establish as facts many of the traditions that have been drifting along for so many years without knowledge as to their control and application in normal times, or even in emergencies like that of the present day.

The problems that concern us most are those of the immediate future. Are we going to have coal enough to see us through the coming winter? The present indications are that unless some radical steps are taken immediately, the coal shortage will be much worse than it has been. To be satisfied with preferential shipments and permit many of our basic industries to close down is to be a quitter, when by concentrating our efforts on loading clean coal at the mines and improving the efficiency of its combustion in furnaces we can have ample coal for all, thereby helping instead of hindering the Thrift Campaign.

We have heard the argument that we should be patriotic and be content with inferior coal, old culm banks and other refuse fuel the same as we are with wheat substitutes in our bread. But the food and fuel problems are very different. Economy in their use applies equally to both, but the neck of the bottle of the food question is production, while the weakest link of the coal problem is transportation. It is a crime to burden our railroads with hauling dirt when it is within our power to ship clean coal and supply heat units in their most concentrated form.

Boiler Explosion at East Chicago Kills Seven

At 10:15 p.m., on Feb. 18, a most unfortunate boiler explosion occurred at the Inland works of the Republic Iron and Steel Co., East Chicago, Ind. A total of 43 men were victims of the accident. Two were killed instantly, two died in the hospital soon after, and in the course of a few days three more succumbed to their injuries. Of the others ten were wounded seriously. At the time of writing they were still in the hospital but on the road to recovery. The remainder, for the most part, received minor injuries requiring only first-aid dressing. As an explanation of the excessive casualty list, it may be stated that at the time of the accident a number of men were sitting in their favorite gathering place in the vicinity of the boiler, eating lunch. Near-by, others were transferring a truckload of material from the mills. Scalding from hot water issuing from a broken feed line on an adjacent boiler and flying brick from the setting of the ruptured boiler were the sources of injury.

The boiler was of the Cook vertical water-tube type, rated at 250 hp. It had been installed in 1901 as a waste-heat boiler, taking the gases from a furnace serving a 16-in. bar mill. With a similar outfit it occupied a sheet-steel building measuring 65 x 140 ft. About three years ago the two furnaces were removed, but the boilers were retained, equipped with dutch-oven furnaces provided with hand-fired grates and used as auxiliary units to help out with steam on large orders and to furnish a necessary supply on Sundays, holidays and at times when the furnaces and their respective waste-heat boilers were down. In other words, the boilers were subject to intermittent service, being fired up and allowed to cool off frequently in the course of a month.

Including the two auxiliary boilers just mentioned, the plant contained a total of 18 vertical water-tube boilers, 11 rated at 125 hp. and 7 having double this capacity. As previously intimated, 16 are waste-heat boilers, each being located in proximity to its respective furnace. All feed into a common steam line supplying the engines of the mill. The pressure on this line, depending upon the number of furnaces and waste-heat boilers in service, the condition of each and the demand of the engines, varies from 70 to 125 lb., the latter pressure being the maximum allowed for safe operation. A chart from a recording gage on the steam line showed that the pressure had run through this range on Monday, the day of the accident. At the time of the explosion seven boilers were in service and the pressure on the line was 70 lb. The ruptured boiler had been cut out of service Saturday on account of two leaky tubes. These tubes had been replaced on Sunday, and the boiler filled with water. One hour before the explosion the boiler had been fired up cold, and within this period the pressure had built up to 50 lb. Both the engineer in charge and the water tender had looked at the gage just before the explosion, as they were intending to "cut in" the boiler on the line when the pressures equalized.

Without any preliminary indication the boiler exploded, the brick walls of the setting spreading out and the top drum with the tubes rising through the roof and landing about 50 ft. distant on the side opposite from the furnace. The roof was damaged badly and the whole side of the building blown out, the property loss approximating $20,000. The lower drum and the tube sheet remained on the foundation.

The steel stack connecting with the boiler through a cone-shaped breeching, was propelled 75 ft. in the opposite direction. The guy wires apparently turned it top down, and in this position it cut through a box-car half filled with firebrick, coming to rest on an axle of one of the end trucks and remaining in that position as shown in the general view. The boiler steam pipe was ruptured between the valve and the main steam line, and a length was broken out of the latter, so that steam from the other boilers rushed out of the ruptured ends. Within three minutes the pressure was down on the whole plant, but before the other boilers could be emptied completely, hand-operated valves in the line beyond the ruptured points were closed. With the line located about 40 ft. above the floor and the building open, it is felt that steam issuing from the header did not contribute to the suffering of the injured. Those scalded were in line with a stream of hot water forced from an adjacent boiler and this was the cause of at least half the injuries. A 2½-in. feed pipe leading into the bottom drum of this boiler had been ruptured by the explosion.

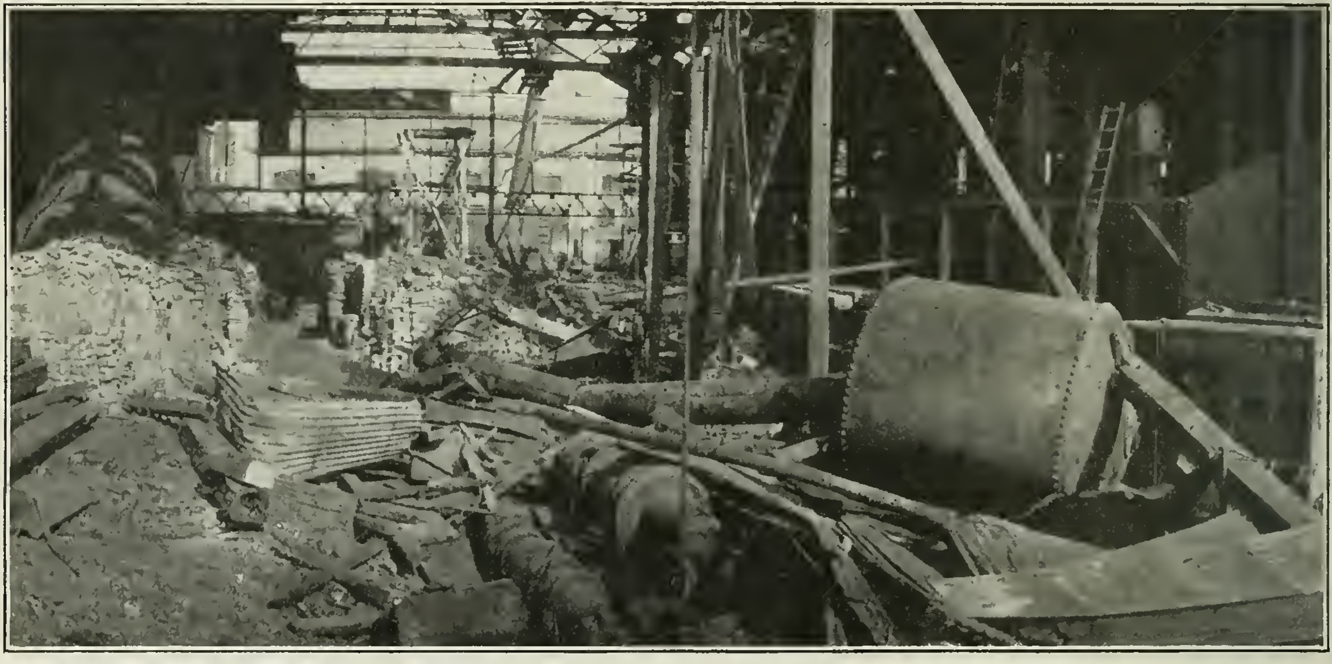

FIG. 1 GENERAL VIEW OF WRECKED BUILDING; STACK STICKING IN BOX-CAR IN BACKGROUND

As the Cook boiler, formerly built by the McNeil Boiler Co., of Akron, Ohio, is no longer made, it may be well to review its construction. The boiler under discussion consisted of an upper steam drum and a lower mud drum connected by a 14-in. central flue and 120 No. 10 gage seamless Shelby tubes 4 in. in diameter and 20 ft. long. The tubes extended through the sheets and were rolled and belled to make tight joints. The drums were 80 in. in diameter, the top drum being 7 ft. deep and the lower drum 44 in. The vertical seam was double-butt-strapped triple-riveted, having a computed efficiency of 85.8 per cent. The metal of the crowned heads was ⅞ in. thick, the shell plates ⅝ in. and the tube sheets ¾ in. At either end the central flue was riveted to a flanged portion of the tube sheet, turning into the drum in each case. In addition eight 1¼-in. round stays tie the flue to the crowned head of the steam drum and six 2½ x ½-in. flat braces secure it to the lower head. The tube sheets were also tied to the heads by evenly spaced 2 x ½-in. double-strap stays, six having been placed in the upper drum and eight in the mud drum.

FIG. 2. LOWER DRUM, SHOWING THE RAISED TUBE SHEET

In this particular boiler water was fed into the steam drum. The circulation was down through the central flue and up through the tubes. The gases from the furnace made one pass along the tubes and around the upper drum into the conical outlet to the stack. The boiler had a full brick setting. It was equipped with two 3½-in. pop safety valves in good working order. Manholes in both drums were provided to afford access for inspection and repairs. From the outside it is difficult to inspect the central flue. A subsequent inspection of this part of a duplicate boiler required the cutting away of 20 tubes.

An inspection of the damaged boiler revealed no defect in the top drum or in the tubes. The stays in this drum were twisted, and one of them had been broken as a result of the explosion. The central flue was intact, but had been buckled slightly near the center, a natural result if the bottom of the flue first struck the ground. In the lower drum the central flanged portion of the tube sheet had been torn off and the sheet pulled up at the center to form a convex surface having about the same radius as the head of the drum. The joint attaching the sheet to the circular wall of the drum held fast. All the stays were broken. In four of the flue braces the crowfeet at the bottom were ruptured. In the other two the break was near the top of the stay, the riveted end remaining intact in each case. With one exception the flat double stays supporting the tube sheet broke at the top.

Nearly all the breaks in these stays gave evidence of some crystallization, but not sufficient to materially lessen the strength. Notwithstanding the long service there was no evidence of corrosion in the boiler. The metal was clean and free of scale. Two years previously, the boiler had been entirely retubed and 20 new tubes had been put in place Christmas week. On Jan. 20 an insurance inspection revealed no defects. Cracks or any visible cause of weakness would probably have been discovered at that time. On account of coal shortage the boiler had not been fired more than ten times since the inspection.

A review of the case would indicate that the initial rupture occurred at the knuckle of the central flange of the lower tube sheet. As will be remembered, this was broken away and could not be found after the explosion. The 21 rivets of $\frac{13}{16}$-in. diameter holding it to the flue were greatly elongated, in some cases the reduction in area being 75 per cent. The conditions under which the boiler operated were favorable to induce failure at this point. As previously stated, the boiler was in irregular service, being fired up and cooled off frequently. Before the explosion it is evident that the boiler must have been forced to raise a pressure of 50 lb. from cold water in one hour. For a boiler of this type three or four hours would have been better. With no baffle to guide the flame, the intense heat from the furnace would strike the tubes on the furnace side and the front of the central flue, leaving the other half of the flue and the rear tubes comparatively cold until proper circulation had been established. This would create expansion on the furnace side of the boiler and tend to tilt it away from the fire. In a boiler of this type after being used for a short time, the tubes will warp to a certain extent and will have little holding power until straightened out. Consequently much of the stress would be thrown on the central flue and with the tilting action previously mentioned the strain on the lower flange would be particularly severe, tending to weaken and crystallize the metal in the flange. It is quite probable that during the hard firing a crack developed at the knuckle of the flange on the furnace side and followed around until the metal weakened enough to let go. This would release the pressure, the water in the

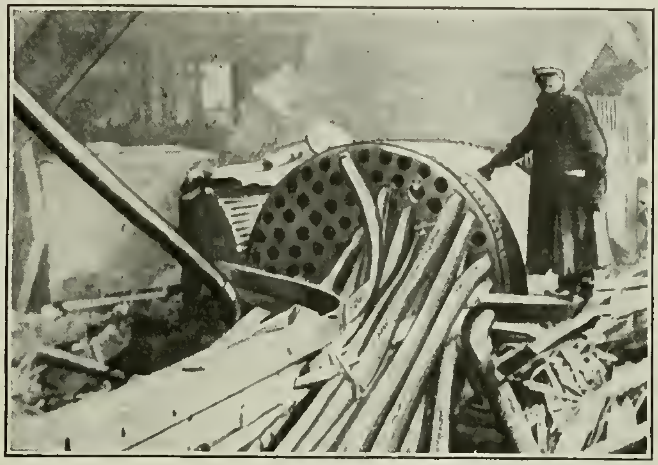

FIG. 3. UPPER DRUM AND TUBES SHORTLY AFTER THE EXPLOSION

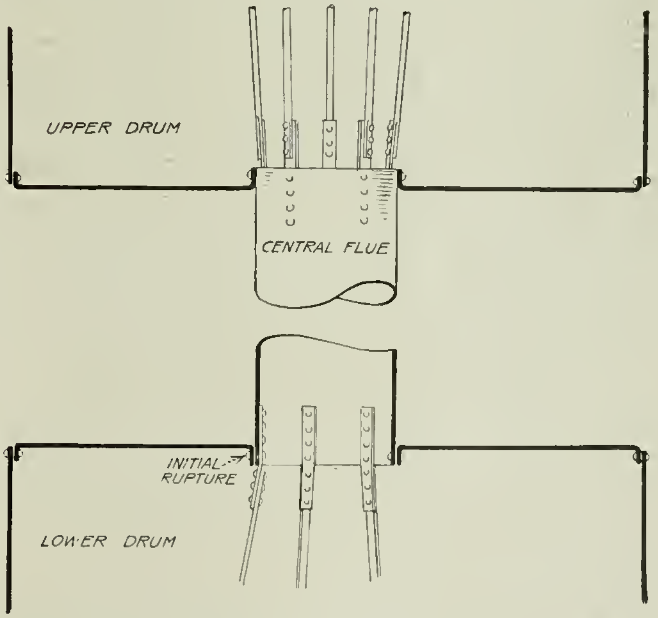

FIG. 4. VERTICAL SECTION THROUGH BOILER, SHOWING FLUE BRACING AND POINT OF INITIAL RUPTURE

boiler would flash into steam and in rushing down the central flue would produce a skyrocket effect that would be irresistible. Coming suddenly, this force snapped all of the lower stays, pulled the tubes out of the sheet and, in doing so, raised the sheet itself as previously described, the upper drum and tubes shooting upward and landing some 50 ft. away.

Other theories have been advanced. For example, the unequal expansion might have snapped the tube-sheet braces on the furnace side and so weakened the holding power that the explosion resulted. The boiler in this case would have been propelled away from the furnace, and this is the direction in which it did go. The evidence, however, favors the theory first advanced, and if this is correct, the central flue was an undesirable element in the boiler design. It appropriated much of the stress created by expansion, acted as a powerful lever on the [illegible]nge and centered the holding power in one element rather than in the 120 tubes of the boilers.

Chicago Section A. S. M. E. Discusses Coal Situation

On Mar. 1 at the La Salle Hotel, the Chicago Section of the American Society of Mechanical Engineers held its second dinner meeting of the season. The topic was "The Coal Situation." Prof. H. H. Stoek, head of the Mining Department, University of Illinois, and chairman of the Conservation Committee of the Fuel Administration for Illinois, and Joseph Harrington, also a member of the committee, were the speakers. Prof. A. N. Talbot, the newly elected president of the American Society of Civil Engineers, was present and in response to an invitation from the chairman made a few remarks upon the present need for coöperation among engineers. The recent decision of the civil engineers to take quartrs in the Engineering Societies' Building, he said, was a step in advance and it was his opinion that it would result in close and united effort of the various engineering bodies.

Joseph Harrington, who was called upon to open the topic of the evening, said that it was not his object to reiterate the familiar phrases in regard to the character and extent of heat losses, assuming that the body of engineers present were familiar with these details. With engineers of experience it is not so much a question of what constitutes efficiency or wherein the losses occur, as it is to apply the knowledge of efficiency measures from both the physical and the human viewpoint. The efficiency of a boiler plant depends on the inherent efficiency of the equipment and the efficiency of the operatives in using this equipment.

Mr. Harrington contended strongly that efficient apparatus must be provided. While intelligent operation serves to overcome to a certain extent the deficiencies of the equipment, it is not adequate to offset old worn-out inefficient apparatus, and it is a matter of mathematics to demonstrate the wisdom of scrapping old equipment and providing modern machinery in its place. As to the efficiency of operation, this depends on the intelligence and interest of the operating force. These, in turn, must be supplemented by adequate instruments and a general record of observations. Granting that all of the foregoing is understood and applicable in such instances where both the will and the money are available, the question still remains, how to apply this knowledge in the universal manner necessary to have any practical effect on the coal consumption of the entire country.

Two general methods appear—the educational, or patriotic, and the autocratic, or compulsory. The former method is that which is now being attempted by the conservation department of the Fuel Administration, and in spite of every effort it is almost impossible to reach all coal consumers. It would mean the education of millions, and the outlook is more or less discouraging to those who see the necessity of conservation for the immediate future. This method, however, is necessary and satisfactory as far as it goes. It is applicable to the larger plants having the more intelligent type of engineer and sufficient capital for proper equipment.

It was Mr. Harrington's belief, however, that the educational method must be supplemented more or less by the autocratic method. Recognizing the painful fact that every coal consumer in the country has not yet reached the point where he is willing to forego some of his own peculiar advantages for the sake of the public, there seems to be a necessity for some Governmental agency endowed with power to step into a man's plant and, after an intelligent examination of the situation, set forth imperatively the needs of such a plant. Care would have to be exercised and it would probably be necessary to have some organization or clearing house composed of a body of fair-minded, intelligent and experienced combustion engineers to which appeal could be taken in case any owner was dissatisfied with the requirements laid down by the inspector. There are so many cases wherein the conditions call loudly for simple remedies that it is more than likely that great good could thus be accomplished. Mr. Harrington closed by stating that he advocated a country-wide application of compulsory measures through state committees and all acting through a central clearing house such as the United States Bureau of Mines or some specially created body. As in the case of the enforcement of smoke ordinances, it is more than probable that compulsion would be required only in the exceptional cases. The mere fact that there was such a body competent to prescribe measures and insist upon enforcement would go a long way in inducing plant owners to spend their money for conservation measures. The only attractive feature of the whole program is that money thus spent reacts immediately to the advantage of the owner.

Coal Output Hampered by War Conditions

Professor Stoek reviewed the coal situation in war times. He showed how coal is related to everything connected with war and how badly it is needed to carry the war to a successful conclusion. The United States uses more coal per capita than any other nation, and as we have more of it, many might wonder why enough could not be obtained to meet all needs. In 1913 the coal production of the world was 1,478,000,000 tons. Of this the United States produced 570 million tons and Great Britain 322. In 1914 the production in Great Britain fell to 262 million tons, to 252 in 1915 and to 256 in 1916. Consequently the coal output in that country suffered as a result of the war. It would be reasonable to expect that there might be a similar falling off in this country.

The speaker briefly reviewed the coal resources of the Allies. All of the Belgian mines and most of the French mines are in the hands of the enemy. Italy needs 1,000,000 tons of American coal per month. Russia is a negligible quantity as far as the coal situation is concerned, and of the neutrals Holland and Switzerland are particularly scarce of coal.

Now that the immediate shortage is over, there is no occasion to feel too optimistic. The conditions producing last season's shortage are still with us, and there is little hope to increase the output. Conditions next winter may be even worse, unless large economies are effected.

In 1916 the output of coal in this country was 600,000,000 tons. To maintain the normal increase of 10 per cent. a year would call for an increased production of 60,000,000 tons. This would mean the opening of fifty new mines of the largest size or greatly increased capacity in existing mines. It would also mean a 10 per cent. increase in the 700,000 men employed last year, or 70,000 new men. With a decreasing labor supply the chance of increasing the output of present mines is small. New mines would require enormous capital investments and with slow deliveries new equipment could hardly be obtained in time to do much good. It would look as though all will have to make the best of it and get results by economizing as much as possible.

Professor Stoek reviewed the causes leading up to the coal shortage. The enormous demand, the high prices in effect last June, the attempted reorganization in Washington on the Peabody plan, the rumor of cheaper coal delaying its purchase and the final fixing of the price by the present Fuel Administration were all mentioned. When the busy transportation season in the fall arrived, there was a great shortage of coal and the unusually cold weather handicapped transportation. In addition there was a shortage of coal cars. To keep pace with the usual 10 per cent. increase in coal requires new cars in the same proportion. The increase in cars last year was only 4 per cent., and although the average time for the return trip of a coal car, 30 days, was reduced, there was not a sufficient number to meet the demand. A number of experiments such as pooling, revolutionized present methods and temporarily resulted in disorganization. In addition far too much waste material was shipped with the coal. The 50,000,000 increase in tonnage was counteracted by three times the quantity of dirt, slate and ash. Lack of coal was not due to export. We sent almost a negligible quantity to France.

The severe fuel restrictions imposed in Europe were reviewed and in conclusion the ways of saving coal proposed by our Fuel Administration, such as lightless nights, curtailing the schedule of electric roads, changing the running time, lessening the temperature in the cars, the skip-stop plan and coöperation of all employees. Many of these regulations were put into effect and resulted in saving. It is hard to make the consumer realize the enormous increase in demand and that his little saving with numerous other comparatively small savings made in reality a large aggregate. Efforts are being made to get in the hands of those using fuel, literature dealing with conservation and care in operation, not only in the power plant and the railway locomotive, but in the home as well.

With the railway facilities taken up, storage will not greatly augment the annual supply, but to relieve the situation it is evident that as much coal as possible should be obtained before the fall rush. Storing can be safely done if care is used to separate the fine from the coarse coal and to keep the pile away from external heat. Fine coal must have very little air or an abundance of air to carry away the heat of oxidation. When heat does show it is necessary to move the pile to cool it. With the difficulty of moving eliminated, high piles are just as safe as low ones, the burning generally starting near the surface and frequently at the top of the pile. Storage of screenings is risky unless under water. When storing in basements, the coal should never be drenched with water.

The discussion turned to storage, the possibility of large savings by the railways, which use one-quarter of the entire coal supply, and in the power-plant supervision over improvements that would effect economy. It is important to get a better grade of firemen and make the pay commensurate with the saving.

In conclusion it was strongly emphasized that as the coal production cannot be greatly increased, all must save—the railways, the industrial plant and heating in all buildings and the home. It is everybody's problem—the man at the mine, transportation and the consumer. All should be impressed with the need of saving and with the fact that if each "does his bit" it will tend to relieve the situation next winter.

Increase in Electric Rates

Public utilities commissions throughout the country are wrestling with the question of increased rates asked for by electric-light companies, which maintain that they are losing money under the present rates. It is not clear, however, as to whether the losses are based upon the falling off of revenue below actual operating expenses or are based upon lesser profits as compared with those before the beginning of the war. These increases in rates are considered by many of the users as being excessive and are being fought.

In the City of Mobile, Ala., the Mobile Electric Co. is desirous of increasing its present rates, which, according to the contract of Dec. 31, 1906, should remain in force perpetually. On Dec. 26, 1917, the city and the electric company entered into another contract for municipal lighting, which contains the provision that the electric company shall furnish customers with current on a meter basis at its regular schedule of rates. The rates under the perpetual contract are as follows: From 0 to 50 kw.-hr. per month inclusive, 10c. per kw.-hr.; from 51 to 150 kw.-hr. inclusive, 9c. per kw.-hr; from 151 to 300 kw.-hr. per month inclusive, 8c.; from 301 to 500 kw.-hr. inclusive, 7c. per kw.-hr.; from 501 to 1000 kw.-hr. inclusive, 6½c.

A discount of 2c. per kw.-hr. to be allowed if bills are paid within ten days after rendered, except that during the ten years of this contract the rate mentioned from 0 to 50 shall be 10c. per kw.-hr. less a discount of 3c. per kw.-hr. if paid within ten days after the rendering of the bill. All over 1000 kw.-hr. special contract. The minimum charge per customer is to be $1.25 per month less 25c. if paid within ten days after the bill has been rendered.

The proposed increased rates, to take effect Mar. 1, 1918, are as follows: First 50 kw.-hr. per month at 10c. per kw.-hr.; next 50 kw.-hr. at 9c.; next 100 kw.-hr. at 8c.; next 300 kw.-hr. at 7c.; next 1500 kw.-hr. at 6c.; excess kw.-hr. per month at 5c. per kw.-hr.

Prompt payment discount 10 per cent.

Minimum bill, $1 net per meter per month.

Legal steps have been taken to prevent the enforcement of the proposed increase in rates.

Another instance is that of the Wilmington & Philadelphia Traction Co., which has asked the public utility commission for permission to raise its rates. At the hearing it was brought out that the big users of electricity are willing to pay the proposed increase, but there are those who are opposed to an increase to the consumer for the lighting of homes.

The increase of rates was protested on the ground that the actual cost of production of current, even under present conditions, does not warrant it; that the actual cost now is at least 50 per cent. below the price that the company is receiving for the current; that the plant and equipment are sufficient to supply local needs, and that the abnormal demand for current is due almost exclusively to contracts with outside parties. Other objections were also brought to the foreground.

The proposed new schedule for electric current rates is as follows:

Lighting Rate: First 75 kw.-hr. used per month, 9½c. per kw.-hr.; next 150 kw.-hr., 8c.; next 175 kw.-hr., 7c.; all over 400 kw.-hr. used per month, 6c.

Minimum monthly service charge, for residence, 50c. per meter; for business, $1 per meter; 5 per cent. discount for cash on bills exceeding the minimum amounts when paid within 10 days from date of bill.

Retail Power: First 100 kw.-hr. used per month, 8½c. per kw.-hr.; next 100 kw.hr., 8c.; next 100 kw.-hr., 7c.; next 300 kw.-hr., 6c.; next 400 kw.-hr., 5c.; next 3000 kw.-hr., 4c.; next 26,000 kw.-hr., 3c.; all over 30,000 kw.-hr. used per month, 2½c. per kw.-hr.

Minimum monthly service charge, $1 per hp. for the first 10 hp., 75c. per hp. for the next 10 hp., 50c. per hp. for all over 20 hp.

No minimum less than $3 for direct-current or single-phase alternating; nor $5 for three-phase alternating; 5 per cent. discount for cash on bills exceeding the minimum amounts when paid within 10 days from date of bill.

High-Voltage Wholesale Power: First 50,000 kw.-hr. used per month, $0.02 per kw.-hr.; next 50,000, $0.019 per kw.-hr.; next 50,000 kw.-hr., $0.018 per kw.-hr.; all over 150,000 kw.-hr. used per month, $0.017 per kw.-hr.

In addition to the charges as per foregoing schedule add 25-100 of one mill for each 10c. of increase of cost of coal delivered at power plant in excess of $3.05 per long ton. Guarantee 50,000 kw.-hr. per month. Prices are net. Current metered at primary voltage.

That the central stations have been hard hit by the coal shortage this winter is well known. Some of the heating companies have been hit by the ruling of the public service commissions. For instance, the Kansas City Light and Power Co. has had its rates reduced from those which existed last August. The company claims that it lost $57,000 during the last three months of 1917 under the August rates and estimates that its loss under the new rate just fixed by the commission would have been at least $75,000.

The new rate is as follows: First 20,000 lb. of condensation, 85c. per 1000 lb.; next 180,000 lb., 70c.; next 500,000 lb., 60c.; all over 700,000 lb., 50c.; minimum on buildings, $5 a month from Oct. 1 to June 1; minimum for water heating and other purposes, $5 per month for 12 months.

Although it is said that the company is considering dismantling its $1,500,000 heating plant and quitting the heating business, it is doubtful that such a step will be carried out.

With the increase in rates sought by the central stations and the curtailment of power from time to time, the position of the isolated plants has been strengthened in that they have in most instances been able to operate, while neighboring plants depending upon central station service have suffered from more or less interrupted service.

Abandoning Isolated Plants in Favor of Central-Station Power

A public hearing was held on the afternoon of Mar. 4, before the Public Service Commission of New York, to obtain information as to whether coal could not be saved by the closing up of many small private plants and the substitution of electrical power generated in large central stations. Representatives of the United States Fuel Administration attended the hearing, as the question is one in which Dr. Garfield is vitally interested.

J. W. Lieb, vice-president and general manager of the New York Edison Co., repeated the statement he had made at an earlier hearing, that the shutting down of some 650 small steam-power plants in Manhattan and the Bronx and the taking over of their power business by the large central station would result in a saving of 500,000 tons of coal a year, as a conservative estimate. He based these figures on the savings obtained in the cases of sixty isolated plants that had been closed up in 1917 and that were now purchasing current from the New York Edison Co.

Mr. Lieb cited several instances, covering office and loft buildings, apartment houses and the like, in which the change from private-plant to central-station service had produced savings in coal consumption ranging from 19.8 per cent. to 60 per cent. When asked to name one or more of these instances specifically, however, Mr. Lieb emphatically refused, on the ground that the data in each case were private matters between the company and its patron, and that the figures could not with propriety be made public.

Inasmuch as the whole purpose—in fact, the sole purpose—of the investigation is to determine whether coal will actually be conserved by the substitution of central-station service for isolated-plant operation, it was a decided disappointment to find Mr. Lieb unwilling to divulge the name of a single one of the plants in which such marvelous savings had been effected. This secretive and sacrosanct attitude of the central-station representative was in marked contrast to the readiness with which the isolated-plant representatives were prepared to show their cost figures and to identify them by naming the plant location in every case.

W. J. Salmon, representing the Apex Leasing Co., stated that his company operated a private plant in which electric current was generated at a cost of 2c. per kw.-hr. The exhaust steam from the engine was used in connection with Turkish baths and heating in the building, and so the engine acted practically as a reducing valve. As a result, their current was obtained at a smaller cost than the Edison Co. would quote.

J. I. Straus testified that at the time R. H. Macy & Co. erected their building the New York Edison Co. was asked to estimate the probable current demand, with the idea of using central-station current. The Edison company's engineers estimated 1,250,000 kw.-hr. per year and quoted a rate of 3c. per kw.-hr. But they refused to accept a contract calling for the payment of $37,500 a year for current used. The reason, so Mr. Straus inferred, was that the estimate was ridiculously low. For, during the first year of operation of the private plant installed by his company, the current consumption was 2,000,000 kw.-hr., and in late years the figure has increased to 4,000,000 kw.-hr.

The testimony offered by Mr. Townsend, of the Hotel Majestic, was illuminating. During a ten-month period just before current was taken from the Edison company, the coal consumption was 5622 tons, costing $21,860. In a similar ten-month period after entering into a contract for central-station current, 5352 tons of coal was used for heating and cooking, at a cost of $26,342, and in addition $14,118 was paid to the Edison company for current. Thus, although there was an apparent decrease of 270 tons in coal consumption, the amount burned at the central station should be taken into account. The total cost was $18,600 greater than before—certainly a very expensive experiment in the use of central-station service.

It is not difficult to see why the owners of small plants are anxious to see this question openly discussed. If it could be proved that the abandonment of small plants in favor of central-station service would save coal, the Fuel Administrator might order the closing of such plants as a fuel-conservation expedient.

In a matter that may involve the sacrifice of costly equipment and the means of livelihood of many employees, there should be no secrecy or evasion. A fair decision as to the correct course to pursue should be based on well-authenticated facts and data, and not on mere estimates based on figures to which access is obtainable by only one party to the controversy, and an interested party at that.

The hearing will be resumed on Monday, Mar. 11.

New England's Shipping Needs

In an international shipping shortage such as the allied countries are now facing, it is difficult to determine what branch of war endeavor should have precedence over others. But with New England mills and factories turning out war supplies for the Allies, valued at billions of dollars, the Massachusetts Fuel Administration feels that it has a right to priority of bottoms at the Southern coal-loading points.

Notwithstanding at the present time 216,200 tons of shipping are engaged in bringing fuel to New England for commercial consumption, there is still a shortage of 115,000 tons of shipping. In other words, says the Boston *News Bureau*, Mr. Storrow has figured that with the threefold increase in industrial activity due to the war, a total of 351,000 tons of shipping must be available for the New England coal-carrying trade or production of essentials must be curtailed.

While the boats turned over to this district the last two days (Feb. 25 and 26) total 21,000 tons, they are still far short of the required amount and are providing only temporary relief to those factories that were verging on shutdown.

Through the western gateways Monday (Feb. 25) a total of 973 cars of both anthracite and bituminous coal were moved into New England. This is the second-best rail movement in a day and approaches the required maximum of rail-coal income of 1000 tons a day. This is for commercial purposes and does not include coal which must be moved by the railroads for their own consumption.

Locally, conditions are greatly improved and dealers' supplies on hand Tuesday morning, Feb. 26, showed an increase of nearly 6000 tons compared with Monday. Officials at the Fuel Administration are sending out warnings that while domestic conditions are more comfortable, all unnecessary use of coal for lighting or heating must still be prevented to keep New England war plants working.

Aviation Section, Signal Corps, Needs Skilled Workers

Ten thousand machinists, mechanics, chauffeurs and other skilled workers are needed at once by the Aviation Section, Signal Corps. The dependence of the air service on the most highly skilled men is being brought out more emphatically with every week of development. Practically 98 men out of every 100 in the service must be skilled in some branch of work.

Men registered in the draft may be inducted into this service by applying to their Local Draft Board. Men not registered may enlist at any Recruiting Office. Further information may be had by applying to the Aid Division, Personal Department, Washington, D. C. In either case they will be sent to San Antonia, Texas, for segregation by trades, followed by a brief course of instruction at the flying fields or at various factories and organized into squadrons mostly for service overseas.

New Publications

STEAM POWER PLANT ENGINEERING—By George F. Gebhardt. Fifth edition, rewritten and reset. Published by John Wiley & Sons, New York. Size, 6 x 9 in.; 1057 pages; 642 illustrations. Price, $4.

Few books are more highly valued among power-plant men than this one, the first edition of which appeared nearly ten years ago. Its wide use is its best commendation, especially when one reflects upon the remarkably rapid development in this field during the last decade. As the author says in the preface to this latest edition: "Revisions in 1909, 1911 and 1913 failed to keep pace with the art, and the task of recording correct practice appeared to be a hopeless one." He puts out the new edition, rewritten in great part, believing that radical changes are not likely to come in the immediate future. He has aimed, therefore, to produce a general work of stability, one which, assumably, he believes will present current practice for some time to come without the frequent editions which events of the past have made necessary. That Mr. Gebhardt is sound in this belief is the opinion of the reviewer. Certainly, no new types of prime movers of such revolutionary character as the steam turbine and "express" stokers and boilers are in sight on the horizon; and as the author has excellently covered these and allied subjects, he likely has put his work in more stable form than it has ever been. A period of refinements in detail and thorough quest of economical performance is now here, and these, as always before, the engineer must get from current journals and add the worth-while data to his loose-leaf notebook which forms a working supplement to a book like the one under review.

The most conspicuous additions to the work are the new chapters on Elementary Thermodynamics, Properties of Steam and the Properties of Dry and Saturated Air. In Chapter XXIV, Supplementary Elementary Thermodynamics of Steam Engine, the author has done a real service to the great number of men who use his book. There is not an integral sign in the chapter, which will gladden the hearts of 98 per cent. of his readers, and that he gets through the Carnot and Rankine cycles without the forbidding "log" will be appreciated by those studious operating men who have mastered by self-study, the use of letters and symbols in formulas, but have balked at logarithms. The table of properties of saturated steam, which are from Marks and Davis, are well arranged, the pressures selected being such that they cover all but the most unusual found in practice.

No less welcome in this book is Chapter XXV, Supplementary on the Properties of Air—Dry, Saturated and Partially Saturated. Gebhardt has needed this chapter on account of the air problems that in ever-growing numbers confront the engineer in these days of widening application of refrigeration and humidifying processes. Goodenough's air tables, the most widely used, are included in this chapter.

Gebhardt has greatly enlarged upon his treatment of fuels and combustion. Suffice it to say that in this latest edition he has presented the most suitable treatment of these subjects, judged by the needs of power-plant men, that the reviewer has ever found, even in books devoted exclusively to fuels and the theory and chemistry of combustion—the theory and chemistry, mind; not those details of technique of combustion as it must be carried on in boiler furnaces. For these he refers the reader to articles in engineering periodicals, and the references are many.

That part of Chapter II devoted to fuel oil would please more if it had, among the many excellent tables it contains, one giving the equivalent heating values of some of the coals and fuel oils widely used along the Atlantic coast. The value of such a table may be questioned, it is true; but it is useful, and its use will grow, particularly in New England, where fuel oil is said to now displace one million tons of coal yearly.

The reviewer regretted to find that in the sectional views of settings of horizontal return-tubular boilers the shells are shown only 28 in. above the grate. Of course, this is satisfactory for anthracite; but the author would have done well to show these shells at least nearly twice as far above the grate. He owes it to the book to help discourage the installation of these low settings. He does give a whole page to drawings of the Chicago No. 8 setting, which has a wing wall and in which the shell is 36 in. above the grate.

The chapter on stokers is almost wholly descriptive, and the power dump plate is not shown, though brief mention is made of it There is little or nothing said about clinker grinders as applied to some underfeed stokers, and the reviewer finds no mention of development in cooling the furnace side walls or of the desirability of doing this to avoid clinker accumulating here and seriously affecting the operation of the stoker. Stoker operation is too vital a part of power-plant practice to receive such scant treatment in a book which deals so well with the operation of other power-plant apparatus. But then, no other book, so far as the reviewer knows, covers this subject even half well; so perhaps Mr. Gebhardt should not be too severely criticized for this omission.

There is something familiar about the chart showing the effect of temperature on strength of materials on page 238, and the reviewer thinks Mr. Gebhardt forgot to credit "Power," Feb. 13, 1917, p. 208, for it. But then, he has referred so often to "Power" that this oversight is not serious. The chart was plotted by the reviewer from data obtained from the "Valve World," and Mr. Gebhardt's chart is a reproduction.

The reviewer is sure that the author's many readers will wish he devoted a paragraph or two to the relative advantages of cast iron and steel for economizers, and sketched tendencies in America and Europe in these materials as used in economizers. It is an important part of power-plant practice now that high pressures are "coming in" and safety and long periods of uninterrupted service from boilers are demanded.

That Maurice Leblanc has but recently brought out his multijector (steam jet) air pump probably accounts for the lack of reference to it in the chapter devoted to air pumps. The "Radojet," a purely American steam-jet air pump of recent development, is described.

On page 531 appears the statement: "No better material than admiralty brass has been found, and it is the standard for modern condenser practice." The reviewer believes that it should be made clear that while this is true for salt water, Muntz metal is now the standard for condenser tubes passing fresh water.

Except for the fore part, the chapter on steam turbines is wholly descriptive, with too much omitted about turbine oiling systems which, by the way, are not as broadly treated of in the chapter on lubrication as one wishes. So far as the reviewer knows, nothing has transpired to impair the hopes engineers have in the Ljungström turbine, yet no mention of it is found in the chapter dealing with turbines.

This fifth edition is indeed a creditable work and the reviewer regrets that space forbids more about it here. Reviewing it is like eating peanuts—one does not want to stop. The subjects embraced are so numerous and well presented that only in rare instances does one care to criticize; but rather, to suggest at these places, realizing the enormity of the fatiguing task of compiling such numerous and varied data. Chapter XVIII, pp. 845-890, on Finance and Economics—Cost of Power, is, in the reviewer's mind the best extant. Mr. Gebhardt is to be congratulated.

Obituary

Adam Cook, the senior member of the firm of Adam Cook's Sons, manufacturers of Albany grease, died on Feb. 19, at his residence, 148 West 78th St., New York City, after an illness extending over a period of seventeen weeks. Adam Cook was born in Albany, N. Y., in 1367, and was a graduate of the Albany Military Academy. At an early age he became a member of the firm of Adam Cook's Sons, which his father founded at Albany, in 1868.

Personal

Harrison Williams has succeeded Samuel Scovil as president of the Cleveland (Ohio) Electric Illuminating Co.

H. P. Curtiss has been appointed representative for the New England States of the Clarage Fan Co., of Kalamazoo, Mich., with office at 120 Milk St., Boston, Mass.

J. S. Green, formerly erecting engineer and master mechanic for the Wickwire Steel Co., of Buffalo, N. Y., has resigned to accept a position as master mechanic for the Edgewater Steel Co., Pittsburgh, Penn.

Engineering Affairs

The New England Water Works Association will hold a meeting on Mar. 13, at the Hotel Brunswick, Copley Square, Boston, Mass.

The American Society of Mechanical Engineers announces the following Section meetings: Baltimore, Md., Mar. 13; Chicago, Mar. 15; Philadelphia, Mar. 26; Bridgeport, Conn., Mar. 27.

The New York Chapter of the American Association of Engineers will hold its next regular meeting on Mar. 13, at the McAlpin Hotel. E. W. McKnight, of the First Canadian Expeditionary Forces, will speak on "War-Time Experiences."

The American Institute of Electrical Engineers announces the following Section meetings: Baltimore, Md., Mar. 18; subject, "Air Brakes;" Chicago, Mar. 25; subject, "Electrochemical Processes," by Charles F. Burges; Portland, Apr. 2.

The Minnesota Electrical Association will hold its annual convention at the Hotel Radisson, Minneapolis, Mar. 11-13. Among the important papers to be presented are "Minnesota Water Powers," by R. J. Thomas, superintendent of the St. Anthony Falls Water Power Co., and "Iron-Wire Transmission," by Prof. W. T. Ryan, of the University of Minnesota.

The American Institute of Electrical Engineers will hold an inter-section meeting in Pittsburgh, Apr. 9 and in New York, Apr. 12. Two papers will be presented: "The Physical Conception of the Operation of the Single-Phase Induction Motor," by B. G. Lamme; and "The Theory of the Phase Converter and the Single-Phase Induction Motor," by R. E. Hellmund.

Miscellaneous News

Boiler Explosion Kills Three in Providence—The explosion of a boiler in the Mount Pleasant Laundry, Providence, R. I., Monday, Mar. 4, is reported to have killed three persons, injured four and completely wrecked the laundry building. A "Power" representative is now after the details of the explosion.

A Heating Boiler Exploded at the Crown garage, Main St., Peoria, Ill., on Feb. 20, wrecking the back wall of the garage, shattering the boiler walls into thousands of pieces and doing damage estimated at nearly $10,000. The boiler has only been installed a year, and the cause of the explosion is unknown.

A Boiler Exploded at the sawmill of James Roberts, seven miles northeast of Clanton, Ala., on Feb. 26, instantly killing three workmen and injuring several others. There were two big boilers standing side by side at the mill, and from some unknown cause one of them exploded with such terrific force that it caused the other boiler also to blow to bits, breaking its iron part.

Business Items

Flynn & Emrich Co., of Baltimore, Md., are manufacturing the Huber hand stoker, which was formerly made by the Huber Grate Bar and Stoking Co., a description of which was published on page 665 of the Nov. 4, 1913, issue of "Power." It will be remembered that the movement of the grate advances the coal to the rear of the furnace, sifts out the ashes, and at the same time breaks up the fire. The movement of the grate is accomplished by levers operated from the front of the boiler.

The Schütte & Koerting Co. will continue business in all its lines and to its full capacity, as always, under a board of directors reconstructed as follows by the Alien Property Custodian of the United States: E. Pusey Passmore, governor of the Federal Reserve Bank, Philadelphia; Ralph J. Baker, assistant general counsel of the Alien Property Custodian; D. W. Hildreth, treasurer of Schütte & Koerting Co.; T. H. Johnston, of Schütte & Koerting Co.; Charles S. Caldwell, president, Corn Exchange National Bank, Philadelphia. The new board has elected the following officers: President, Charles S. Caldwell; treasurer, D. W. Hildreth; secretary, Ralph J. Baker.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Mar. 7, 1918	One Year Ago	Mar. 7, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F o.b. Mines*		Alongside Boston†	
	Mar. 7, 1918	One Year Ago	Mar. 7, 1918	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Mar. 7, 1918	One Year Ago	Mar. 7, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.25—7.50
Buckwheat ..	4.30—5.00	2.75	5.50—5.80	7.00—7.25
Barley	3.25—3.50	1.95	4.00—4.25	4.00—4.25
Rice	3.75—3.95	2.20	4.50—4.80	5.00—5.50
Boiler	3.50—3.75	2.20	....	3.50—4.00

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)........	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Mar. 7 1918	One Year Ago	Mar 7, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Illinois Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Mar. 7, 1918	One Year Ago	Mar. 7, 1918	One Year Ago	Mar. 7, 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.50-2.75
2-in. lump..	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Steam egg ...	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Mine-run ...	2.40-2.55	2.75-3.00	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	2.50-2.75	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Cal., Oakdale—An agreement has been reached between the Sierra & San Francisco Power Co. and the Oakdale and South San Joaquin Irrigation Districts by which the power company will build reservoir on the south fork of the Stanislaus River. This work will be followed by that of doubling the output of the hydro-electric plants. Estimated cost, between $2,000,000 and $3,000,000.

Calif., Redding—City plans to sell $40,000 bonds to build an electric-lighting plant soon. W. D. Tillotson, City Attorney.

Calif., Sacramento—The Pacific Gas and Electric Co. plans to extend its transmission line from here to Guinda, Humsey and Brooks. C. W. McKillip, Mgr.

D. C., Wash.—A. L. Flint, Purchasing Agent, Panama Canal, is in the market for generator sets, copper cable, transformers, etc.

Ga., Sandersville—City plans to rebuild its electric-light and water plants which were recently destroyed by fire. I. N. Lozier, Supt.

Ill., Evanston—The Public Service Co. of Northern Illinois, Chicago, plans to build an extension to its transmission line from Evanston to Highland Park. G. H. Lukes, Gen. Supt.

Ill., Grafton—The Grafton Electric and Power Co., recently incorporated, plans to build an electric-lighting plant here. W. Chapman, Jerseyville, Attorney.

Kan., Dighton—City plans election soon to vote on a bond issue for enlarging its electric-lighting and water-works system. D. E. Bradstreet, Mayor.

Ky., Greenville—The W. G. Duncan Coal Co. is having plans prepared by C. M. Means, Engr., Oliver Bldg., Pittsburgh, Penn., for the erection of a new 1-story, 60 x 80-ft. brick and steel power plant.

Neb., Clarkson—City plans to extend and improve its electric-lighting plant. L. J. Roubineck, Supt.

Neb., Juniata—City voted $7000 bonds at a recent election for the erection of a transmission line from here to Hastings; also the installation of an electric lighting system. Noted Feb. 8.

N. Y., Chenango Forks—The Binghamton Bridge Co., Press Bldg., Binghamton, will not receive bids in April for the erection of a brick and steel power house, steel penstocks, etc. When plans have matured, the work will be done by their own forces. Noted Feb. 26.

N. Y., Clyde—The Clyde Glass Works plans to remodel its plant and completely re-equip same by installing power plant with 500 hp. capacity.

N. Y., Buffalo—(East Buffalo)—The Delaware, Lackawanna and Western R.R. is in the market for power plant equipment. G. J. Ray, Hoboken, Ch. Engr.

Ohio, Salem—The Salem Lighting Co. has been authorized by the War Department to build a power line from here to the Morgan plant at Alliance.

Okla., Ada—The Oklahoma Power and Transmission Co. plans to build a transmission line to supply the surrounding towns with current.

N. H., Claremont—The Claremont Power Co. plans to equip a new substation. J. G. Menut, Mgr.

Penn., Coudersport—The Home Electric Co. plans to issue $22,000 bonds; the proceeds will be used to extend and improve its plant and system. D. B. Belknap, Mgr.

Penn., Indian Creek—The Mountain Water Supply Co. is having plans prepared by King & Wightman, Engrs., 1513 Walnut St., Philadelphia, for a new 30 x 70-ft. power plant to be erected soon.

Penn., Philadelphia—The Coca Butter Manufacturing Co. is having plans prepared by A. F. Sauer & Co., Engr., 908 Chestnut St., for a new 1-story, 30 x 60-ft brick power house to be erected at 2626 Martha St.

Penn., Pittsburgh—The West Penn Power Co. has been authorized by the Public Service Commission, to issue $1,500,000 bonds; the proceeds will be used to extend and improve its plant and system.

S. D., Newark—L. Severson has gained control of the electric-lighting plant here and plans to increase the capacity of the plant by installing new machinery.

Penn., Williamsport—The Lycoming Rubber Co. is having plans prepared by Lockwood Greene & Co., Engrs., 60 Federal St., Boston, for the erection of a 1-story brick and steel power house. H. S. Marlor, Supt. Noted Jan. 29.

S. D., Scotland—City plans an election to vote on the issuance of $35,000 bonds for the erection of an electric-lighting plant.

Wis., Brodhead—The Brodhead Electric Light and Power Co. plans to rebuild and remodel its electric-lighting plant. K. Guelson, Supt.

N. S., Halifax—The Department of Public Works plans to build an electric-lighting plant. L. F. Monashan, Clerk.

POWER

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The Unexpected

Contributed by C. H. WILLEY.

IT IS the unexpected that always happens, and how often we could avoid disaster or humiliation if we kept our eyes open. A young engineer of my acquaintance recently came to see me and pour out his troubles in the hope that I could aid him.

HE WAS in charge of a factory power plant and had gotten along pretty well for several years, keeping things running. He felt quite content with his job and really sort of prided himself that things went so smoothly. And now he had received a bump that startled him, and he professed he was up against it and worried. The factory owners had called him into the office and told him that they wished him to go over the power plant with a fine-tooth comb and submit a report on items that were causing waste of steam or that, in his opinion, were so antiquated and inefficient that they could be dispensed with. They also wished him to make recommendations as to new and modern devices that would return a reasonable interest on the investment.

THEY explained that as fuel prices were now so high and the prospects were that they would remain so for an indefinite length of time, they desired to bring the old plant up to a more modern standard. This rather large order caught the young engineer wholly unprepared. When asking me to assist him, he said: "Gee! I never expected the old crabs would ever spend any money on improvements. Why, every time I sent in a requisition for supplies, they grumbled over it and cut it down, and now here they are asking me to remodel the plant!"

SEEING that he was up against it, I tried to help him out and succeeded. I wonder how many more of his kind are working blindly along each day. These are days of quick decisions on the part of power-plant and factory owners. Many who have been skimping along on old dilapidated equipment all at once decide to yank out the old junk and adopt the modern.

THE new is always trying to crowd out the old everywhere, and to those engineers who would keep up with the times I would give this advice: Keep your eyes peeled for new ideas and be alert to grasp them. Get acquainted with every up-to-date device that could be applied to your plant to aid efficiency and economy. Do not allow the small details of everyday work to crowd out new thoughts and modern ideas. Become a spare-time student of your trade paper—it will keep you abreast of the times.

Wreck of a Thirty-five Thousand Kilowatt Turbine

An account of the wreck of a 35,000-kw. horizontal single-cylinder impulse steam turbine in the O Street Station of the Boston Elevated Railway Co., Boston, Mass., Feb. 14, 1918

A 35,000-kw. 20-stage 1500-r.p.m. 25-cycle horizontal single-cylinder impulse steam turbine in the O Street Station of the Boston Elevated Railway Co. was completely disabled and seriously damaged while in service Thursday, Feb. 14, 1918. There were no casualties and no one was injured. A distorted cast-iron diaphragm in the 18th stage presumably fouled the 18th wheel, breaking off the buckets, after which the buckets and diaphragms from the 18th stage on to the last, or 20th, wheel, also the entire casing, were destroyed. There are excellent photographs of the wreck in existence but are not available for publication without the consent of the manufacturers of the turbine, which consent is refused. A turbine of a type similar to that which was wrecked is, however, shown in Figs. 1 and 2.

To get a proper perspective of this accident one should go back a year ago, when the turbine was installed. At this time trouble of a nature similar to that which wrecked the turbine was experienced; the date was Feb. 14, 1917. At that time the 18th diaphragm became distorted; that is, it deflected at its edge in the direction of the 18th wheel, rubbed the buckets where they join the wheel and stripped the buckets from the 18th and 19th wheels, seriously damaging the 18th and 19th diaphragms. This happened when the machine was being given trial runs. Rubbing began and the throttle was tripped, after which the damage to the buckets and diaphragms followed. When the buckets let go, the speed was below the normal 1500; perhaps 1000 or 1200 r.p.m.—no one knows.

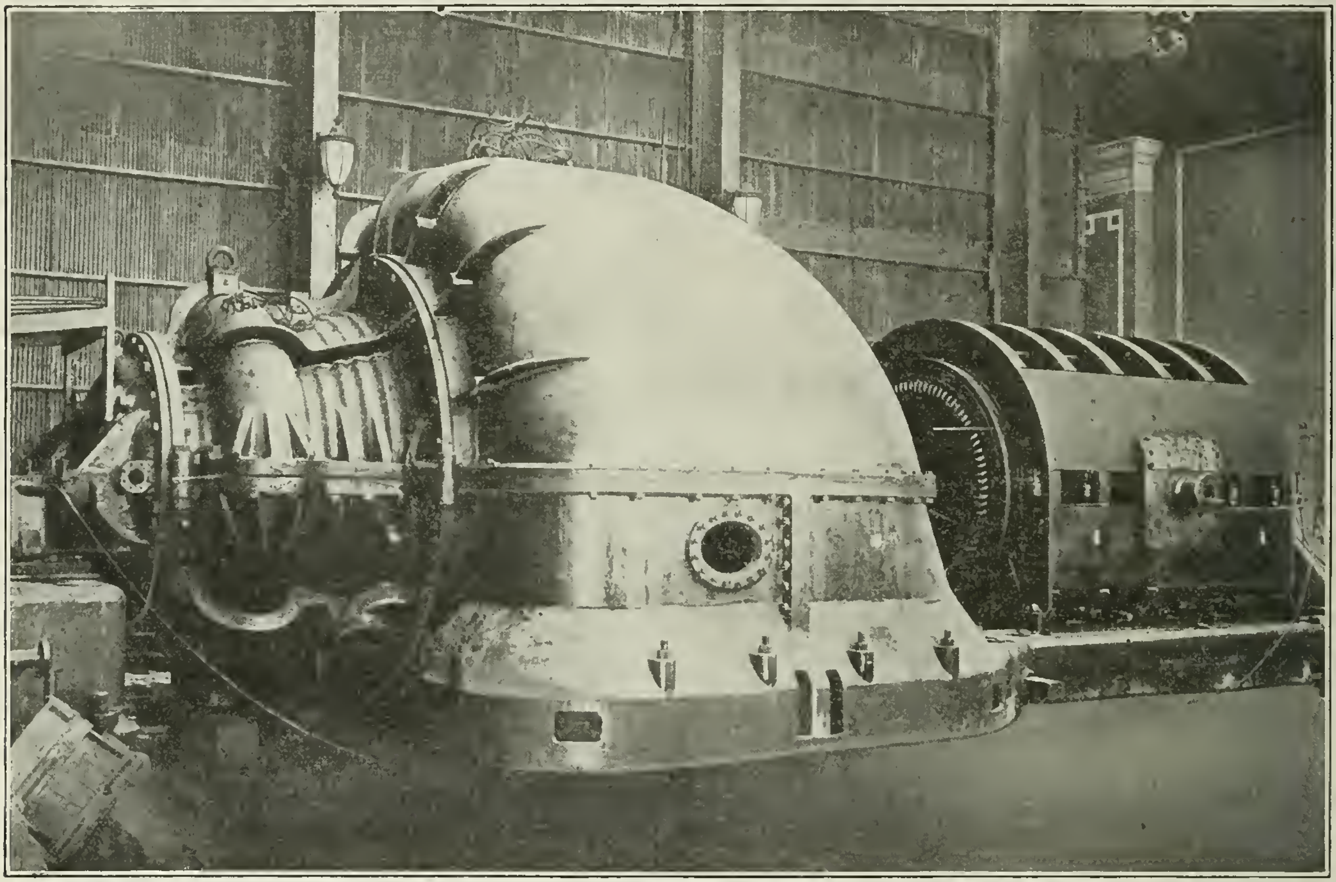

FIG. 1. CASING OF TURBINE OF TYPE SIMILAR TO THAT DAMAGED IN BOSTON

After the accident of Feb. 14, 1917, the capacity was reduced to 20,000 kw. from Mar. 17 to May 23, while repair parts were being made, by locking closed the secondary valve, which admits steam to the 7th stage. The repair parts in place and the machine in service, annoyance was given because the machine would not carry the load with its swings of 2500 kw. above the rated 35,000 kw. under the operating conditions. When these swings came, the cycles dropped from the normal 25 to 24. The purchaser was most anxious that the turbine carry the swings, and it was suggested that nineteen 1⅛-in. holes to be drilled in the eighth diaphragm in front of the eighth wheel. See Figs. 3 and 4. The holes were drilled to allow high pressure steam to that stage. The turbine then carried these swings.

The machine was designed for 200 lb. gage pressure at the turbine throttle, 200 deg. F. superheat and 29 in. vacuum at 30 in. barometer. There was a pressure drop of 4 lb. in the steam line between the boilers and the throttle, or from 200 lb. to 196 lb.; the drop through the governor valves was also slightly more than normal. The builder states that on Aug. 15 last, with 188.7 lb. gage pressure at the throttle, 132 deg. F. superheat and 28.7 in. vacuum, the turbine carried 36,500 kw., and that based on these figures the capacity would be 39,000 kw. under contract conditions.

Rumor has had it that thrust-bearing trouble was responsible for the accident of Feb. 14, 1918. In view of this it is well to point out that the most authoritative statement claims that what little thrust-bearing trouble did arise did not present itself until December, 1917. The trouble was not inherent in the bearing, but was due to oil of poor quality, it having been used for too long a time, as seems evident from the gradual rise in temperature of the oil and from the chocolate-colored deposit left on the bearing. After this incident new oil was put in and the bearing burned out a week later, caused likely by interference with the oil circulation. Slight changes were made to the circulating system, and the machine was put in service on Jan. 26, 1918, after which no further trouble was experienced with the bearing. So, evidently the bearing had no influence whatever on the present accident.

With the foregoing in mind, take up the details of the accident. On Feb. 14, 1918, at 4:55 p.m., when the evening peak load was mounting, the machine was heard to rub and observed to vibrate. Members of the operating crew climbed on top of the platform to adjust the thrust bearing, hoping to stop the rubbing and consequent vibration. The statements of these men say that the first vibration was heavy, that it was of the nature of a shock, after which there came a second with such evident commotion within the casing as to cause all hands to seek safety by running to cover.

At 5:01 p.m., six minutes after the first sign of serious rubbing, the damage was completed and pieces of metal had ceased to fly about the room. [This time is variously given as 3, 4, 5 and 6 minutes; but 6 minutes is the most authoritative as it is that given by the men who were handling the machine and the switchboard.] The period during which pieces of the turbine were flying about and while the low-pressure end of the rotor and the casing were going to pieces was likely not more than 30 seconds.

Now to go back to the time that the first severe rubbing was heard. At this time the Central Station of the same company, which, of course is tied in with the O Street Station, dropped its load of about 10,000 kw. owing to a station blowout. Prior to this the machine now damaged was carrying 32,000 kw. This turbine was practically the only unit to take the system's load—there having been some trouble at the Lincoln Wharf Station—and tried to take all the load dropped when the blowout occurred, by opening wide its secondary valve. The quick opening of this valve so suddenly increased the steam pressure in the low-pressure stages that the impact was probably sufficient either to initially and seriously distort the 18th dia-

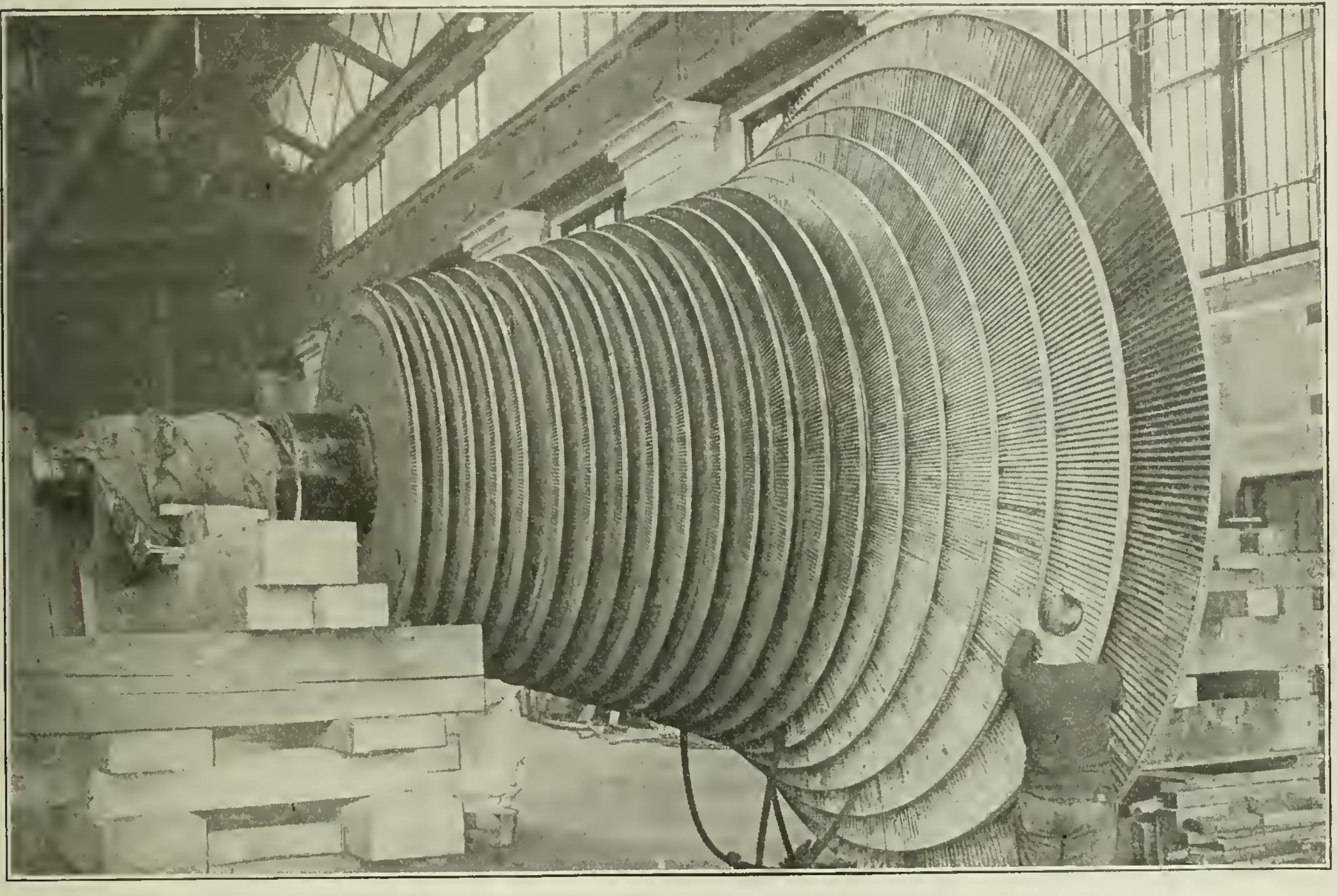

FIG. 2. ROTOR OF THE TURBINE THE CASING OF WHICH IS SHOWN IN FIG. 1

phragm or to further distort it if already deflected, sufficiently to make it further foul the 18th wheel.

When the secondary valve opened, the machine was said to take on 37,000 kw. Whether it took but 37,000 or, because of the momentum of the rotor, took every kilowatt of that 10,000, no one knows for it seems there was no instrument to record the load it did take. But it appears certain that the machine took a very heavy load and took it with the suddenness of a hammer blow. The cycles had dropped from the normal 25 to 24 when the switchboard operator noticed that the turbine was carrying 37,000 kw. Unable to stop the rubbing, the operator on the floor signaled the switchboard man to take off some load, which he did, dropping it to 32,000 kw. It was soon after this that the turbine went to pieces. The buckets on the 18th wheel ripped off, they fouled the 19th diaphragm, which in turn fouled the 19th wheel and the 20th diaphragm.

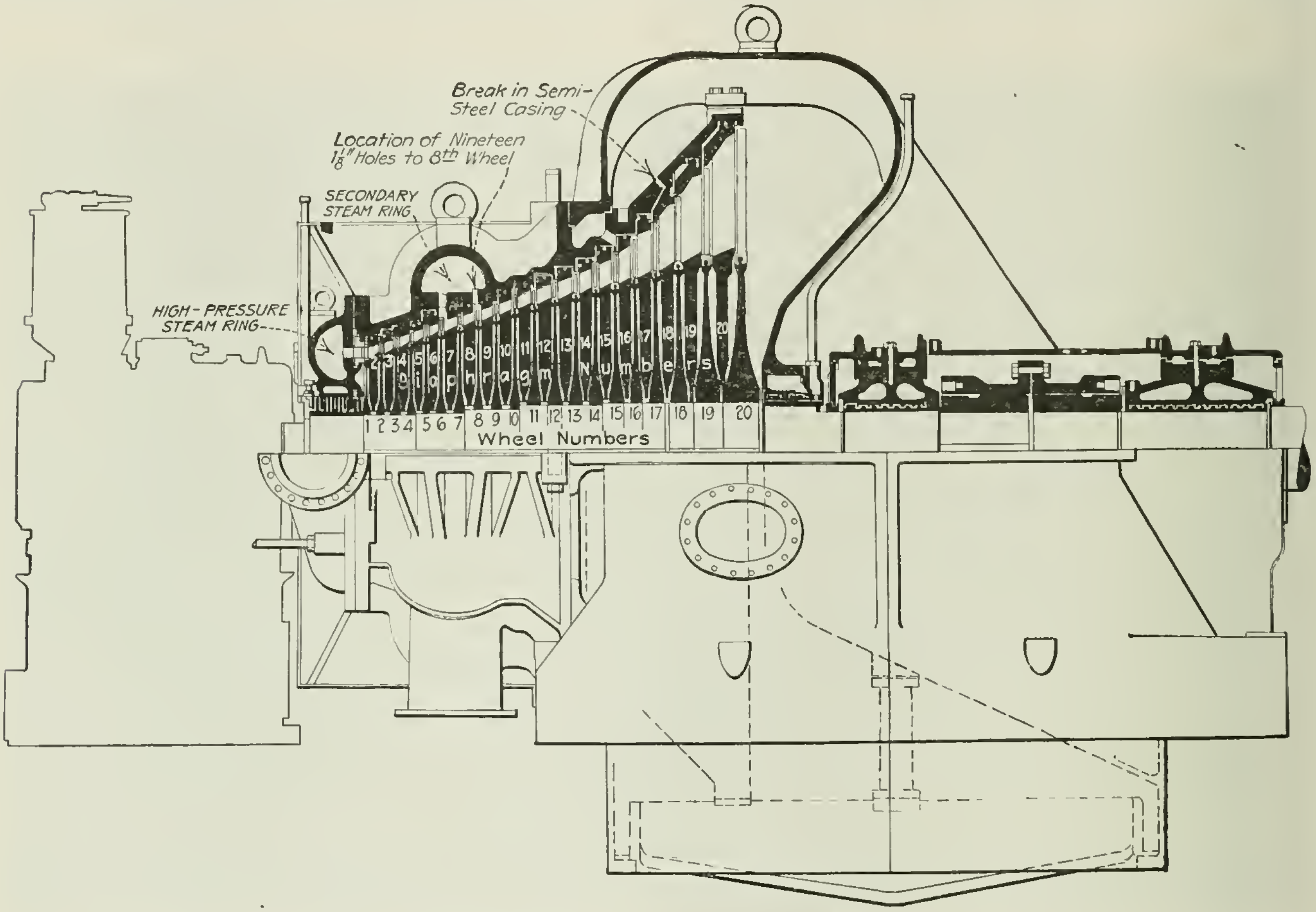

FIG. 3. LONGITUDINAL SECTION OF 35,000-KW. TURBINE DAMAGED IN BOSTON ACCIDENT

It is interesting to note that the buckets from the 18th wheel are broken identically as were the buckets from this wheel in the accident of a year ago. In the recent accident the same evidence of heating of the buckets where they join the wheel is apparent as was apparent on the buckets damaged a year ago. Fig. 5 shows where the buckets were rubbed and how they left the wheel. These buckets are indeed tough, as shown in Fig. 7. The 20th, or last, wheel has all or nearly all its buckets, though they are severely bent and twisted.

Reference to Figs. 3 and 6 shows that a break occurred in the semi-steel frame which holds the diaphragms in the low-pressure end. This conical frame dropped into the condenser, crushing the tubes for a depth of about two feet. When this frame broke, it is probable that the 19th and 20th diaphragms let down on the shaft, or more correctly on the wheelbases, and either revolved with the shaft, then broke due to centrifugal force, or they were broken at the time their supporting frame cracked by reason of being struck by fragments from other stages. These diaphragms, like all others in the low-pressure end of this and other large turbines, were of cast iron. The centrifugal force may have broken them, but at any rate they were broken in many pieces, and these were hurled against the outside casing with force enough to blow out the whole end of this casing and break the great web or bracket, that supports the bearings on the generator side of the turbine. The significant fact is that these diaphragms are the only large pieces of metal to completely break up and leave the turbine. It was some of these pieces that went through the roof and terra cotta temporary end wall of the building. The direction taken by the principal fragments that left the turbine was radially of the shaft, though five pieces went through the building wall near the generator end of the shaft. A piece weighing 70 lb. went through one of the switchboard gallery windows, coming to rest at the other side of the gallery room. One large chunk of diaphragm fell about a quarter of a mile from the scene of the accident. A man was punching the time clock in the turbine room, the clock being at an angle of about 45 deg. from the turbine, when the crash came. As he punched the clock, a piece of metal tore through the board holding the time cards.

There are some interesting speculations as to what broke the conical semi-steel casing which held the low-pressure diaphragms and which inclosed the last five wheels. The man qualified to speak most authoritatively, that is, the eminent designer of the turbine, shows by calculations that high-pressure steam at that point, caused by possible closure of the buckets in the 19th diaphragm, could not do it, as the pressure on the ledges *A*, *B* and *C*, Fig. 6, probably was not more than 186 lb. at most. He thinks that the expansion of the 18th diaphragm, caused by the diaphragm rubbing the buckets on the 18th wheel, may have forced the ring *D*, which is the outside or ring of the 18th diaphragm, to exert pressure enough on the casing to fracture the latter. Others think that it was broken by pieces of diaphragm being jammed against it. A combination of these causes seems not improbable.

The whole turbine casing is ruined, being severely cracked at the low-pressure end, with other smaller cracks extending to the high-pressure end. As stated, the great bracket, or web, supporting the bearings between the turbine and generator dropped away, letting the bearings free. The low-pressure labyrinth packing was destroyed. There was thrust enough to break the collars at the bearings and to push the exciter, mounted on the end of the mainshaft, forward sufficiently to break the four spider brackets supporting the extreme end of the exciter shaft. The collars on the thrust bearing at the high-pressure end are intact.

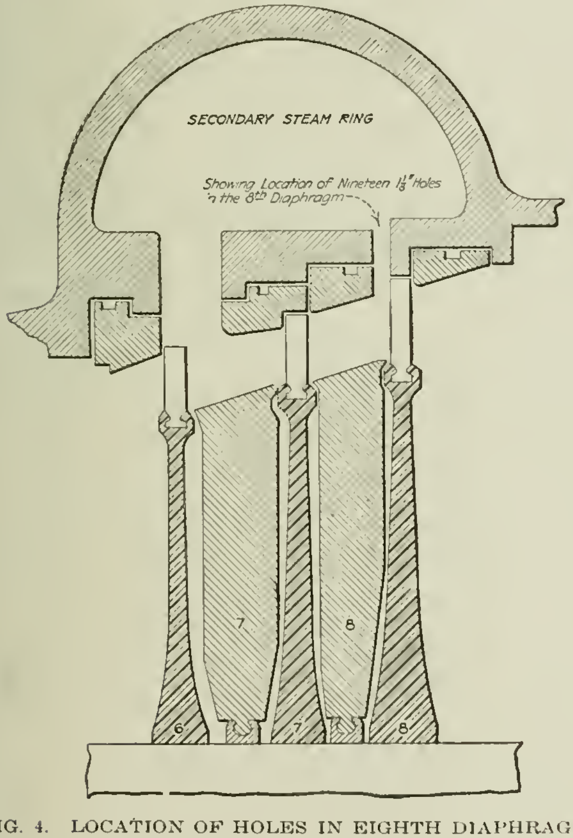

FIG. 4. LOCATION OF HOLES IN EIGHTH DIAPHRAGM

All wheels and diaphragms up to and including the 17th stage are intact. The 18th, 19th and 20th wheels are intact, though their blading is either gone or ruined. There is one small piece out of the rim of the 20th wheel, broken out, presumably, by being struck a tremendous blow by a fragment of diaphragm.

Fortunately, the automatic throttle valve which controls steam to the turbine tripped, either from vibration or because one of the operating crew tripped it by hand. The men do not remember tripping the valve, and one of those present who most likely would trip it is not sure whether he did or did not. It was most fortunate that this did trip, for if it had not one can but conjecture where the damage and loss of life may have ended. Vibration probably tripped the valve, as valves of this design are held open by a catch resting on a knife-edge steel.

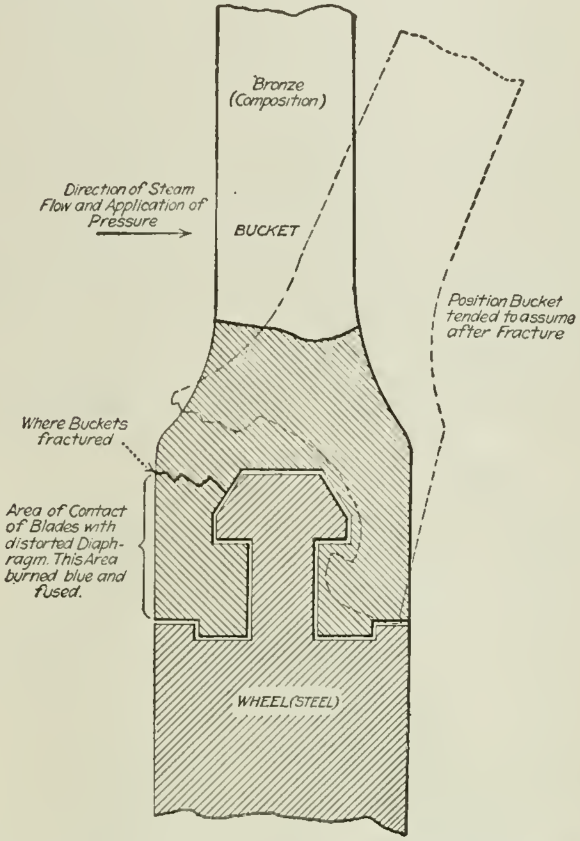

FIG. 5. HOW BUCKETS ON THE EIGHTH WHEEL WERE BROKEN

That the turbine wheels, especially the 20th, are intact is most gratifying. Nothing could more thoroughly prove the correctness of the designer's calculations and more completely convince one of the adequacy of the factor of safety of these wheels.

There were some who were apprehensive about this 20th wheel. In fact, the Massachusetts Institute of Technology was engaged to check up the stresses in the wheel, determine the factor of safety, etc. The results of these checking tests showed astonishingly close agreement with the designer's values. The factor of safety was a little more than four.

On going over the matter with characteristic thoroughness, the professors at "Tech" were in no way apprehensive about the wheel going to pieces. They did express an opinion that because of the shape of the wheel (thick at the hub, then growing thin as the rim is approached) fracture might develop if the wheel were subjected to sudden extreme temperature changes, which of course are not likely in usual operation. Superheat "shoots" through a turbine under certain load conditions; but the wheels, diaphragms or shaft probably absorb an insignificant amount of it. Breaking of the vacuum will cause a more or less sudden change in temperature of the turbine rotor; but the writer does not at this time know of a case where damage or even minor trouble has come from this cause.

The 20th wheel, and presumably the others, has a tensile strength of 130,000 lb. and an elastic limit of 73,000 lb. per sq.in. It is 12 ft. 1 in. diameter, and its tip speed at 1500 r.p.m. is 950 ft. per second.

An engineer of unusual experience with turbines, who desires to remain anonymous, expressed his opinion that before these wheels would fracture or burst they would stretch so much as to become loose on the shaft and cease rotating at dangerous speed. Perhaps this would happen. But one wonders if the wheel would not rub the shaft, fuse both shaft and wheel, and freeze fast. It is recent experience, however, that in some cases of overspeed of turbine rotors, the wheels have been found loose on the shaft when examined after overspeeding occurred.

One wonders if these wheels in large-capacity turbines would ever, except under failure of both governors to function should all load be suddenly lost, reach a speed sufficient to fracture them. In the experiments by the engineering staff of the Public Service Electric Co. of New Jersey, conducted May, 1916, the last or final wheel of an 1800-r.p.m. 25,000-kw. turbine was about four hours being brought to a speed of nearly 3600 r.p.m., or to 198 per cent. of normal, and notwithstanding that a motor of 450 hp. was used to turn the wheel and that steam was impinged upon the blades to assist in revolving it. This gives one an idea of the windage of these wheels. The wheel in question did not fracture, and though painted and marked at the shaft and hub, showed no indications of having slipped or stretched.

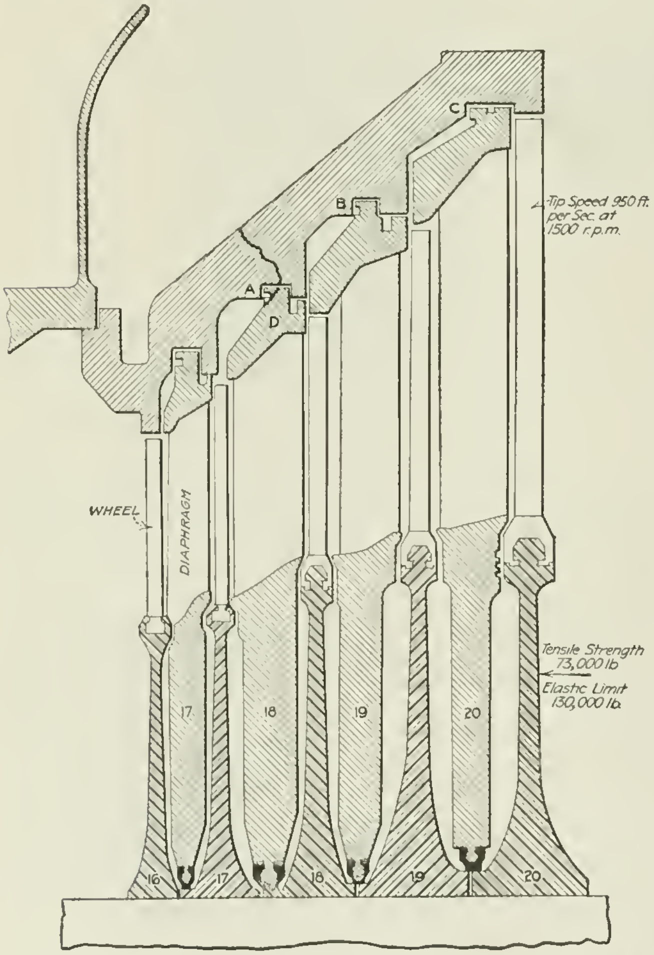

FIG. 6. SECTION OF LAST WHEELS AND DIAPHRAGMS TOGETHER WITH DIAPHRAGM SUPPORT FRAME, WHICH BROKE AS SHOWN

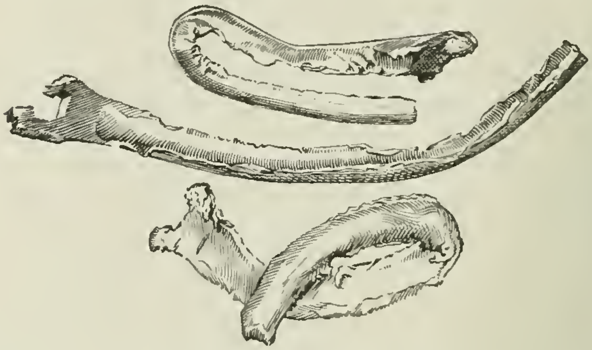

FIG. 7. TYPICAL BLADES FROM THE BOSTON TURBINE SKETCHED AFTER THE WRECK

The Boston wheel was certainly subjected to jamming and impact from broken blading and pieces released from diaphragms, and it withstood these severe shocks while subjected to the centrifugal force due to rotation at the normal speed. This demonstration of resistance is most assuring.

The machine was carrying 29 in. vacuum at the time the low-pressure end of the casing was blown out. Just what effect the sudden release of the vacuum had, one can study out at his leisure.

It is probable that steel will be used in the last stages of the Boston turbine when it is repaired. The builders are, of course, taking steps to avoid a repetition of this accident, and with their wide experience plus that gained in this accident, this should not be difficult, especially as no fundamental changes in design seem necessary.

It is likely that difficulties of manufacture of steel diaphragms as well, perhaps, as cost reasons account for the universal use of cast iron. In making diaphragms one large ring and one large disk, connected by nozzles or stationary buckets, have to be cast. The claim of some persons is that the steel nozzles would likely burn off or become seriously weakened if the disks and rings were cast of steel. However, by pouring and venting in a number of places burning of the nozzles where they join the ring and disk can probably be avoided.

When the Boston machine gets its new casing, the great web supporting the bearings at the generator end will be of steel for reasons of greater safety than cast iron insures.

The turbine with its condenser represented an investment of about $335,000.

The details of the accident described, some general observations are in order: Naturally, the question uppermost in the minds of designers and engineers is whether cast iron should or should not be used for large turbine diaphragm construction. This much is obvious: Cast iron should not be used where it is likely to be subjected to the stresses imposed by the centrifugal force that a steam-turbine diaphragm would be called upon to resist if it revolved with the shaft. But this is the first case the writer knows of where a diaphragm has revolved with the shaft. Certain it is that if there are no probabilities of these large diaphragms being let down on the shaft, and if it is found that cast iron for these relatively thin disks is not subject to too great deflection, cast iron seems suitable, as the diaphragms now in use have a high factor of safety against rupture by normal stage pressure.

Since these high-capacity turbines, with their rotations which give wheel-tip speeds of nearly 1000 ft. per sec., have appeared, all have learned that rubbing of a diaphragm on its adjacent wheel and vice versa must be immediately stopped to avoid the loss of blading or more serious trouble. The element of time is most vital. Take the Boston case: If the throttle had been tripped at the first sign of serious rubbing or vibration, it is probable that the turbine would have needed nothing more than new buckets for the 18th wheel. To go further with the "if," for the good it may do "the next time she rubs hard," the casing would, in the Boston case, simply have had to be lifted off, the loose blades cleared away and the machine closed up and put back on the line—a delay, of course, but not a delay plus a direct loss of, say, $200,000.

THE HUMAN SIDE MUST NOT BE NEGLECTED

The point is that turbine operators not only must be alert, sober and intelligent men, but must be made to realize that they should never take a narrow chance when the safe course is obvious and practicable. The watch engineer on the floor must know the peculiarities of his machines and have judgment quick and decisive enough to know when he should attempt adjustments to thrust bearing or governor, or whether he should signal for load reduction or trip the throttle. This is the human side of the development of turbine art. It must not be neglected, it must develop with the machine, for the machine is right and the human has the quality of adaptation.

Anyone not a switchboard operator would, when he looks at the scarred walls, the broken wire-glass in the switchboard gallery windows and the other turbines down the room at the O Street Station, turn over in his mind or revise his opinion as to placing turbines with their shafts transversely of the room. If the Boston machine had been placed transversely, the other turbines down the room might have been considerably damaged. There are excellent arguments for both transverse and longitudinal positions. The Boston case is an impressive one for the latter.

Just a word about turbine accidents in general. Some folks are foolish enough to try to give the impression that machines may be made, that they are made, so as to be "absolutely free from accident." No sensible engineer ever made such a statement. Be assured of that. Only the other day, in discussing this question with one of the most eminent turbine designers, a man to whom the world owes a deep debt of gratitude for his contribution to the art, he said: "The man who thinks this can be done is indeed foolish."

Accidents are as much a part of the progress in machine design as illness and death are parts of animal life. They are the impetus stimulants that reveal the danger zones and help us the sooner to get out of them.

Heat Carried to the Chimney by the Flue Gases

In a recent issue of the *Stevens Indicator* E. A. Uehling, M. E., derives the following formulas for determining the amount of heat carried off in the chimney gases.

CO = Percentage of CO in the flue gas;
CO_2 = Percentage of CO_2 in the flue gas;
H = Weight of available hydrogen per pound of carbon in fuel;
M = Weight of moisture in fuel per pound of carbon;
t = Temperature of air supplied for combustion;
T = Temperature of flue gases on leaving boiler;
V = Weight of water vapor in the air used to burn one pound of carbon;
W = Weight of water of hydration (water combined in fuel) per pound of carbon.

H is the weight of free hydrogen available for combustion per pound of carbon as distinct from the hydrogen already combined with oxygen and forming the moisture and the water of hydration in the fuel. W is the weight of water $\left(O + \frac{O}{8}\right)$ that is formed by the combination of the oxygen, O, in the fuel per pound of carbon with hydrogen, in which form it is combined in the fuel as water of hydration as distinct from the moisture which is present but uncombined.

Heat Carried Away by the Dry Gases

$$\left(0.24 + \frac{58.46}{CO_2}\right) \times (T - t)$$

Heat Carried Away Through Incomplete Combustion

$$\frac{10{,}150 \times CO}{CO + CO_2} + \text{other combustibles difficult to determine and generally negligible}$$

Heat Carried Away by Water Vapor in the Air

$$V \times \left(\frac{117}{CO_2} + 3.8H\right) \times (T - t)$$

Heat Carried Away by the H_2O from the Combustion of Hydrogen

$$4.32 \times H \times (T - t)$$

Heat Carried Away by the Moisture and Water of Hydration in the Fuel

$$(M + W) \times (0.48 \times T + 1080 - t)$$

Theoretical Maximum CO_2 Obtainable from Fuel Containing Hydrogen

$$\frac{21}{1 + 2.38H}$$

Percentage of Excess Air Supplied

$$\frac{2100}{CO_2(1 + 3H)} - \frac{100 + 238H}{1 + 3H}$$

Percentage of Oxygen in Gas

$$21 - (1 + 2.38H)\ CO_2$$

Be careful that no pieces of rubber gaskets work through the steam pipe into the steam chest of a throttling engine. Wrecks have occurred due to the governor valve being blocked open by pieces of packing.

Training Power-Plant Men for the Navy

By WILLARD CONNELY, U. S. N. R. F.

How ship fitters and gas engineers get expert free training for duty with Uncle Sam's fleets.

NOT all the naval pipefitters, steam and gas engineers, water tenders and boiler men can be trained at sea. There is neither room nor time for that. Schools of instruction on our coasts and inland, too, are adding more and more men to their classes every day. Quite as frequently the raw recruits of four months back pass their examinations at these training stations and are dispatched with all speed to their receiving ships, whose power rooms the new bluejackets enter familiarly, chafing for action.

A school's remoteness from the ocean does not deter the Navy Department from authorizing thereat trade instruction for bluejackets. For instance, witness the training base established at Dunwoody Industrial Institute, Minneapolis, now producing for the fleets nearly three thousand artisan specialists a year.

Dunwoody Institute is a free trade school, and although the Navy now makes demands on the major portion of its facilities, it continues to hold civilian classes in day, evening and extension courses. Of the ten departments now making dextrous naval craftsmen out of bluejacket apprentices, among the foremost are those teaching the foundry and boiler men, the pipefitters, and the gas, steam and oil engineers. Three general divisions of power-plant processes are here involved: Navy blacksmiths in a power plant would do the repairing, metal workers would make new parts, navy gas engineers would represent operation. The naval detachment, under the command of Ensign Colby Dodge, U. S. N., has now a smoothly running routine worked out by the commandant and by Acting Director Kavel of the Institute.

Work in Forging and Welding

The blacksmithing and boiler men begin naturally at the forge. Preliminary exercises involve making various foundry tools, then a week or two building iron racks and the like, and the blacksmiths come to the most significant branch of their course—oxyacetylene welding. At the welding tables the bluejackets repair broken or cracked machine parts. They are dentists to stripped gears. They rebuild a cylinder, a cam or an engine connecting-rod. All this time the ironworkers are having daily classroom work too, in heat treatment of metals, metallography, and related mathematics. Open discussion is encouraged, that the older jackies who have been previously at the trade may relate their power-plant experiences.

The men are admitted to the Soo line car shops in St. Paul, where they tackle welding jobs so comparatively gigantic that nothing thereafter on a battleship will seem too formidable. From a motor-boat engine cylinder to the stripped boiler of a big freight locomotive is a significant leap. After two months in the car foundries the naval apprentices rightly believe themselves to have become fairly competent welders. While acquiring skill at the Soo shops, the blacksmiths alternate training periods in the boiler room at Dunwoody, where at stated hours they assume the responsibility of the boiler operation. This duty they share with men in other departments also, men whose general scheme of training covers a survey of power-house methods. Four to five months, in sum, round out a man in the foregoing vocation, whereupon he goes aboard ship.

Power-plant men will see at once that the instruction of these metal-worker bluejackets is essentially in productive work.

The course in pipe fitting, which embraces training in coppersmithing, tinsmithing, sheet- and galvanized-iron construction, covers mathematics through solid geometry, catalog study, freehand sketching and laying out of water, vapor and low-pressure heating systems, plan reading and estimating quantities.

Gas-Engine Instruction

Outfitted at the start with a set of hand tools and all the standard coppersmith stakes, the bluejackets in the power-plant course are then acquainted with the crimping machine, the bar folder for stovepipe, the cornice brake to bend up edges, the squaring and circle shears, and rolls for forming. Working in tin, the students make mess pans, dust pans, drinking cups, cooking measures and funnels; then they proceed to such marine articles as tees, elbows, bunker lamps and ventilators. While such power-house accessories as oil cans, oil feeders, air chambers and ventilators are made of copper, the more important exercises allied to pipe fitting comprise a cuff joint, a cramped-seam pipe, a long bend, short bend, return and offset bends, a formed tee, and single and double saddle branches.

Through the naval students' gas-engine class at Dunwoody lies the quickest avenue for a recruit to attain the rating of a chief petty officer. This exigency is created by the sudden demand of the Government for experienced gas-engine men to make up the engineer crews of the new submarine chasers. Now that enlistments in the Navy are closed to men of draft age (unless their numbers are obviously far down the list), perhaps the best chance remains for engineers between between 31 and 35 years old, because of their more substantial knowledge of the craft. However, competent men between 18 and 21 are gladly enrolled in this course. The point is, a man who enlists as seaman for training in the submarine-chaser corps can in four months arrive at the rating of chief machinist's mate, provided he knows what he knows. This chance cannot be duplicated, nor will it last for long.

To be sure, not all Dunwoody gas-engine apprentices are pointing for the submarine-chaser service. Some of the bluejackets cannot make all the requirements, which embody a proven ability to handle men and to stand the shaking of the high seas in a small boat. Gas-engine students not so qualified are trained for motor-boat pilots, operating the boats that ply between ships of a fleet or from a ship out in the harbor to shore. On a basis of five days' instruction per week, with Saturday mornings for review and tests, the gas-engine men spend three half-days in the Dunwoody auto shop, tearing down, repairing and reassembling gasoline engines, three quarter-days with classwork on theory of engines and starting and lighting, three quarter-days in the testing laboratory, operating oil and steam launch engines, taking horsepower tests, setting valves and taking indicator cards. The remaining four half-days have been employed at a near-by lake, running motor boats and learning to approach docks properly. Through the winter the boat work is indoors, overhauling and repairing parts. The auto shop is fitted with gas engines of various types from one to twelve cylinders, with axles and transmissions of equivalent diversity. The ignition room has an electric dynamometer for testing horsepower, with a profusion of carburetors, magnetos, starting and lighting systems.

ENGINEER STUDENTS IN TRAINING FOR SERVICE ABOARD SUBMARINE CHASERS

For a comprehensive idea of this highly developed course, a résumé of the work from week to week may be taken. First the men are given classroom lectures on engine types. They make a study of the basic principles of these types, including both two- and four-stroke-cycle kinds, and a survey of general construction and arrangement of parts. The crank case and attached parts are next taken up. This subject covers bearings, crankshafts, flywheels, counterbalancing and connecting-rods. The third week is devoted to cylinder parts, their assembly and correct fitting, concluding with observations on pistons and rings, the whole covering both two- and four-stroke-cycle cylinders. Valves, springs and timing follow, and their correlative subjects of camshafts and timing gears.

Cooling systems claim the fifth week, during which pumps and piping of all recognized sorts are analyzed and examined. The natural corrollary of this topic is lubrication. A description of each lubricating system is necessary, involving questions and answers on oils and their distinguishing characteristics. The seventh week is given to carburetion, under these heads: Fuels and their uses, mixing valves, carburetor types, fuel tanks, piping systems, manifolds, mufflers, inlet, exhaust, cutouts.

By this time the bluejackets are required to apply their knowledge directly to the operation of the Norfolk Navy Yard engine for a week, and then to the Van Blerck engine. On both these highly important pieces of naval machinery each sailor is examined, asked to describe all parts discussed and studied to date.

Three weeks are given to the subject of ignition, covering a description of systems, wiring, coils, interrupters and distributors, magnetos and generators. Two weeks more are taken up with starting and lighting, in the same department. Generators and motors, wiring and cutouts, storage batteries and lights are the subdivisions of this period. Then comes a week of transmission systems with instruction in gear sets, reverse gears, thrust bearings, propeller shaft and propeller.

Oil engines are considered separately. Five days' intensive application to this type is given, with horsepower tests and valve notations, so that by this time the bluejacket is familiar with every kind of engine in wide use—gas, steam or oil. Finishing training succeeds on the Norfolk and Van Blerck types, with a study of all features not previously inspected.

The final teaching period is occupied with boat construction. A bluejacket who knows how to run a motor boat should also know how to build and repair. In the gas-engine class he winds up with learning displacement theory, hull construction, engine mounting, control and signals.

As fast as the bluejackets can complete this course satisfactorily they are sent to receiving ships or transferred to Columbia University for a four weeks' supplementary training on actual submarine-chaser apparatus. The time required by the average student in gas-engine work at Dunwoody is four to five months. At the school of mechanical engineering at Columbia the sailors have a week in the electrical laboratory, a week in the mechanical laboratory and two weeks of outside training under the supervision of instructors. The first week of outside work is in the assembly department of a chaser yard somewhere on the Atlantic coast, and the final week before going to sea is spent studying the engine itself in the process of manufacture.

Before a gas engineer is recommended for transfer to Columbia he must pass a rigid personal examination, aside from his technical test, by Ensign Dodge. Two companies of Dunwoody men have qualified and are now at sea.

Anthracite Coal from Lignite

By Charles Philip Norton

A lawyer named Fiske, whose standing and connections command respect, startled the Seattle public in February by announcing that after years of experimentation he had perfected a system of coal distillation by which the full power value of lignites could be utilized, saving the byproducts of gas, coal tar and oils and producing a manufactured coal containing seven-eighths of the fuel value of the best Pennsylvania anthracite. In the process of making coke from bituminous coal the byproducts are saved to some extent, but anthracite coal goes to market untreated.

Mr. Fiske said he had no stock to sell, no scheme to promote. In proof of his patriotism he proffered his formulas to Franklin K. Lane, Secretary of the Interior, for the use of the Government. Together with his offer to Secretary Lane, Mr. Fiske urged that the Government appropriate $500,000 and establish the first coal-manufacturing plant, utilizing lignites, with a capacity of 100,000 tons per annum. The volume of byproducts, he said, would be enormous and profitable. He guaranteed that the coal manufactured by his process from the practically worthless lignites would be almost as good as the best anthracite and that it would stand every test in use.

Mr. Fiske is a man of independent means. He said that if he desired to make a fortune he would engage in such manufacture upon a colossal scale and in a few years would rank with Rockefeller, but that his sole desire at this time was to "swat the Kaiser." "It is almost a crime, in my opinion," said Mr. Fiske, "to waste the byproducts in coal—products which we need so badly in everyday life."

The Fiske manufactured coal is not even second cousin to the well-known briquet, according to his statement. The latter, he says, simply is coal in a different form, containing all the byproduct elements, while his coal is divested of these products *in toto*. He further says:

> If the Government is afraid to experiment with my process, but will appropriate the necessary capital for the initial plant, I would be perfectly willing to operate the plant upon a lease and commercial basis, paying the Government 7 per cent. on the investment, and would put up a bond in any amount to guarantee the Government against possibility of loss. Being a Westerner, believing in immediate action in a matter so vital as this, which promises permanent insurance against coal famine as well as a never-ending supply of the valuable byproducts of coal, I am urging the Government to do it now.

In almost every Western State and in Northwestern Canada there are vast deposits of lignite coal which is undesirable as fuel in its natural state. Mr. Fiske is of the opinion that the United States should lead in coal distillation. He says:

> It is no secret process, but is well known to scientists and power engineers the world over. The stupidity of governments is such, however, that none has yet started this industry. Once begun, it will develop rapidly into a colossal enterprise. Large capital is required to get immediate results. That's why I am anxious to have the Government take hold of it.

He said his process and formulas were the result of many years of scientific study and experimentation; that he was willing to make a gift of the whole thing to Uncle Sam, provided the Government would use it to help win the war.

Warrior Steam Plant of the Alabama Power Company

By W. B. West

A stand-by steam station to be held for taking care of emergency loads. There is but one 25,000-kw. turbo-generator unit, the largest in the South. Two additional units are to be installed. Coal is obtained from a mine but a few hundred feet distant.

PRIOR to August, 1917, the Alabama Power Co., operating in North Alabama, with headquarters at Birmingham, generated most of its power at Lock No. 12 on the Coosa River, thirty miles below Birmingham, and had but a 10,000-kw. steam plant in reserve. This plant is at East Gadsden, Ala.[1] At Lock No. 12 there are five 13,500-kw. vertical waterwheel generators. When the river gets low, these generators cannot carry the load, and it was seen that the East Gadsden plant would soon be too small to take care of an emergency. The company officials, therefore, decided to construct another steam plant on the banks of the Warrior River (Fig. 1) about forty miles northwest of Birmingham, to be held in reserve. By the time the first unit in this plant was started, the load in the Birmingham district, at Gadsden and at Anniston, had become so heavy as to make it necessary to put it into operation at once.

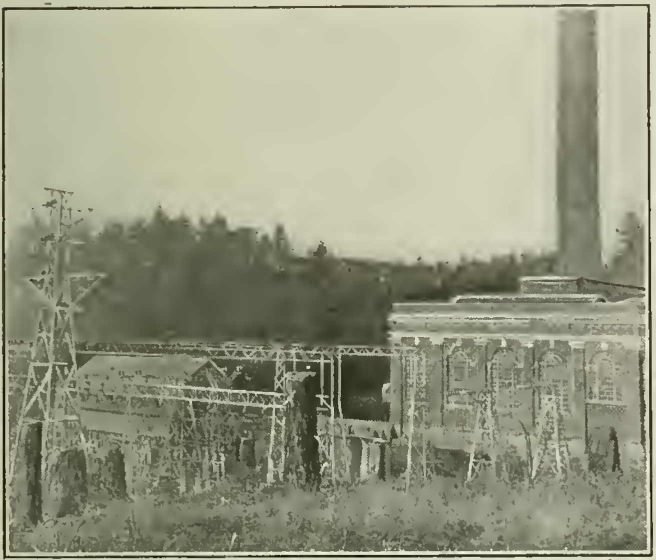

FIG. 1. GENERAL VIEW OF THE POWER HOUSE AND SUBSTATION

Since that time the Government has decided to use power generated at this plant for the operation of its industries at Muscle Shoals on the Tennessee River (Near Sheffield, Ala.) until the $12,000,000 dam at that place is completed. Construction crews are hastening the completion of the transmission line. The power plant to serve the Government projects will be enlarged and extended at an initial cost of $3,000,000. The size of the new units to be installed has not yet been determined. It is certain, however, that they will have a capacity of over 25,000 kv.-a. each.

It is interesting to note that the Warrior River plant is at an apex of a large imaginary triangle whose sides inclose the Birmingham district. Lock No. 12 is at another apex, and the East Gadsden plant is at the third. While most of the load is still carried by the Lock No. 12 plant, it is necessary to keep the Warrior River plant in operation except during periods of high water on the Coosa River.

The location of the new plant was determined largely by the available supply of coal and water. Ground was broken early in July, 1916, and in spite of the congested freight situation and manufacturing delays, the first unit was started in August, 1917. While not a record performance, yet in view of the fact that the main equipment was much delayed, it compares well with similar installations even in the less active periods.

In general plan the plant follows pretty well the established practice for an installation of its size. The foun-

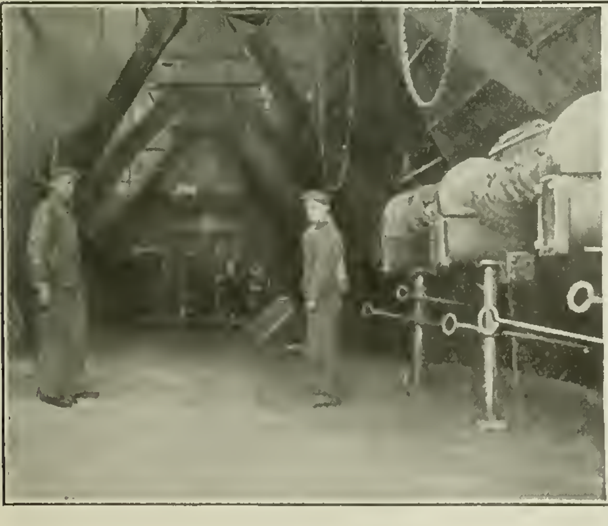

FIG. 2. BOILER ROOM AND AUTOMATIC STOKERS

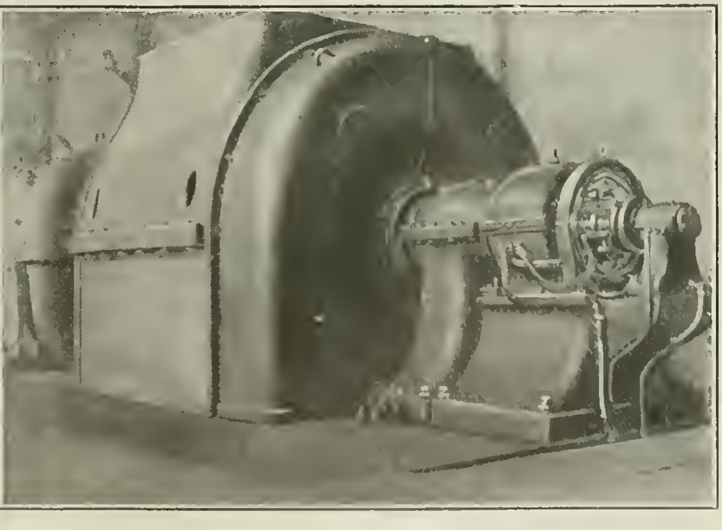

FIG. 3. THE EXCITER END OF THE MAIN GENERATOR

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[1] See "Power," p. 156, Aug. 4, 1914.

dations are carried down to bedrock, which lies fairly level about fourteen feet below grade. The basement walls of the turbine room and the walls of the cold well are carried down to rock, which is below the river-water level; but in the boiler room the columns are carried on piers founded on rock.

The boiler room at present is 86 x 120 ft. in the clear and accommodates six water-tube boilers, Fig. 2, each of 1200 normal horsepower with 150 deg. superheat. Five of the stokers are the underfeed tuyere type. All are driven by two stoker engines.

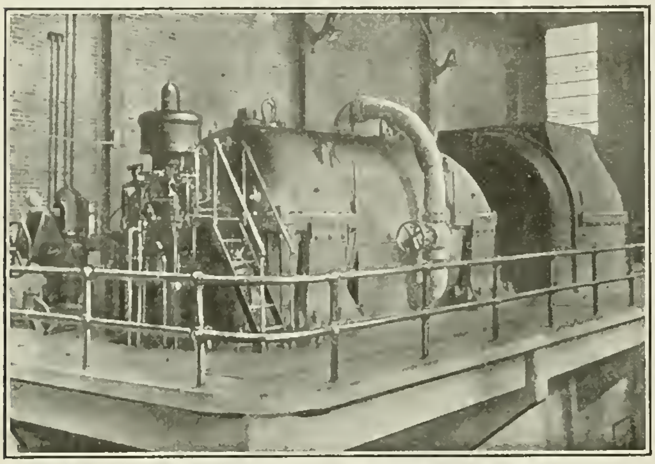


FIG. 4. THE 25,000 KV.-A. TURBO-GENERATOR

The fact that coal is mined only a few hundred yards up the river from the plant is one of its interesting features. The plan of establishing a power plant at the mouth of a coal mine has been advocated by many of the leading engineers, but as yet very few plants have been so located. After it leaves the mines the coal is carried to the crusher in cars drawn by electric locomotive. From the crusher it is delivered upon a 24-in. belt conveyor driven from the lower end. The belt conveyor discharges into a steel bunker having a capacity of 600 tons. From the bunker the coal passes into the automatic registering scales. Each stoker is equipped with two sets of scales. The total weighing capacity of the twelve scales is 9600 lb. per min. Ordinarily, the daily coal consumption is about 450 tons.

At present the turbine room is 40 x 86 ft. in the clear and is served by a 60-ton overhead crane. In order to make room for the two additional units that are to be installed at once for the Government, the turbine room will be enlarged to 258 x 40 ft. Another crane, larger than the one in use at present, will also be installed in the near future.

At present there is one 25,000-kw.-a., turbo-generator served by a jet condenser located in the basement (see Fig. 4). Circulating water is pumped from the river and goes back by force of gravity. The generator is cooled by means of a water-driven blower located in the basement.

Water for boiler feed is drawn either from the discharge or from the intake canal and is measured by venturi meters. Centrifugal feed pumps are used. The boiler piping follows the usual lines.

The generator is equipped with a direct-connected exciter, Fig. 3. There is also a motor-generator exciter set and a turbine-driven exciter. The latter supplies power to haul coal from the mines to the plant. It is a 100-kw. 230-volt machine, making 3600 r.p.m. The main generator speed is 1800 r.p.m. The current is three-phase 60-cycle generated at 6600 volts and is stepped up to 45,000 volts for distribution. The switching system consists of duplicate busses with remote-controlled solenoid-operated oil switches. The feeder circuits are equipped with three-phase aluminum-cell lightning arresters.

The installation was designed and constructed by the company's engineers and construction department, O. G. Thorlow, chief engineer, and J. A. Sernit, chief electrical engineer having charge of the work. A. R. Gilchrist is in charge of construction.

Speed-Reduction Gear

Small steam turbines and electric motors to be cheap and efficient must run at a higher speed than the machinery which they drive. Reciprocating engines, on the other hand, often run much slower than the generators, fans, pumps, etc., for which they furnish power. To step the speed of the prime mover up or down to meet the requirements of the driven apparatus is a problem which the engineer must often solve.

The ideal thing would be a self-contained device which could be inserted in the shaft connecting the prime mover with the load and which would receive the power at the motor speed on one side and deliver it at the desired speed on the other. Such a device is the Turbo-Gear, shown in Fig. 1, and manufactured by the Poole Engineering and Machine Co., of Woodberry, Baltimore, Md. If the speed is to be stepped down, the swiftly running motor or turbine is connected to the smaller shaft at the right, and the larger shaft, in the same axial line at the left, rotates in the same direction at the desired speed. If the speed is to be stepped up, the prime mover is connected to the larger shaft.

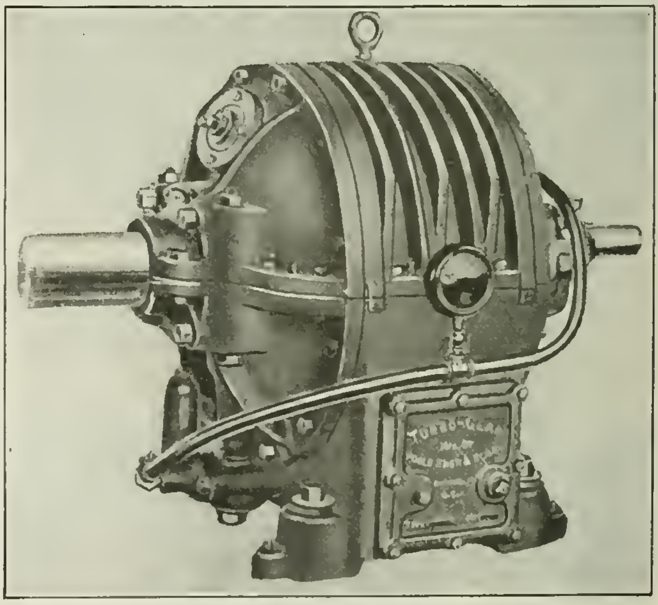


FIG. 1. EXTERIOR OF THE TURBO-GEAR

The method by which the change is effected is shown in Fig. 2. If the shafts or pins upon which the intermediate or planet gears *C* turn, were held in a fixed position, it is apparent that if the internal gear *A* were rotated counterclockwise it would rotate each of the intermediate gears *C* counterclockwise upon its own axis and these would drive the pinion *B* in a clockwise direction. But suppose the internal gear *A* to be held stationary and the planet gears *C* to be mounted in a carrier, Fig. 3, free to turn upon its axis. If now the pinion *B* is revolved in a clockwise direction, it will turn the gears *C* each upon its own axis in a counterclockwise direction, but they will roll around upon the internal gear *A*, carrying the cage which supports their axes, and the shaft to which it is attached, around in a clockwise direction, like the actuating pinion.

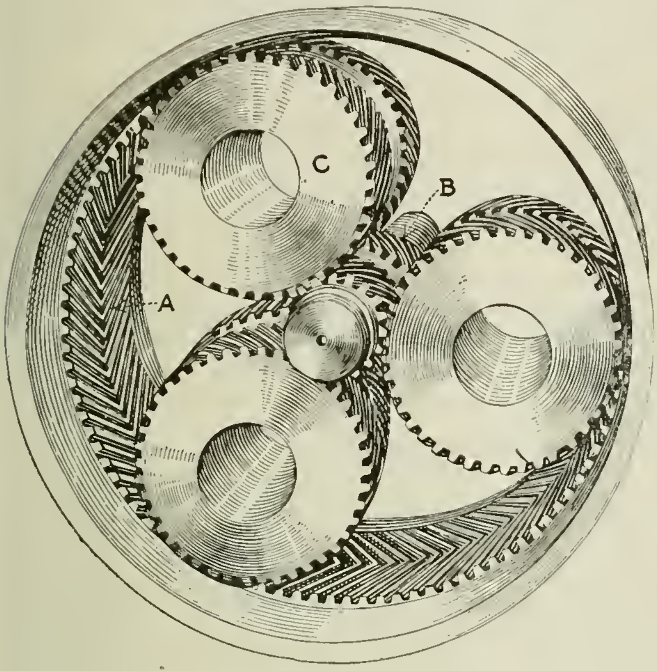


FIG. 2. DETAILS OF THE GEAR MEMBER

The assembled mechanism is shown in longitudinal and cross-section in Fig. 4. The pinion shaft is supported at the left in a ring-oiled bearing, and at the right its reduced end is carried in a bronze bushing in the axis of the low-speed shaft. The low-speed member is supported on both sides of the gears by ball bearings.

An eccentric on the low-speed shaft within the casing actuates the plunger of a pump by which oil is forced to all the bearings and gear faces through the channels shown. This oil gravitates back to a chamber in the base containing a cooling coil, from which chamber the cooled oil is taken by the pump through a filter.

The change in speed depends upon the ratio of the pinion to the large internal gear, the intermediates or planet gears being simply carriers. The gear must be designed with reference not only to the change in speed, but to the load to be transmitted and to the actual as well as the relative speeds. As an indication of the range of speeds and horsepower capacity offered, the following data are given relative to five types of Turbo-Gears:

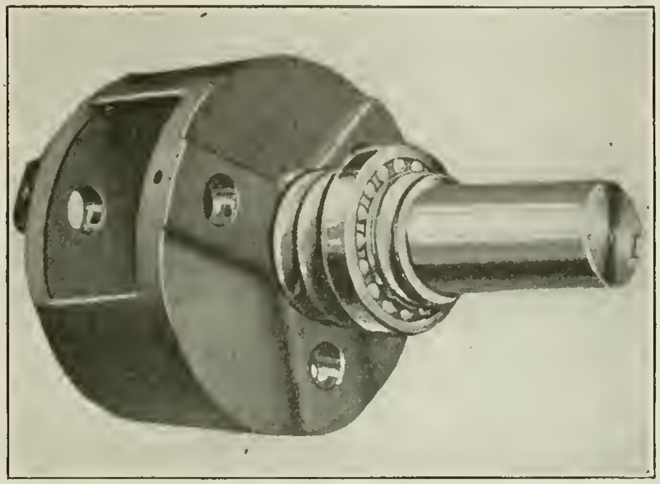


FIG. 3. THE CARRIER AND SLOW-SPEED BEARING

Type A, with 24 separate ratios from 4 : 1 to 7 : 1, good for from 1 to 50 hp.;
Type B, with 51 separate ratios from 4 : 1 to 10 : 1, good for from 1 to 130 hp.;
Type C, with 71 separate ratios from 4 : 1 to 13 : 1, good for from 1 to 240 hp.;
Type D, with 105 separate ratios from 4 : 1 to 19 : 1, good for from 1 to 400 hp.;
Type E, with 135 separate ratios from 4 : 1 to 17 : 1, good for from 1 to 800 hp.;

The Poole company is, however, able to furnish gears capable of transmitting any load up to 20,000 hp. with speed ratios varying from 4 : 1 up, which ought to meet any case likely to occur in ordinary practice.

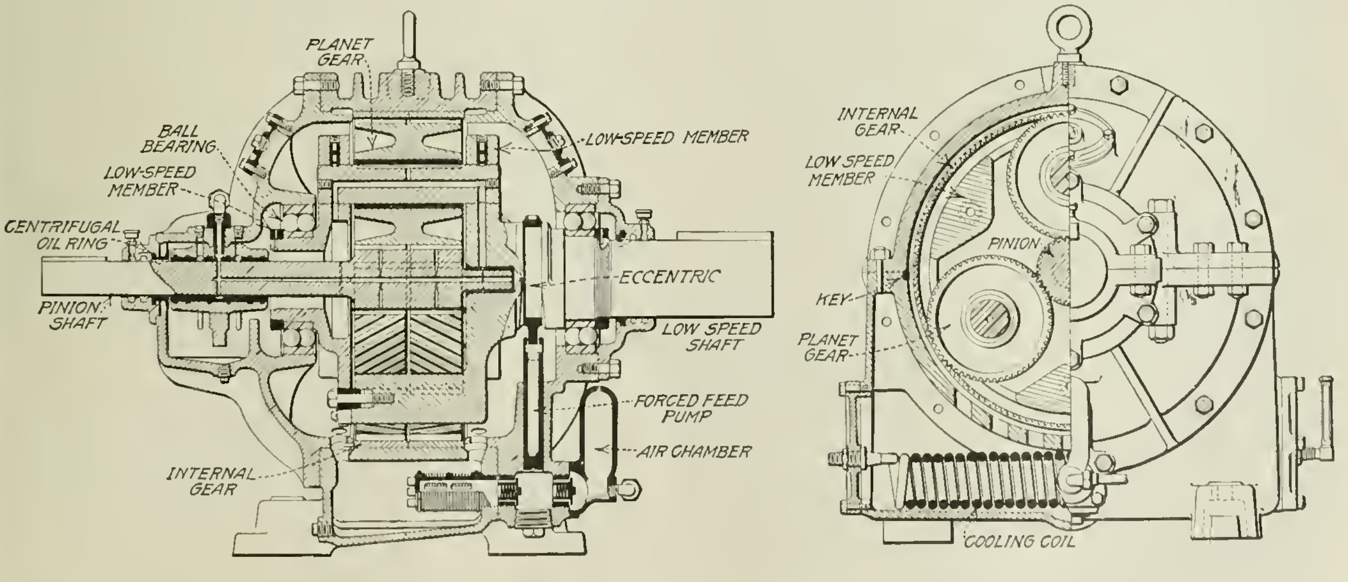


FIG. 4. LONGITUDINAL AND TRANSVERSE CROSS-SECTION OF THE TURBO GEAR

Electric Welding Stops Leaks in Girth Seams

BY ROMEO A. GRISE

To engineers who have experienced trouble with leaks in the first girth seam of return-tubular boilers, the following is of interest. The trouble referred to in this article is leakage due to fire-cracks at the seam over the fire.

IN THE plant to which this article refers there are five 84-in. return-tubular boilers with overhanging fronts, nine 72-in. return-tubular boilers with flush fronts and two water-tube boilers. The boilers that gave the trouble are the 84-in. and that in spite of the fact that the oldest of these five has been in service seven years. None of the other boilers has ever given any trouble at the girth seams.

The first of the troublesome boilers had been in place almost four years before any leakage occurred, and that was so slight at first that when new boilers were needed for extensions it did not influence us against choosing the same type. The fire-cracks through which the leakage passed appeared from the rivet hole to the calking edge. At first only a few were noticed, but as time wore on it was not surprising to find twelve to sixteen cracks on one boiler extending from a point over the fire to about one-quarter way around the shell. Some of the cracks were from one rivet hole to another. Pieces of the plate actually fell out while the boilermakers were calking the edge.

Cause of Leaks Perplexing

The cause of the trouble puzzled us all. Some said it was due to the water; but if that was so, why did we not also have trouble with the 72-in. boilers? One thing seems certain, and that is, the thickness of the metal from which the shell was made had some influence. These boilers are made of $\frac{5}{8}$-in. plate, while the 72-in. boilers are of $\frac{9}{16}$-in. plate. The extra thickness makes some difference when the plate is over a very hot fire, but beyond the possibility of thick plate no one here offers a good reason for the trouble. The material used in making these boilers was not necessarily poor, because all boilers gave the same trouble and no two of them were built at the same time. We do not believe that mud or oil was to blame for the fire-cracks; for while there was just a trace of oil and a little mud did collect in the bottom of the boilers, the same conditions were true for the 72-in. boilers.

It was finally realized that just plain calking would not stop the leaks. It was then decided to try oxyacetylene welding.

The way this was first tried was to weld the plates together solid along the calking edge; but this did not hold, as on absorbing the heat the inside plate would curl up and away from the lap and the weld would break almost immediately. In one joint the strain caused by the cooling of the weld pulled the rivets apart. Then it was decided to take out the rivets where the fire-cracks occurred, "V" out these cracks, weld the plate back to normal again and scarf the edge. After the plate was welded, the rivet holes on the welded plate were drilled and the boiler again riveted just as in the shop. This job seemed to give satisfaction, and the remaining four boilers were similarly repaired. The first boiler ran about six months before it started to leak again, but the other four lasted only a short time; one of them, the last one repaired, held hardly two weeks.

About this time forced draft was used under these boilers, a fact which doubtless did not better conditions, as the fire in the furnace was almost white hot. Still, forced draft was not the cause of the boilers leaking again.

For the next five months we were trying to keep going as best we could. The load was quite heavy, the coal very bad and the draft poor. Those boilers would leak so badly that when the men came on in the morning, there would be a large area on the grates where the fire was dead and the fuel bed water-soaked. Some of the boilers had two or three streams the size of a lead pencil pouring down on the fire. Imagine trying to get up steam under those conditions. It was necessary to have boilermakers on the job every two or three weeks to calk the cracks.

The Electric Welder Is Called In

Finally we got in touch with electric welders who would tackle most any kind of a job and guarantee it to hold. The guarantee was something new to us as the oxyacetylene people would not guarantee their work. As a last resort we decided to give these electric welders a trial. We had everything to gain and nothing to lose; the condition of the boilers meant patching each one of them and possibly having the pressure cut down by the insurance company. And a patch would expose two seams to the fire instead of one, which presented the possibility of twice the trouble and of eventually compelling us to throw out the boilers.

When the electric welder arrived, we had our worst boiler out for him. He looked it over carefully and asked a few questions, then calmly told us he could fix the boiler so it would be tight and would give us a three-year written guarantee. He also gave us as references the owners of two large power plants where he had done similar work. We wrote these people and received encouraging replies.

The process of electric welding required that first the boilermaker chip away all the old stock on the outside of the girth seam till clean metal was reached. When he had chipped away all that was necessary, the welder built up new stock on the plate, bringing it up to its original length and thickness. At the same time that the plate was being built up, it was welded to the other plate at the lap, and when the calking edge was reached the whole seam was welded together.

Where there was much new stock to build up, it was necessary for the boilermaker to chip off the scale of each "layer" as it was applied by the welder. The loose rivets were also welded to the plate without being removed, it being necessary only to chip all around the heads.

For electric power the welder used our regular 110-volt direct current with about 50 amperes. The voltage was cut down to about 20 through a water rheostat. One side of the line was grounded at the switchboard so that the boiler proper formed the other side. On an average job it took the welder between 12 and 14 hours to weld six feet of girth seam.

After this boiler was finished and satisfactorily passed the scrutinizing inspector of the insurance company, we waited a couple of weeks for developments. As the job, however, appeared to hold well and to be as good as guaranteed, we decided to have the remaining four boilers welded.

It is now more than four months since the first boiler was welded, and all five look as good and are as tight as the day they were finished. We feel pretty certain that the welding will hold for the three years and longer.

In the opinion of the writer the success of this job over the oxyacetylene is due to two facts. One is that with oxyacetylene welding the metal is heated over a large area and consequently there are strains when the metal is cooling. In the electric welding the heat is localized with little or no attendant strains due to cooling of the material.

The success of this welding is due also, I believe, to the man doing the work. He must know how to do a first-class job and must use good judgment both as to the amount of stock to be chipped away before he starts welding and as to the thickness of stock applied on each "layer" as he is building upon the old plate.

Maintenance of Electric Elevators

By CHARLES W. NAYLOR
Chief Engineer, Marshall Field & Co., Chicago, Member A. S. M. E.

Cable and brake troubles, iron vs. steel ropes, governor cables, the need of lubrication and kilowatt-hour consumption per car-mile of electric elevators are discussed.

CABLES, as the wire lifting ropes of elevators are called, are the source of one of the two chief elevator troubles. The substitution of steel for iron ropes, which has come about during the last twenty years, has added greatly to the worries of maintenance engineers, for the change has not brought with it all that might be wished for. The more recent machines, with their higher speeds and greater loads, naturally led to the use of new materials without necessarily adding to their reliability. The increased cost of renewals accompanying the use of steel cables is almost enough to condemn them. If the operator would be satisfied to put up with the troublesome stretch of iron ropes, he would be tempted to use them exclusively, but excessive stretching or lengthening of the cables has to be equalized by frequent and tedious readjustments of the limit stops and the compensating devices, particularly where there is only a small overtravel space at the top and bottom of the hatchway. When it is considered that these adjustments must be made for both the car and the counterweights as well as for compensating weights or chains, the engineer will often ask himself, Does it pay?

The harder and stiffer a rope, provided it is flexible enough to suit the carrying sheaves or drums, the more rapidly it crystallizes and breaks. A good quality of iron rope and perhaps a soft-steel cable, may run four or five years on a traction machine, while a hard-steel cable will need replacing in two years or less on account of its greater brittleness. This defect is intensified by the manufacturer making the ropes too hard on the pretense that great strength is needed. This applies equally to all makes of rope.

In spite of the utmost precaution no manufacturer is certain that two batches of rope of the same catalog grade will act alike in service. At any rate the engineer using them knows it by the cost to his employer for renewals. Breakage is liable to occur at any point of the cable running over the drums.

There is another break, which occurs at the shackles on top of the car. It is caused by the flection produced by the cables swinging from side to side. The severe changing torsion set up at this point, because of the tendency of the cable to unwind and rewind on itself due to the set given it when built in the factory, also contributes to the stress at this point. The set in the cable is disturbed by the frequent and great changes in load that accompany the starting and stopping of the car. The strain runs from zero to several thousand pounds and may take place a number of times in each minute that the machine is in operation. The ball-bearing swivel shackle is intended to obviate this trouble, and is successful to a considerable degree.

If a cable runs many years, as was common in the use of elevators years ago, the inner strand will frequently crumble and be broken in small pieces, the cause being largely a lack of interior lubrication in the cable itself. If cables are in use less than three years under average operating conditions, and run in a warm, dry place over generously proportioned drums having a diameter of 60 to 1 for the rope, the lubricant put in the cables by the manufacturer will be sufficient to prevent this cracking. If the life of the cables exceeds this period, and particularly when the cables travel over small sheaves, if the former is of hard material and is used in a cold and damp place, frequent lubrication is necessary. A good penetrating oil or liquid grease is best for this purpose.

Governor ropes or cables are made of vegetable fiber-like hemp or cotton and of steel or iron. They are naturally more flexible than the lifting ropes, but have troubles similar to the larger cables although to a lesser degree. They require internal lubrication only when run in damp places and when in use for unusually long periods. A record kept on manila governor ropes for 15 elevators shows a wearing-out or breaking period varying between 14 and 56 months, with an average life of 37 months.

The second cause of serious trouble in an electric elevator is the brake—and these two troubles, cable and brake, are of more moment than all others combined.

An elevator brake, in many installations, is applied many thousand times every day and must bring a high-speed 40- to 50-hp. motor and a fast-moving elevator car weighing 6000 to 8000 lb. to rest and hold it each time the car is stopped. Of course it is helped to some extent by the dynamic-braking action of the motor, but the real stopping is done by the brake itself. Since the brake has to act so frequently and positively, it must act through a small space, which minimizes the opportunities for adjustments. In fact, it is an extremely difficult task to adjust a brake so that it will work equally well on up and down travel, and particularly with temperature changes that come with frequent use. Brake bands and their lining and the brake wheels or drums, become hot on severe service, rising 75 or 100 deg. F. above the temperature of the surrounding atmosphere.

The lining of the brake band, on which the brunt of the work falls, gives the most trouble. No really good substitute for the usual leather lining has been found, although a number of asbestos and fibrous compounds have been given trials. The old-style wooden blocks with the grain end on did not prove satisfactory.

A brake must set itself smoothly, not too suddenly, and with certainty. Brake slippage, if not too serious, may be anticipated by the skilled operator, except at the top and bottom landing, where there is small pit space. A car must come to the top and bottom landings at normal speed, as otherwise the automatic limit stops interfere with the car reaching the floor.

A good brake lining in easy service may last for years, but in heavy work only a few months. The leathers must be solid and clear of hard spots. Built-up leather in which glue or cement is used, will not last long enough to justify giving it a trial.

CALCULATING THE ENERGY CONSUMPTION

The energy consumption in kilowatt-hours per mile of car travel is best obtained by taking the total readings over a period of not less than eight hours. An ordinary recording watt-hour meter and a revolution counter attached to the main drum or sheave will answer the purpose nicely. The counter must not be attached to the drum periphery, because the speed, often 400 to 500 ft. per min. is too great. A good place to connect on the counter is at the small chain operating the signal lights, if this latter device is used.

There is a movement of the car at the end of its travel that is too small to register a full unit on the counter, but this is absorbed in the total travel when the test is extended over several hours. It is seldom that the recorded revolutions of the counter match evenly with the cable travel, so that a constant must be found and used in multiplying the revolutions to give a correct product in feet or miles.

As explained in a previous article ("Operating Costs of Electric Elevators," Feb. 5 issue) the plant in question contains 91 elevators, 77 being used for passenger service and 14 for freight. Fifty of the passenger cars are of the worm-gear overhead drum type. The others are traction elevators, a few being of the basement type.

The drum machines run 11 to 15 miles per day and the traction elevators, 16 to 20 miles each. The energy consumption of the drum-type elevators is 3.5 to 5.5 kw.-hr. per mile of car travel. No two cars out of the 50 under discussion use exactly the same amount of current, except by accident, and any one car will register differently from one day to another, but the average for any ten cars taken at random, is 4.55 kw.-hr. per car-mile. For the traction machines it is 4.25 kw.-hr. per car-mile. The car speed per minute is greater in the case of the traction machines, but the cars are smaller and lighter. The drum-machine motors are rated at 42 hp. and run at 700 and 850 r.p.m., while the traction-machine motors are 35 hp. at 60 to 65 revolutions.

In a working plant it is not convenient to get the comparative records for up and down travel, and when varying loads in both directions are taken into consideration, there is no good reason for assuming any difference. In the plant under discussion about 40 cars are operated on the basis of 20 for up passengers only and 20 for down travel. These cars run empty in the opposite direction, yet careful and numerous readings fail to show any material difference in the results that are obtained.

Five basement traction machines showing 9.4 miles each per day, average 6.3 kw.-hr. per car-mile. Eight overhead one-to-one traction elevators with 16 landings, running express to the seventh floor, show 17.5 miles each per day and an average of 4.6 kw.-hr. per car-mile. Two overhead drum-type machines with light cars, stopping only at the first, seventh, eighth and ninth floors, travel 16 miles per day on a current consumption of 3.6 kw.-hr. per mile. Forty or more overhead drum-type machines averaging 14.5 miles per day, use 5.1 kw.-hr. per car-mile. The accuracy of all tests on individual machines has been demonstrated by comparing results obtained on two watt-hour meters and further checked by testing the machines in groups of five on a large watt-hour meter.

Carelessness Wrecks Gasoline Plant

Carelessness on the part of a helper in the engine room of the Moon gasoline plant, near Tulsa, Okla., wrecked the building, as shown in the illustration. The explosion was due to two causes. First, one of the compressors exploded, filling the plant with gas; then an inexperienced engineer's helper took it upon himself to stop the engine, and in doing so he made the mistake of pulling a spark-plug connection, which ignited the gas and caused an explosion. Eight men were seriously injured. As shown in illustration, the roof, which was made of corrugated iron, and the sides of the building were partly blown off.

BUILDING WRECKED BY GAS EXPLOSION

SMALL WEIGHTS ON BIG SCALES

BY
M. D. Church

It is occasionally desired to weigh small articles accurately when the only means available is a platform scale designed for weighing hundreds of pounds. By a method outlined herewith, small articles may be weighed on platform scales within 1/100 lb. and often within 1/400 lb. of accuracy.

On most platform scales the 100-lb. weight actually weighs one pound. That is, one pound on the weight pan will balance 100 lb. on the platform. Other scales have ratios of 200: 1 or 50: 1. In any case the ratio can usually be found easily by reading the marks on one of the weights or weighing one or more of them.

Let us assume we have a platform scale capable of weighing up to 600 lb. by half-pounds and that it has a ratio of 100: 1. If it is desired to weigh a small article accurately, place it on the weight pan and run the sliding weight back to zero. Then put sufficient weight of any kind on the platform to raise the beam. Your own weight is usually most convenient. Balance the scales with the sliding weight, and note the reading. Suppose this to be 115½ lb., for example; then remove the article being weighed, say it is a spring, and again balance the scales by sliding the weight on the beam or adding scale weights to the weight pan. Note the reading again, say 153 lb. The weight of the article is (153 — 115½) ÷ 100 = 0.375 lb.

This method can be extended to cover many uses, as for any weight from as small as will tip the beam up to a weight as great as the range of the scale divided by the ratio.

One particular use of this method is for the determination of specific gravity. If we have a specimen of metal, rock or other insoluble substance that will not float, the following method may be used: With a light cord hang the specimen a foot or so below the weight pan and take its weight. Then hold a pail of water so that the specimen is submerged and weigh again. Using the rule, specific gravity equals weight in air divided by loss of weight in water, if a piece of metal weighs 1.43 lb. in the air and 1.225 lb. in water, the specific gravity is 1.43 ÷ (1.43 — 1.225) = 6.97+.

In the case of liquids hang an empty bottle on the scale pan by a cord and balance the scales. Then fill the bottle to a given point with water and find the weight of the water by the method already given. Then fill the bottle to exactly the same point with the liquid to be tested and get the weight of that. The specific gravity of the liquid will be equal to the weight of liquid divided by the weight of water. That is, if the water weighed 2.147 lb. and the weight of an equal volume of a certain kind of oil was 2.042 lb., the specific gravity of the oil would be 2.042 ÷ 2.147 = 0.952.

The idea of using the ratio of the scales applies also to utilizing the scales for counting when the amount of counting to be done does not warrant a special scale. Suppose we have a thousand or so nuts to be counted. Place a box on the scale platform and balance the scales by the sliding weight. Then put the nuts into the box. Again balance the scales by piling nuts on the weight pan. If the ratio of the scales is 100: 1, there will be as many hundreds of nuts in the box as there are nuts on the pan. If accuracy is desired, the final balancing may be done by taking a few nuts out of the box and counting the odd nuts and those on the pan by hand.

When there is much counting to be done, it will be found handy to make a special pan out of a small pie tin and a piece of rod to take the place of the regular pan. It should be made to weigh exactly the same as the regular pan and will hold many more small parts. Such an arrangement will be found handy in any storeroom and will usually pave the way for a regular counting scale.

Industrial Plant Furnishes Street Railway Power

It is often possible for an industrial power plant to find some use for its excess power which will extend the period of the peak load without increasing its magnitude and at the same time materially benefit the new power user. An interesting example of this is the supply of direct current by the Westinghouse Electric and Manufacturing Co. to the Pittsburgh Railways Co. for the operation of its cars in and about East Pittsburgh, Penn. Owing to the tremendous increase in the number of employees at the Westinghouse plant, the present overhead equipment of the street railway was overtaxed for about two hours morning and evening.

To take care of this condition, connections were made between the railway-feeder system and the Westinghouse company's rotary converters in its power house. Since this arrangement has been in operation there has always been plenty of power to move cars at any time and the day's demand upon the industrial power plant has not increased, although its duration has been somewhat lengthened.

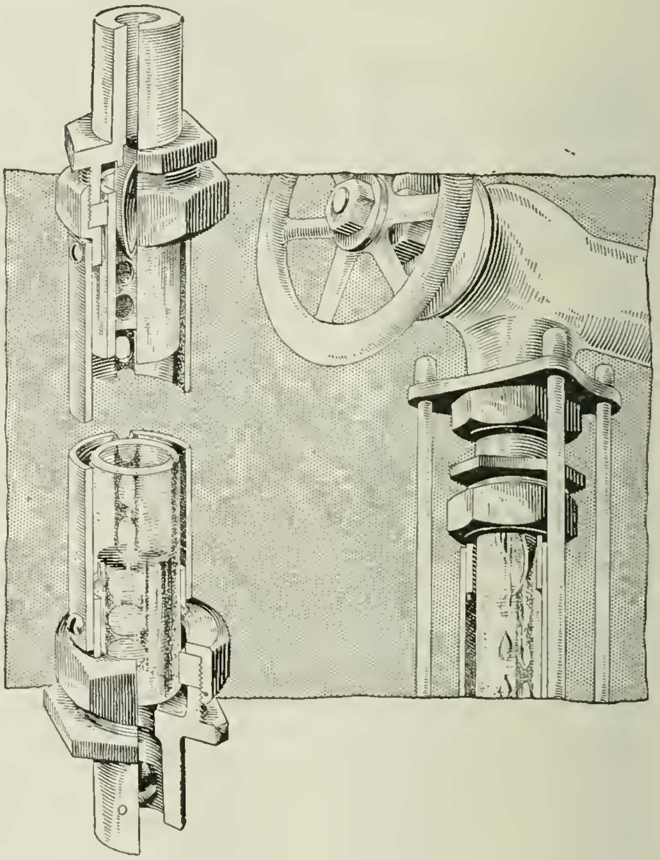
There is no doubt that many industrial companies similarly located with respect to transit lines extending out a considerable distance beyond the railway's last substation could use such a method with great advantage. While the revenue from the sale of power is of course desirable, the principal benefit will be found to be in getting employees to and from work on time, in which an ample supply of power is an important factor.

Ernst Safety Gage-Glass

One of the annoyances of the boiler room is the breaking of water-gage glasses. This is due to several reasons, such as the connections being out of alignment, erosion of the glasses at the upper end, due to the action of steam, cold drafts striking the glass, accidental breakage, etc.

These causes of breakage seem to have been overcome in the Ernst safety-gage glass, manufactured by Ernst & Co., Newark, N. J. The water glass is fitted into a centralizing member composed of an upper and a lower holder, each fitted with a packing nut. To a projection of each a removable metal half frame is secured, which holds the whole rigid. The back of the frame is drilled with ¼-in. holes and three lines of red are painted on the inside of the strip, which causes the water to show red when it is viewed from any direction.

In the upper connection there is a hollow pen-shaped member through which all condensation trickles without touching the glass, which is held tight in the upper and lower members by rubber washers and packing nuts in the regular manner.



DETAIL OF THE ERNST SAFETY GAGE-GLASS

The top and bottom nipples of the centralizing device fit into the regular water-glass connection, the same as the ordinary water glass, but any ordinary packing can be used to keep them steam- and water-tight.

The bottom member of the centralizing device is fitted with a check ball which operates only when the glass breaks, in which case the ball is forced up against its seat, thus preventing the escape of water. As the ball operates in a vertical chamber, which, although containing a ball, has an area equal to that of the opening in the top member, it cannot remain in a closed position. Any glass will fit into the protecting frame, and the complete member takes the place of the ordinary water glass.

A country worth fighting for is a country worth saving for. Buy Thrift Stamps.

Editorials

The Miracle of the Mass

NORMALLY the mass of the people follow a few leaders. History is the record, page after page, of the doings of the nations under the guidance of a few men. But now and then in the record you come to a story—and it is always a thriller—in which the mass of the people yank their leaders from the head of the procession and move whenever and wherever their whims or their wisdom dictates. Such a page is being written now in the logbook of the world.

Mass movements are the miracles of the day. They are the big surprise. When the war began, our minds ran riot with the expectancy of inventions—of miracles of matter. We awaited the daring developments of wizardry—things wireless, things uncanny.

There have been miracles of matter, of course. In time of peace we would have acclaimed them as marvelous. But we give them a glance and turn with serious interest to the miracles of mass movement. If a chemist came forth now and turned gold into lead, our eyes would still be riveted to the Russian drama where diamonds have become dust, and dust is becoming—what? We look at Germany and Austria. Will the miracles of the mass overcome their own miracles of matter and make ours unnecessary? In England, they tell us, an orderly miracle of the mass is taking place—and in France.

Who doesn't sense the upgathering sweep of it at home? And if your feeling is one akin to fear, is there or isn't there, mingled with it and dominating it, a sense of relief because many of the hampering grips of the old order are passing into history?

It will be an interesting story when it is written by a future Carlyle; and those of us living in the life of it will understand it better when we read it than we do now. Old phrases will come back to us. "Cost Plus" will be one of them. We shall wonder then, not at the miracle of the mass, but at the stark madness of men—we had thought them big men—who played poker openly at a holy moment. The tragedy of it is that the poker players are a minority of what we have come to call our classes—distinctions by professions.

But the mass indignation does not discriminate. By its very nature it cannot discriminate. It is too overwhelming. It is a thing of the heart, not of the head.

The miracle of the mass can wreck us or save us. In all groups there are good and bad, in the moral sense. There are good lawyers and bad lawyers, good employers and bad employers, good engineers and bad engineers, good laborers and bad laborers. If the old classification by professions does not disappear—and that quickly—the outlook is ominous. If the employers stick together *as a class*, the lawyers *as a class*, the industrial workers *as a class*, regardless of the good and evil among them, Heaven help us. But if the upsweeping protest against the poker players of all classes destroys the class distinctions and aligns the good against the bad, then we are saved.

The hope of salvation grows day by day. Our fight against a ruthless autocracy to whom people are pawns has stirred our deepest age-old moral instincts. The sons of most of us are in that fight. Their lives cannot be gambled with by the poker players of any class, and this feeling is permeating the good men of all classes.

What the miracle of the mass will mean to us in this country lies in a large measure in the hands of the good employers. Are they courageous enough to meet their clear duty, to cut loose from an artificial class grouping, and align themselves, *by their acts*, with the good in the new moral grouping?

What will the future Carlyle say of them?

The Boston Turbine Accident

NATURALLY, much interest is centered in the accident to the thirty-five thousand kilowatt horizontal twenty-stage, impulse turbine in the O Street Station of the Boston Elevated Railway Co. The machine was of a type that represents the most advanced in design of single-cylinder turbines of large capacity. With condenser and air pump it represented an investment of about $335,000.

The details of the wreck are told on page 390 of this issue, so there is no need of reiteration here. It seems certain that deflection of the cast-iron diaphragm in the eighteenth stage causing the diaphragm to rub the wheel and release the buckets was the immediate cause of the accident, just as similar deflection of a cast-iron diaphragm in the same stage of this turbine once before stripped the buckets from the wheel.

Considering that the whole low-pressure end, rotor and casing, went to pieces, it is miraculously fortunate that no one was killed or injured.

As pointed out in the article, the question arises as to whether it is advisable to extend the use of steel to the large diaphrams in the lowest stages of these high-capacity machines. The question is one which cannot be finally answered offhand at this time. If in these very large diaphragms it is found that the cast iron is subject to frequent deflection; that the bond between the buckets and the disk and ring of the diaphragm soon weaken; or if these relatively thin disks are likely through any cause foreseen to be subjected to the stresses set up by centrifugal force imposed by accidentally revolving with the shaft—then steel seems advisable unless some means of avoiding these possible troubles with cast iron are found, and this seems possible. It should here be pointed out that the Boston accident is the only case we know of where a diaphragm let down on the shaft.

This Boston accident gives an impressive example to all operating engineers of the value of accurate, decisive and quick judgment while on duty and responsible for turbines in their charge. With wheel speeds up to nearly one thousand feet per second, as in these large machines, the operator must be quick enough either in adjusting the thrust bearing or tripping the machine out of service to avoid longer than momentary rubbing of buckets and diaphragms at this speed. There must be no continued rubbing. That is a vital maxim. The operator must develop with the turbine. The builder and the employer must see to it that he so thoroughly understands how the machines under his care are put together that he can in effect look through the casing and see every detail, gage every clearance and anticipate the effect of this and that happening upon the safety and economy of the machine. The operator has the right to demand that every reasonable facility be available to him to know his machine. For this reason the policy of any builder to make it difficult to get drawings or photographs that would assist the operator in better knowing his machine is a policy that has no place in modern power-plant engineering, regardless of commercial considerations. All builders maintain corps of men for the very purpose of providing such information to operators. But that is not enough; the operator must get it and use it.

The accident at Boston is simply an unfortunate one in the development of the art. Because the turbine is the first of the particular type that it represents does not mean that there is anything fundamentally wrong in its design. We believe the design is safe. It is the opinion of all users of large-capacity machines whom we know personally that this design is safe. There are millions of kilowatts of such types of machines on order for large plants the country over. The accident at Boston is, perhaps, the most momentous in turbine history, and likely it will in time have done more good for turbine development than any other factor one can name.

What Is the Capacity of a Turbine?

IF YOU order a ten-, a twenty-, or a fifty-thousand kilowatt turbine and if, when installed, it carries a water-box load of just the capacity specified, but will not carry a thousand- or two-thousand kilowatt load swing above that amount without speed reduction and decrease in cycles—if these are the conditions, have you got a ten-, a twenty- or a fifty-thousand kilowatt machine? If the load was such as to swing one or two thousand kilowatts above ten, or twenty or fifty thousand, would you report the load to the public-service commission, if a public utility, as the average or as the peak maximum?

Of course these points have been quite thoroughly thrashed out, but all engineers do not agree. The disputes about machine capacity led to "max. rating," as engineers like to call it. That is, the greatest load a machine will carry with specified speed is the capacity of that machine. Technically, that seems reasonable. But the early conservatism of builders in rating their machines got engineers into the habit of expecting more than rating from them.

We thought that this question of rating had been settled, but there are still some wrinkles in it that have not been ironed out to the satisfaction of some folks. In fact, it is probable that recent events will open up the whole question anew, notwithstanding the set opinions of authoritative persons. Obviously, three factors influence the capacity of the machine; namely the pressure at the throttle, or better, the pressure at the first stage, the superheat and the vacuum. In disputes about the capacity of any particular turbine at some particular time—as, for example, on load swings—one naturally inquires what the steam and vacuum conditions were at the time. Were these below what the turbine required in order to develop the necessary capacity? If so, the cause is not in the turbine and the purchaser is at fault. If these conditions were normal, that is, as specified in the guarantee, and the swings, whatever they may be, five, six or seven per cent. of the turbine rating could not be carried, then is anyone at fault? Who is going to say where the limit is in this ability of a turbine to carry swings above the rated capacity? Who will say that the turbine should not be expected to carry any swing above its rated load? What is the consensus of opinion? One requisite is clear as concerns the purchaser—he should have a record of load, steam pressure at the throttle, superheat and vacuum as his evidence in event of dispute. Frank expressions now would clear the air, and *Power* welcomes such expressions.

Ash-Handling Apparatus

IN OUR issue of February 5 appeared an article by Herbert E. Birch entitled "Buying an Ash-Handling System." The editor who handled it did not know that the author was the consulting engineer of a manufacturer of conveyors of the bucket or skip type, and even if he had would not have considered that fact a disqualification. It is to specialists of this kind that we must turn for the latest and best information upon their respective subjects. We do not intentionally pay such authors for briefs of their cases in favor of their own apparatus nor permit them to go outside of engineering grounds in criticizing the apparatus of their competitors.

Letters from several manufacturers of apparatus of other types and their representatives express surprise that *Power* should have printed an article which attacks so viciously their type of apparatus. The "attack" was so well camouflaged as not to have been apparent to a disinterested editor, and its viciousness appears to be more evident to the minds of the victims of the supposed attack than to the less-interested reader.

The article stands simply for what it is, a presentment, by a man who is identified in a consulting capacity with one type of ash-conveying machinery, of some of the points to be considered in selecting an installation. It bears nobody's indorsement and is open to criticism, denial, refutation and reversal if anybody has a case against it and the will to state it. We have no interest or predilection in the matter and invite the fullest and freest discussion upon any statement which the author has made or any suggestion which he has advanced, not only from makers of the apparatus criticized, but from all our readers, especially those who have had experience with ash-handling apparatus of any kind.

Incidentally, we have an apparatus of one of the types criticized in our own plant.

Correspondence

The Conservation of Fuel

There have been some mighty good articles on fuel conservation published in various papers, but it seems to me that the good advice, in general, is directed at the operating engineers and boiler-room attendants. Without a doubt there could be enormous savings effected in some plants, but on the whole the best the operator can do is to operate the plant of which he has charge at the highest degree of economy possible under the given conditions. As a rule, the highest degree of economy cannot be brought about by the operator alone; some good sound judgment has to be exercised by the purchasing department as well. For instance, there are plants where at least 40 per cent. of the fuel burned goes for live-steam heating, yet such plants are operated condensing, with motor-driven auxiliaries and not enough steam-driven noncondensing units to even bring the temperature of the feed water up to 212 deg., to say nothing of heating buildings.

If the Government wishes to conserve the coal supply, it should request all municipalities and private corporations that contemplate building power plants or making changes, to submit full plans of the work and detailed information regarding it, to their engineering department for inspection. This would do away with the jumping-at-conclusions method and make the purchasing man sit up and take notice. **Louis P. Allen.**

Johnson City, N. Y.

A Talk to Firemen on Saving Coal

In the Jan. 22 issue of *Power*, there appeared an article on the conservation of coal which I am sure appeals to all who have any intimate contact with this, at present, scarce and costly commodity. That firing is an art learned only through experience is a fact that no engineer will deny; yet how small is the percentage of men who use their brains with their efforts when shoveling coal into furnaces.

Supervision of the coal pile by chief engineers is something which the average fireman resents, and often leads to the frequent changes that are made in the fireroom.

Mr. Bromley states that employers need educating as well as employees. While this is true, it does not get at the real seat of the trouble. To analyze the situation it is necessary to go back to the inception of the plant, to the point where it was planned. In many cases I think it will be found that the boiler plant, as well as all other machinery, was laid out largely according to the views of an architect. Boilers, boiler settings, grates, etc., agreeing to some arbitrary standard were installed with little regard to conditions as they would apply after completion. The result is that after the engineering staff has been placed in charge it must make the best of it.

The hints given for the handling of the different kinds of fires I think are good. They are practical. From experience I have found that the dumping grate is far more desirable than either the stationary or shaking grate. It seems, too, that the hand-fired stokers now being offered have a good field.

As regards the excessive ash content of the hard coals now available, most any engineer will agree that Mr. Bromley's statement is correct. Under these conditions, then, conserving the coal supply is extremely difficult, and when one considers that the cost of coal is about 70 per cent. higher this winter and that more of it has to be burned to get the required results, it is almost beyond human effort to economize in any plant where care is always used to see that only the required amount of coal is used to economically carry the load.

I should like to see a discussion in *Power* as to the probable savings to be gained by changing grates and ashpit levels under boilers built 20 years ago where the heating surface is approximately 30 in. above the grate, to the heights of 60 or 72 in. as advocated in Mr. Bromley's article. It seems that the time is ripe for a discussion on the relative merits of what is gained by keeping the water in the boiler at a certain level under all conditions of load, also if it is preferable to return the water of condensation to a storage tank or to pipe it to a governor through which it will be pumped to the boiler after passing through a heater and meter. **H. H. Burley.**

Brooklyn, N. Y.

Climbing a Smoke-Stack

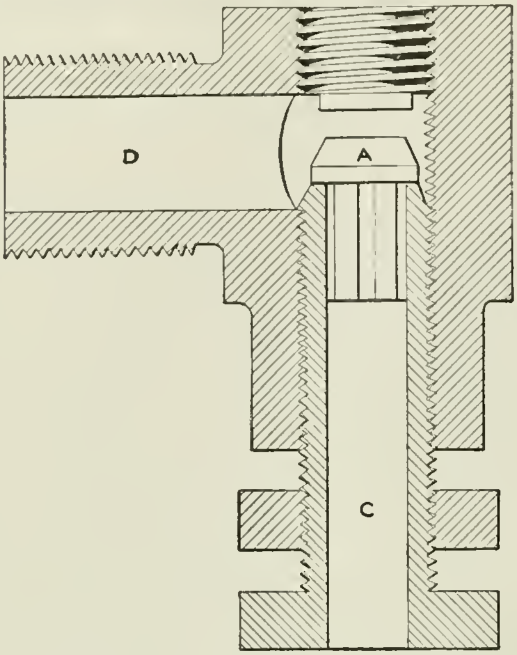
In connection with the letter by D. R. Hibbs in the issue of Jan. 1, page 24, regarding climbing smokestacks not fitted with ladders, the following may be of interest. A stack painter of my acquaintance uses three slings made of three-quarter inch rope with one end made into an eye; two of the slings have stirrups at the other end and the third has a long loose end. When climbing a stack, the slings are passed around the stack with the rope drawn through the eye, the feet being placed one in each stirrup, and the free end of the third sling drawn around the painter's waist and one end of a light hand line made fast to the waist line convenient to the painter's hand. In climbing the stack, the waistline sling is placed around the stack above the stirrup lines and is raised by drawing it back and forth around the stack; the others are then raised the same way, one at a time.

When the painter reaches the top of the stack, he hauls up the paint bucket and brush with the hand line, hangs it on the waist line with a hook and paints the stack above the slings. Moving the slings around and down the stack, he paints the whole stack as he goes down. This man once painted a stack seven feet in diameter and one hundred feet high in eight hours from the time he started to climb up.

Ringwood Manor, N. J. **A. A. Blanchard.**

Improved Snifting Valve

Snifting valves are a rather despised and neglected pump accessory, but their utility is above question. Even slow-running boiler-feed pumps with a long stroke and a perceptible pause at each stroke have such valves fitted, although they are less necessary than on high-speed pumps, and there are many such, which must employ means to cushion the blow. They are usually fitted between the suction and delivery valves to admit air on the suction stroke, cushioning the blow of the plunger and seating the valves without shock; and there is a difference in running with and without them, especially under variable speed.



AUTOMATIC AIR INLET FOR PUMP SUCTION

In the pulsometer type of pump the snifting valves are of more than ordinary importance, and unless they are correctly adjusted, the efficiency of the pump (never very great) is much impaired. The air has a special function in this type of pump in that it acts as a nonconducting layer between the steam and the water. Air being a bad heat conductor, heavier than steam and lighter than water, admirably fills the necessary conditions. The quantity of water delivered is seriously affected by imperfect adjustment of the snifting valves.

The usual fitting is in most cases leaky, the seat and valve get battered so that at each delivery stroke it leaks water, to the annoyance of the engineer, for the type of fitting usually employed is of a cheap character of soft brass, wears rapidly and is tolerated as a sort of necessary evil. Its function is to admit air and close against the escape of water, and while it does the former whatever condition it may be in, it often fails to perform the latter office. Retruing the seat is difficult, the fitting being of small size, while the screw adjustment for lift becomes slack after short service.

The improved valve illustrated was designed by a marine engineer now in charge of a shop making high-grade pumps, and it has had several years' trial with entire satisfaction. The chief feature of the design is a means of adjustment which controls the valve lift. The body of the valve consists of a hard-brass casting *D* fitted with an adjustable valve seat *C* held in the desired position by the locknut shown and a valve *A* made of hard bronze.

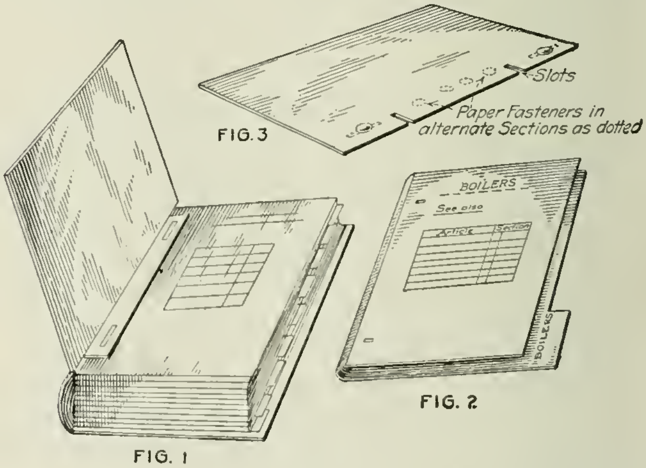
It will be seen that the machining is easy as one hole is drilled through the body and tapped out and the other, at right angles, breaks into the first. The adjustment for valve lift is by means of the portion of *C*, which may be screwed up so valve *A* is close to the stop or as far down as desired. Retruing the valve seat is done in a few minutes wherever that becomes necessary by the withdrawal of *C*. There is nothing to go wrong; it is a rational design for which credit is due to its originator, for although an inversion of ordinary practice, it needs only to be seen to be appreciated.

A. L. **Haas.**

London, England.

Binder for Detached Pages

Readers of *Power* may be interested in the following description of a binder for keeping articles from periodicals in a handy form for reference. A standard *Power* binder is used with manila folders cut and folded as shown (Fig. 2) for each section subject and held in place by the binder strips. Pages from periodicals are clipped together for each section with standard paper fasteners, the edges trimmed and slots cut in the inner edge to pass the binder strips. These are then inserted in their respective folders and the whole binding tightened up in the usual way. The paper fasteners securing the articles in each section should be "staggered," in order to even up the thickness of the binding. To insert new articles, any section can be readily removed from its folder without disturbing those on either side.



FIGS. 1 TO 3. LOOSE-LEAF BINDER FOR MAGAZINE PAGES
Fig. 1—The units all assembled. Fig. 2—One of the manila folders. Fig. 3—Pages clipped together ready to file.

When there are articles relating to different subjects, overlapping or on the same page, the pages are filed under one section or title and reference is made to the other article on the front of its particular section folder in a ruled space for that purpose. I have found it most convenient to have about fourteen section folders in each binder with the marginal title tabs 1¾ in. long in two courses making seven in the length of the folder.

Typical section titles are "Boiler Construction," "Scale and Corrosion," "Boiler Setting," etc., and the number of pages in any section, extending over a period of five years, varies between ten and forty, so that it is easy to refer to the particular information required; and as long as there is room, any article that has any item of interest is inserted and the items marked. Such an adjustable post binder, of a size to take standard pages, and fitted with manila folders ruled and cut for marginal title tabs and having suitable detachable clips for holding the articles in each section and securing them to the binder, would, in my opinion, be of great value to engineers who wish to keep only one or two articles out of any periodical. Couldn't someone get out a binder designed along these lines?

Montreal, Que., Canada. F. A. COMBE.

Helping Out a Worn Compressor

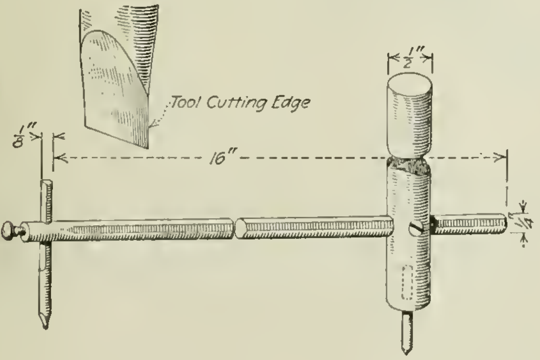
On taking charge of this plant I found the compressor supplying air to the Diesel engines so badly worn both in the valves and piston-packing rings that it was impossible to keep up the required pressure of 75 atmospheres. It was also impossible to get repairs within a reasonable time, therefore it was necessary to do something to overcome the trouble temporarily. The compressor seemed to be blowing back almost half of the air that was drawn in at the suction stroke so I connected a swing-check valve on the air intake and it worked "beautifully"; in a few minutes the air pressure increased from 45 to 80 atmospheres. That gives us a surplus, and we get rid of it by turning the check valve part way over so that it stays open late, allowing some air to escape.

The compressors are of an old two-stage, single-acting type and it is not likely that there are many of this type in service, but the idea may help someone get by while it is so hard to get repairs promptly.

Austin, Texas. F. C. WILLIAMS.

Cutter for Round Gaskets

The illustration shows a simple and easily made device for cutting round gaskets rapidly and accurately of any size within its capacity, from sheet packing. The saving in time is most pronounced when a number of gaskets of the same size are wanted, and it is only necessary to set the cutter once for the diameter desired. It is constructed along the same lines as a beam compass. The main bar, or beam, made from ¼-in. cold-rolled steel rod, is ground flat on one side on an emery wheel to give a good bearing for the setscrew.



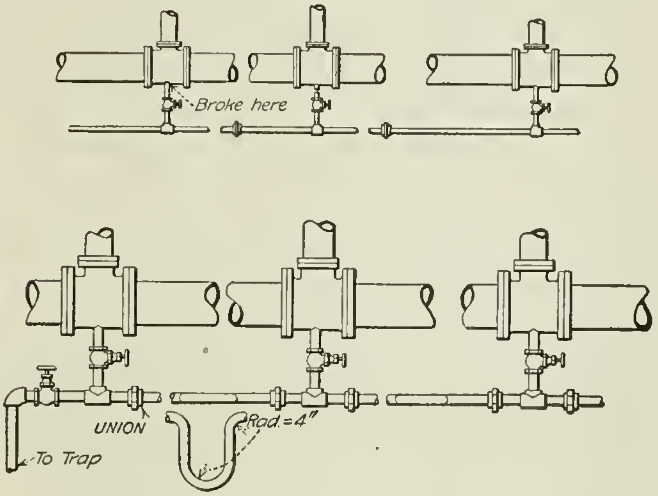
ADJUSTABLE CUTTER FOR GASKETS AND WASHERS

The center point in the handle is made from a broken twist drill of small diameter ground to a needle point. For the cutter use is made of another broken drill about ⅛ in. diameter flattened slightly on an emery wheel, as in the case of the main bar, to give the binding screw a good grip. The cutting end is ground V-shaped and sharp and given a fine edge on an oilstone.

Readville, Mass. H. M. NICHOLS.

How Not To Connect Drain Pipes

The drain line of a header was attached rigidly, as shown in the upper part of the illustration, and there was no chance for expansion, so it broke one of the nipples off one day and shut the plant down, proving that it was not designed rightly. I had some bends made and put in, after which there were no more leaks as there was plenty of chance for expansion; besides, whenever it was necessary to put a new gasket in any part of the header, the flanges could be spread without disconnecting the drain line.



OLD AND NEW HEADER DRAIN LINE

Northport, Wash. N. C. GLEASON.

Taper for Flash Test of Oil

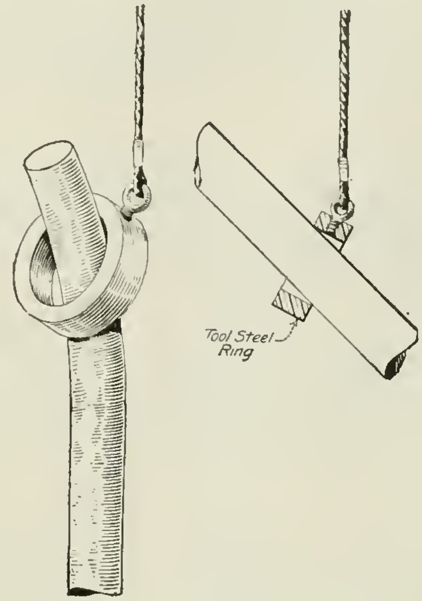
In applying the open-cup oil test for determining the flash and burning points of lubricating oils, a "lighted taper" is passed over the cup about a quarter of an inch above the surface of the oil, but a lighted string or broom straw, as usually suggested, is unsatisfactory to manipulate because embers may drop into the oil and spoil the accuracy of the determination of the flash point at least.

I have found that an old bunsen burner or chemical blowpipe connected to the gas supply with rubber tubing will give a fine gas jet which can be easily regulated to obtain the desired test flame. The blowpipe should be held so that the flame is in a horizontal plane. A cruder but effective "taper" can be made by inserting into the end of the gas tubing a piece of small tubular porcelain such as is used to support crucibles above bunsen burners. WILLIAM J. DANA.

Baltimore, Md.

Ring for Hoisting Wire

The steel ring shown is a time saver and gives a perfect grip when hoisting wires up to elevated lines inside or outdoors, where the common knot frequently slips. This ring can be used to raise any wire that is stiff enough not to be bent by the strain of the ring; the heavier the wire the more positive the grip. The ring is made of tool steel, with sharp edges and hardened.



HOISTING RING FOR CABLES

Ozone Park, L. I. M. P. **Bertrande.**

Valve Opening Against Pressure

The damage and delay that can be caused by incompetent men handling machinery was demonstrated the other day in a plant where several elevator pumps take their suction supply at 80 lb. pressure from an elevated tank.

A helper, when ordered to start one of these pumps, found that the globe valve on the suction line was hard to open (on account of the pressure), but proceeded to apply force to it until the stem was broken, instead of first equalizing the pressure on the two sides by means of the bypass as he should have done. The pump was out of service for several days, and considerable expense was occasioned by this lack of knowledge on the part of the operator. W. T. **Osborn.**

Newark, N. J.

Resistivity of Copper

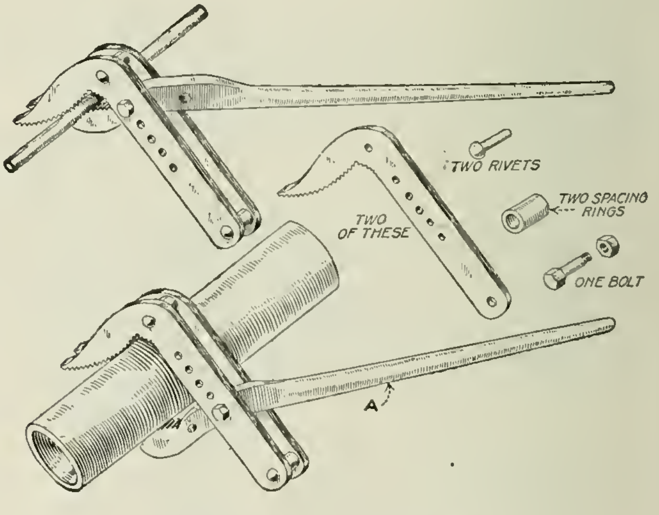
Certain formulas that are used for figuring the size of wire to transmit a certain current a given distance with a specified voltage drop read: Circ.mils $= 10.6 \times 2 \times D \times I \div E_d$. Others read: Circ.mils $= 11 \times 2 \times D \times I \div E_d$, where D equals the length of the circuit one way in feet, I the current and E_d the volts drop in the circuit. Note that the formulas are the same except that the constant 10.6 is used in one and 11 in the other. Why these two different values are used may be explained thus: The values 10.6 and 11 respectively represent the resistance per circular-mil-foot of copper. The resistance of copper or any metal increases with its temperature and varies with the purity of the metal; hence a circular-mil-foot of copper will have a resistance of exactly 10.6 ohms only at some certain temperature and when the metal is of a certain degree of purity. For example, copper of 98 per cent. conductivity has, at 68 deg. F., a resistance of almost exactly 10.6 ohms per circular-mil-foot. At a temperature of 86 deg. F., copper of 98 per cent. conductivity has a resistance of 11 ohms per circular-mil-foot.

It is evident, then, that the value 10.6 may be entirely correct for a certain condition and the value 11 ohms also correct for another condition. However, in making wiring calculations there are so many indeterminate factors that affect the problem that it is a waste of time to endeavor to attain great accuracy. The value D (distance) in the foregoing formulas can ordinarily not be determined within 10 per cent. and the value I (amperes) is usually also an approximation. For these reasons it is believed that, on the whole, the result will be as accurate if the value 11 is used instead of 10.6. Furthermore, the value 11 is easier to remember and can be handled with less labor. T. H. **Nash.**

St. Louis, Mo.

Pipe Wrench for Many Sizes

Having the bar *A* originally belonging to a large pipe wrench "kicking around" the power house, I decided to utilize it and avoid the expense of buying a new one. The upper jaws are home-made. They are different from the regular ones and in my opinion are better for some work and have a larger capacity or adjustment for different pipe sizes. The holes are for adjusting for various sizes of pipes. The two parts of the jaw are held together by two rivets with two spacing rings to keep the jaws the right distance apart. The construction is easily understood. J. A. **Lucas.**



ADJUSTABLE PIPE WRENCH

Ozone Park, L. I.

When you save and buy War-Saving Stamps, you help to make the world safe for democracy and at the same time make your financial future safe for yourself.

Inquiries of General Interest

Limitation of Size of Safety Valves—Why are not spring-loaded safety valves made larger than 4½ in.?
M. F.

When safety valves are larger than 4½ in., unequal expansion of the parts from temperatures imparted by the steam is likely to cause leakage or derangement.

Dead-Weighted Safety Valve—What is a dead-weighted safety valve and what advantage has it over a weighted-lever safety valve?
E. W.

A dead-weighted safety valve is one that is held to its seat by the dead weight of the valve and generally an additional weight, consisting of a cast-iron ball mounted centrally on the valve spindle. The principal advantage of this form of valve over a lever safety valve is that it cannot be so easily overloaded.

Auxiliary Valve on Single Steam Pump—Why is it necessary to provide an auxiliary steam valve on a single-cylinder steam pump?
J. R. S.

Proper movement of the main valve cannot be derived from a positive connection to the piston rod, as the steam port would be closed gradually toward the end of the stroke, and although the stroke might be completed, there would be no movement of the valve appropriate for reversal of the stroke. Hence the necessity of an auxiliary valve to effect movement of the main valve.

Rotary Converter Hunting—What are the causes of a rotary converter hunting and how are they remedied?
W. E. A.

The causes of a rotary converter hunting may be divided into two classes, mechanical and electrical. Mechanical causes may be present when reciprocating engines are used to drive the generators, due to the turning effort exerted on the crankpin not being uniform at all parts of the stroke, causing momentary variations in the engine's speed during each revolution. The momentary variations in engine speed cause variations in voltage and frequency of the generator which are transmitted to the converter and cause the machine to hunt. This cause may be remedied by using a heavier flywheel on the engine, or a governor that will not respond to these momentary variations. This trouble can also be alleviated by placing a damping winding, similar to the copper structure on the rotor of a squirrel-cage motor, in the pole faces. The electrical causes are excess drop in voltage due to the transmission line being overloaded, and also to the lack of dampers in the pole faces of the converter; the remedy in this case is obvious.

Hot-Water Supply in Conjunction with Hot-Water Heating—What are the objections, if any, of obtaining a hot-water supply out of the boiler of a gravity hot-water heating system?
G. H. J.

For heating purposes the temperature of the water would need to be adapted to the variable requirements of the heating apparatus and thereby may be unsuitable for the hot-water supply. Another objection is that drafts of water thus made from the heating system would need to be replenished by a supply of cold water that would impair the operation of the heating system, and the sudden changes of temperature would have a tendency to warp and crack the boiler. If it is desired to dispense with a separate fire for obtaining a hot-water supply, it is better to heat the water by means of a water-back or pipe coil placed in the firebox of the heating boiler. Although this may reduce the size of the boiler firebox and interfere to some extent with the capacity of the heating apparatus and economy of fuel, these objections may be compensated by greater convenience and economy in operation of a single fire for the heating apparatus and a hot-water supply.

Requirements and Appointments of Fire Pumps—What are the leading differences between fire pumps and standard pumps?
W. F. C.

Fire pumps are designed with special consideration as to reliability and durability. The valve area must be larger than that of standard pumps, as the demand for water may at any time be in excess of the rating, and the pump can then be run at a very high speed even if the operation may be regarded as unsatisfactory in an ordinary pump. A fire pump should be strong, rustproof and reliable and one that any inexperienced man, who may be excited and in a hurry, could start up instantly without doing any damage and should be provided with cushioning sufficient to prevent damage from pounding when the pump discharges against only atmospheric pressure, as from sudden breaking of a hose or discharge connection near the pump.

Closing Cracks in Brick Settings—What is the best material for pointing the cracks in brickwork of boiler settings?
J. W. R.

Cracks develop from expansion and contraction, and once a crack forms, it will open wider from continued use of the boiler, as small pieces of the wall material fall into the opening with each contraction and, when reëxpansion occurs, these particles and the jagged fracture prevent the joint from closing as tight as it was at the time of the previous expansion. Hence for keeping a crack closed it is necessary to close the opening with an elastic material or cover the crack with a material that will adapt itself to increase of its width. A good plan is to fill the opening with dry asbestos cement, point the outside with ordinary lime mortar for holding the asbestos cement in place, and if serious objection is believed to result from renewal of the cracks, the leakage can be stopped by covering the openings with strips of muslin pasted on the outside of the wall with a good flour paste. The muslin strips should be thoroughly sized with the paste on both sides and applied when the openings are widest, which for most cracks will be when the walls are cold.

Required Size of Duplex Boiler-Feed Pump—What size of duplex boiler-feed pump would be suitable for boilers rated at 450 hp.?
N. H.

To meet emergencies boilers are likely to be forced to deliver one-third more than their rated capacities, and in case of low water at such times, the delivery capacity of the feed pump should be at least double the rate of evaporation. To meet these conditions, without operating the pump beyond the speed proper for a pump in regular service, the regular service capacity needs to be about three times the steady requirement of the boilers when operated at their rated capacity. Allowing the rating to be equivalent to an evaporation of 30 lb. of water per boiler horsepower per hour, the feed pump should be of size suitable for a delivery in regular service at the rate of $450 \times 30 \times 3 = 40{,}500$ lb. of water per hour, or make a displacement equivalent to $40{,}500 \div (60 \times 8.33) = 81$ gal. $= 81 \times 231$ or 18,711 cu.in. per min. Allowing 6 in. stroke, and for maximum rate of delivery a piston speed of 65 ft. = 780 in. per min. (which will be the piston speed for each side of the pump), the pump would make $780 \div (2 \times 6) = 65$ revolutions, or $65 \times 4 = 260$ single strokes per minute; and neglecting the reduction of plunger area due to piston rods, each plunger area would need to be $18{,}711 \div (2 \times 780) = 11.99$ sq.in., which corresponds to about 3⅞ in. diameter. The usual commercial size of duplex pump coming nearest to the above would be 6 × 4 × 6 in.; that is, 6-in. diameter steam cylinders, 4-in. diameter water cylinders and 6-in. stroke.

Economy of Refrigerating Power Plants*

By VICTOR J. AZBE

Résumé of the various factors entering into economy of a refrigerating or ice-making plant. The boiler room, prime mover, auxiliaries and condenser and suction pressures are considered.

WHILE power plants are generally wasteful, the average refrigerating plant is especially so, by reason of the many factors that enter into the ultimate economy. It is generally accepted that five to six tons of ice is produced per ton of coal, but more often only one to two tons is obtained, and to find an ice plant where a saving as great as 50 per cent. could be made is quite common. Some of this loss is due to the improper equipment and improperly proportioned plants, but most of it is due to the fact that good refrigerating power-plant engineers are scarce.

Table 1 shows what a good operating engineer in a plant can do over a mediocre man. It is evident that the chief problem of the mechanical and refrigerating engineer is to develop the proper caliber of power-plant operator. A large percentage of the total loss is ordinarily found in the boiler room, due to either improperly selecting or burning the fuel. Close attention to CO_2 is necessary and seldom exercised. Proper installation of boilers and such damper arrangement that regulation at all loads can be maintained, are important factors.

TABLE I. RESULTS OBTAINED BY TWO ENGINEERS IN THE SAME PLANT WITH THE SAME EQUIPMENT

Tons of Ice per Ton of 10,000 B.T.U. Fuel

	1916	1917	Improvement, 1917 Per Cent.
March	2.88	5.08	76.7
April	3.64	5.02	37.7
May	3.74	5.12	36.7
June	4.00	5.44	36.0
July	4.16	5.53	32.9
August	4.32	5.48	26.7
September	4.06	5.21	28.3
October	3.96	5.35	35.1

Simple steam-driven ice plant. Distilled water can ice. In addition storage to the extent of 150,000 cu ft was maintained with average atmospheric temperature of 90 deg. F., for which no correction was made.

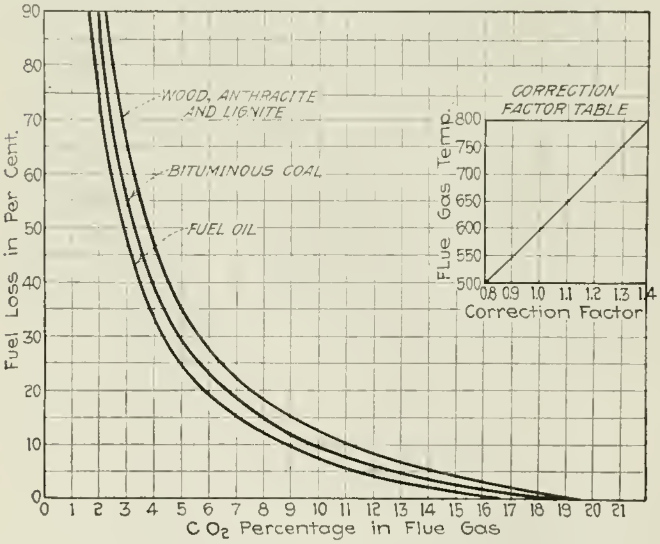
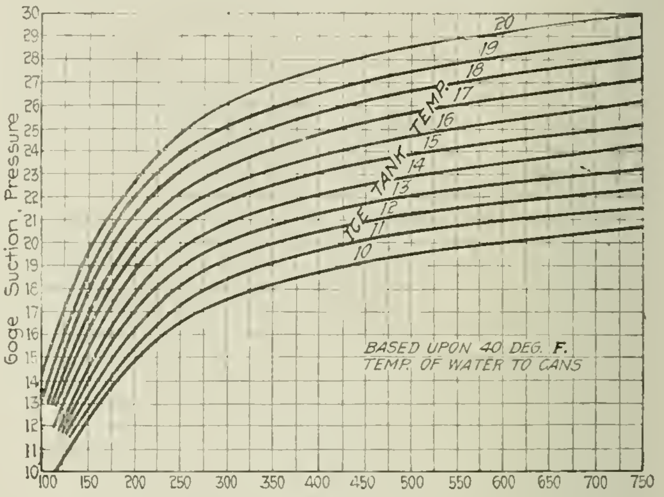


FIG 1. LOSS OF FUEL DUE TO EXCESS AIR WITH VARIOUS CO_2 PERCENTAGES

Fig. 1 gives the loss of fuel with different percentages of CO_2 in the flue gases. Table II gives the loss due to carbon monoxide. It must be remembered that CO is not the only loss when there are smoke and incomplete combustion. There may be other gases escaping, having an equally great or greater content of latent heat that becomes unavailable.

In the boiler room close attention must be paid to baffling, gas velocity and cleanliness of heating surface, both internally and externally. These factors have an important bearing on flue-gas temperature, which is all-important when it comes to boiler efficiency.

Average relative values of various fuels are given in Table III. Wood and lignite have been somewhat discredited by being burned under improper conditions and by men unfamiliar with their peculiarities. At present many a plant in this country now burning oil or coal could change with profit to lignite or wood fuel. The data given in the table are conservative and should be obtained in any plant properly equipped and operated.



Linear Length of $1\frac{1}{4}$-in. Pipe per Ton of Ice

FIG. 2. RELATION OF LENGTH OF PIPE PER TON OF ICE TO SUCTION PRESSURE

Few plants operate on a discharge pressure as low as it should be. The condenser may be of improper design, improperly operated or filled with air. There may be insufficient water or poor water distribution, and the surface may be dirty. The condenser pressure should correspond to a temperature of 5 deg. F. above that of the cooling water leaving the condenser. The temperature of the ammonia liquid leaving the condenser should also be close to

TABLE II FUEL LOSS DUE TO CARBON MONOXIDE IN FLUE GASES

CO_2		CO 0.25	0.50	0.75	1.00	1.25	1.50
5	B.t.u.	500	960	1,380	1,760	2,100	2,420
	%	3.5	6.6	915	11.1	14.3	16.6
6	B.t.u.	420	800	1,160	1,500	1,810	2,090
	%	2.8	5.4	7.9	10.2	12.3	15.6
7	B.t.u.	360	700	1,020	1,310	1,590	1,850
	%	2.4	4.7	6.9	8.9	10.8	12.5
8	B.t.u.	320	620	900	1,160	1,420	1,660
	%	2.2	4.2	6.1	7.9	9.7	11.3
9	B.t.u.	280	550	810	1,050	1,280	1,500
	%	1.9	3.7	5.5	7.2	8.7	10.3
10	B.t.u.	250	490	730	960	1,165	1,370
	%	1.7	3.3	5.0	6.6	7.9	9.3
11	B.t.u.	220	450	660	880	1,070	1,260
	%	1.5	3.1	4.5	6.0	7.3	8.6
12	B.t.u.	205	410	610	800	990	1,165
	%	1.3	2.8	4.1	5.4	6.1	7.9
13	B.t.u.	190	385	570	725	920	1,085
	%	1.3	2.6	3.9	4.9	6.3	7.4
14	B.t.u.	180	355	530	700	860	1,015
	%	1.2	2.4	3.6	4.7	5.8	6.9
15	B.t.u.	172	330	500	650	800	955
	%	1.1	2.2	3.3	4.4	5.4	6.5

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*Abstract of paper read before the St. Louis Associated Engineering Societies.

the temperature of the coolest water and should pass to the evaporating coils through an insulated receiver and piping by some other way than a hot engine room. Where very cold water is available, a jacketed receiver is desirable. Flooded condensers, however desirable, are greatly misunderstood, and in some plants actually poorer results are obtained than could be expected with the ordinary atmospheric type.

Suction pressure is even more important than condenser pressure, but in spite of this far less understood. Few operating men will take advantage of higher suction pressures at lower loads. Plants actually can be found that in winter operate with suction pressures ten pounds lower than in summer. By increasing the suction pressure to correspond with the lower output, as much as 30 to 50 per cent. in power could at times be saved. Plants should be designed so that high-temperature work can be done at high pressures and in such a way that one or two low-temperature rooms will not spoil the economy of the whole plant. The importance of proper suction and condenser pressures may be realized when it is stated that every ten-pound reduction in ammonia condenser pressure represents about 5 per cent. saving, and every single pound increase in suction pressure represents 2½ per cent. saving. If the length of pipe in the tank is known, Fig. 2 will' give the suction pressure to be expected; Fig. 3 is more complete as it also includes storage refrigeration.

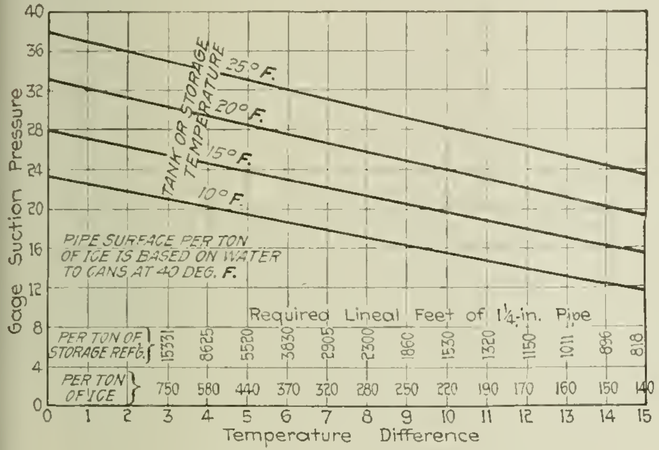


FIG 3. LENGTH OF PIPE FOR VARIOUS TEMPERATURES TO OBTAIN CERTAIN SUCTION PRESSURES

It is known that the power required per ton of refrigeration increases rapidly as the suction pressure decreases. It is also known that the load on the engine decreases with the suction pressure, which in turn tends to increase the steam consumption per horsepower developed. Thus low suction pressure not only increases the power per unit of refrigeration, but also decreases the economy of developing this power. The variation is shown in Fig. 4.

TABLE III. RELATIVE VALUES OF FUELS AND ICE PRODUCTION PER UNIT OF FUEL IN ECONOMICAL PLANTS

	Equiv. Evap per Lb.	Equiv. Cost Not Considering Relative Labor Per Ton	Tons of Ice per Unit of Fuel Simple Non-Cond Plant Tons per Ton	Comp Cond Plant Tons per Ton
Semi-bitum. coal	10.5	$4.50	8.2	14.0
Anthracite.....	9.7	4.16	7.6	13.0
Eastern bitum.	8.0	3.43	6.3	10.9
Western bitum.	7.0	3.00	5.5	9.5
Lignite....	5.0	2.14	3.9	6.7
		Per 3,000 Lb. Cord	Tons per Cord	Tons per Cord
Wood, air dried	4.0	$2.57	4.7	8.1
		Per Barrel	Tons per Bbl.	Tons per Bbl.
Oil	13.5	$0.95	1.7	2.9
		Per 1,000 Cu.Ft.	Tons per 1,000 Cu.Ft.	Tons per 1,000 Cu.Ft.
Natural gas, 1,000 B.t.u.		$0.145	0.26	0.45

Expected production at about 15 lb. suction pressure and 185 lb. condenser pressure.

A serious loss in many plants is uneconomical auxiliaries. There are plants in which the auxiliary steam consumption is equal to or even greater than the steam consumption of the main units, and to further complicate the problem this factor is commonly accepted offhand as not at all serious.

As far as wastefulness is concerned, the duplex steam pump is the champion of them all. Its wastefulness becomes especially great when operated at a low rate of speed. The logical auxiliary unit is a properly designed centrifugal pump of variable speed and driven by power generated initially in an economical unit.

When designing a plant, a careful analysis must be made as to the number and size of auxiliaries. From the economic standpoint they might better be too small than too large. The former can be forced, while the over-large auxiliary is liable to excessive consumption of power or steam.

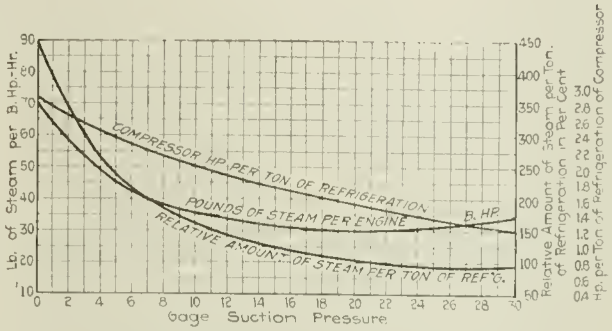


FIG 4. VARIATION OF ECONOMY WITH SUCTION PRESSURE, INCLUDING BOTH ENGINE AND COMPRESSOR

To state that the economy of a properly operated plant, as far as ice per unit of fuel is concerned, should be about the same at half load as at full load may be surprising, but Fig. 5 tends to prove the truth of this assertion and other such diagrams could be given. It will be noticed that the ice production varies from month to month, but the curve representing tons of ice per ton of 10,000 B.t.u. fuel is nearly flat.

Fig. 6 illustrates in a greater detail the foregoing contention. The curves, of course, apply only to a certain plant, and characteristics will vary with each plant. Still in a properly designed plant, and even in improperly designed ones, they will, or should, under proper operating conditions, follow the directions as given on this chart. It will be noticed that the ice-tank temperature increases as the load drops off, up to 20 deg. F., at which point it becomes flat. This curve is the base on which the efficiency of the system is built. The increase of the ice-tank tem-

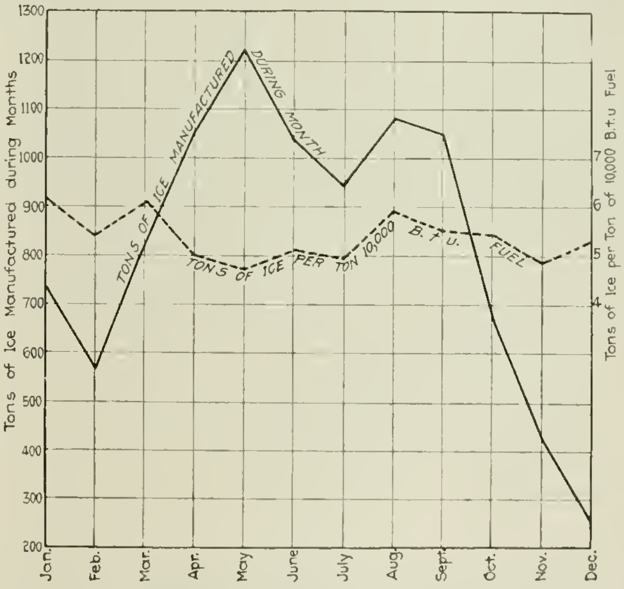


FIG 5. ECONOMICAL PERFORMANCE OF SIMPLE ICE PLANT WITH VARIABLE LOAD FACTOR

perature is the factor that governs the increase of suction pressure on which the economy depends. All too frequently, it will be found that the ice-tank temperature maintained under low loads is the same or even lower than at periods of full ice production. A great many plants in winter will have half of their tank frozen down with ice. It is known that large can surface per ton of ice is a factor of economy, but this can surface must be working, and not idle. The minute a block of ice becomes frozen solid, the can holding it ceases to do work, and if there are twenty cans per ton of ice in the tank and half of them contain solid frozen blocks, then, actually there are only ten cans per ton of ice, with the resulting necessary higher temperature difference to freeze the required amount of ice.

TABLE IV. RELATIVE EXPECTED EFFICIENCY OF VARIOUS ICE-PLANT INSTALLATIONS

	Rel. Eff. Per Cent.	Tons of Ice Per 20,000,000 B.t.u.	Increase of Heat Req. per B.Hp. at ½ Load Over Full Load	Ther. Eff.
Diesel engine	100	30	5.5	33.8
Gas-producer and engine	60	18	36	20.5
Locomobile	40	..	38	13.6
Turbine	36	.	7	12.2
Uniflow condensing engine	32	9.6	4	10.9
Corliss compound cond. engine	27	9.0	22	9.9
Uniflow non-condensing engine	21	6.3	8	7.0
Corliss compound non-condensing	20	6.0	21	6.8
Simple Corliss non-condensing	16	4.9	20	5.4
Simple engine non-condensing	14		17	4.8

Chart is calculated on a standard of 70 per cent. boiler and grate efficiency. An allowance of ½ hp. was made for refrigerating auxiliary load per ton of ice. A total of 3.5 b.hp. was taken per ton of ice, which corresponds to a back pressure of about 15 lb. suction and 185 lb. condenser pressure.

As soon as frozen, ice should be pulled, up to the point where the tank temperature gets to be 20 deg. F. Ordinarily, a higher tank temperature is not advisable owing to the danger that in case of a shutdown or breakdown, the tank temperature is liable to climb to the point where the ice in the can would begin to thaw and upon freezing damage the cans. The amount of frozen blocks in the tank is sufficiently important to warrant careful attention and should be made an item of daily report.

In the further study of Fig. 6 it will be noticed that as the suction pressure goes up the condenser pressure comes down. While the suction pressure is definite and can be calculated, condenser pressure in some plants and climates will go lower even than shown, or perhaps will tend to hold up, but it necessarily will always decrease a great deal with lower loads. With these two factors increasing or decreasing as shown, the compressor horsepower will decrease. This will reduce the amount of steam the prime mover requires per ton of ice, but owing to the fact that the economy of the engine decreases with the speed, the drop of the steam curve will not be as pronounced.

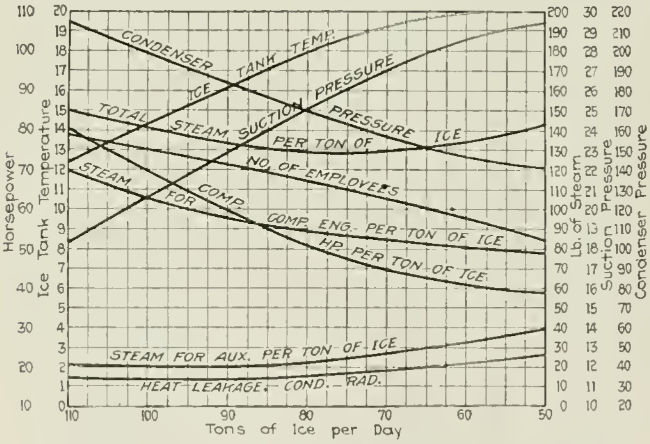


FIG. 6. GOOD ICE-PLANT PERFORMANCE, VARIABLE LOAD FACTOR

The steam required for auxiliaries per ton of ice decreases with the load. Heat leakage, condensation, radiation naturally remain constant. Adding the heat leakage, auxiliary steam and main engine steam gives the composite, or total, steam per ton of ice. This drops off, then increases, and at half load is practically the same as at full load. Consequently the fuel cost per ton of ice should be the same at half as it is at full load.

Table IV shows the relative efficiency of various prime movers for ice plants. The data here and also in other parts of the paper are based upon 20 million B.t.u., equal to a ton of 10,000 B.t.u. fuel. The general acceptance of this standard would make possible accurate comparison of plant operation. The data given in Table IV are conservative and should be attainable with reasonable operating ability. The column showing increased heat or power required at one-half load over full load is especially important in ice plants, where the load is so extremely variable.

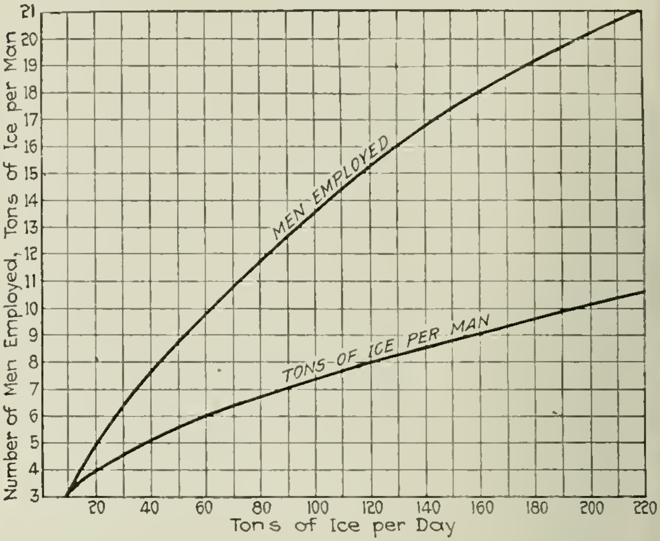


FIG 7. LABOR IN STEAM-DRIVEN ICE PLANT

Next to the fuel cost per ton of ice ranges the labor cost. Fig. 7 gives a good idea of what is to be expected in the average properly operated steam-driven ice plant.

The Plant Engineers' Club of Boston

The Plant Engineers' Club was planned in 1915 by Henry S. Dennison, of the Dennison Manufacturing Co., and E. D. Freeman, of the B. F. Sturtevant Co., along the lines of a similar organization which includes managers of plants and which is called the Factory Managers' Club. Mr. Dennison gave a dinner at the City Club on June 9 of that year, to which he invited about 25 mechanical engineers, master mechanics and chief engineers of various plants in the vicinity of Boston. As a result of this meeting the Plant Engineers' Club was organized. The meetings, which are held each month, usually are followed by an informal dinner, and occasionally a visit is made the same afternoon to one of the plants represented by the members of the organization.

Considerable time was spent during the first year in the study and preparation of a code for continuous boiler-room tests so that the members could adopt a standard by which they could bring up the over-all efficiency of their plants and compare them with what the other members are doing. They have found this code of great value, and it has a tendency to improve the general efficiency of the boiler plant, obtaining very much better results than they had been able to get formerly. The next meeting will be held at the Boston City Club, Mar. 20, at 6:30 p.m., and will be devoted to a discussion of the Cost of Coal Handling and the Storage of Coal. Mr. Eaton, of the Waltham Watch Co., will also recount his recent investigation on the use of powdered coal in large manufacturing plants.

The membership of the club is limited to superintendents, master mechanics and engineers of plants, not more than one in each line of business and not more than 25 in all. The officers are: G. L. Finch, president; H. C. Eaton, vice president; H. S. Scott, secretary-treasurer.

Lubrication of Air-Compressor Cylinders

Recent disastrous explosions in air-compressor systems present striking examples of the danger existing from the use of ordinary engine oil in the air cylinders of air compressors. Only a pure mineral oil, with a flash point as high as good lubricating qualities will permit, should be used. As little as possible of even the best oil should be used.

Numerous cylinder oils are compounded, and such oils are likely to produce a carbon that will stick the valves and collect on valve faces and other parts of the cylinder and valve chambers, resulting in a dangerous condition.

Air receivers are liable to explosion from accumulated oil deposits. Every receiver should be equipped with a pressure gage, a safety valve, and proper drains, and all reservoirs and likely places of deposit in the air line should be thoroughly and frequently drained and cleaned. It is bad practice to have the inlet of an air compressor take from a hot or dusty room—the air should be cool and as clean as possible.

The practice of throwing kerosene oil into the inlet of an air compressor to clean it is an extremely dangerous one, and the cause of an explosion under such circumstances is not difficult to understand. Lubrication of the air cylinder with soapsuds (preferably made of soft soap, about one part soap to fifteen parts water) for a few hours each week (or less frequently if the load is light), instead of oil, will help very materially in keeping the cylinder clean. The only danger from the use of soapsuds is rust, and this should be overcome by being careful to discard the soap and feed the cylinder with oil an hour or so before shutting down. The receiver blowoff should then be opened and the accumulation of oil and water drained off.

An air-compressor engine should not be controlled by the air pressure alone, as many are, but should be fitted with an auxiliary governor which will act as soon as the speed rises above a certain predetermined limit. This will prevent the engine from "racing" in case an accident to the tanks or piping causes a sudden lowering of the pressure. It is not necessary for an explosion to take place to produce a lowering of the pressure, as the giving way of a pipe, valve or tank from any cause will have the same effect.—*The National Safety Council.*

Engine-Room Rules

Employees should be strictly forbidden to enter the engine room except for a special mission, and then should remain only as long as necessary.

The engineer should not be permitted to leave the engine room until some other attendant who is thoroughly familiar with the engine, valves and signals is present to take charge.

No person other than those responsible for the operation of the engines should be allowed to touch any valves or other part of the mechanism or approach any moving part.

No one except the attendants should be permitted to go inside the railings or upon footways when the machinery is in motion.

The safe speed for each flywheel should be known, and in no case should this be exceeded. Flywheel revolutions should be recorded every day in order to make sure that the engine is not running over the speed limit.

All parts of engines and accessories should be frequently and thoroughly inspected, and daily tests should be made of the governor mechanism and automatic engine stops.

Under no circumstances should engines be started until they are thoroughly cleared by alternately blowing live steam through each end of the cylinders, and the steam pipe and cylinders thoroughly drained of all water. The drip should be left open until the load is put on and then closed. Be sure to warm the engine cylinder at both ends.

In shutting down, the drip valve should be left closed until the engine is stopped. If the throttle is equipped with a bypass valve, the throttle should be closed and engine stopped with the bypass. This gradually stops the engine, avoids the pumping effect of the piston and prevents water being drawn into the cylinder.

Never attempt to "bar" a flywheel around nor pull it off center by grasping the belt when the steam pressure is on.

Never start to take cylinder head off or piston out of cylinder without making sure that the throttle and exhaust valves are shut tight and locked and the drains wide open; nor without trying the indicator cocks to see whether there is any pressure on.

Never stop the air pump before stopping the engine (condensing), as the condenser and exhaust pipe may be flooded and overflow into the cylinder.

All steam traps should be kept clean and in working order. Should a trap get out of order, and it be impossible to repair it at once, the bypass should be opened sufficiently to pass off all water which might collect.

Leaks in pipes, flanges or gaskets should be repaired at the earliest possible time.

In opening up a cold line, all available drips should be opened. The line should be warmed by opening the bypass where possible or by opening the stop valve sufficiently to warm very slowly. Never open the main valve until certain that the line is thoroughly heated. An inexperienced attendant should not be allowed to turn steam into a cold line until properly instructed.

Automatic valves should be frequently examined to insure their proper action in emergency.

Under no circumstances should vacuum breakers, governors, engine stops or other safety devices be blocked or otherwise made ineffective. If such apparatus is out of order, it should be repaired at once.

Do not stand in front of cylinder head of engines.

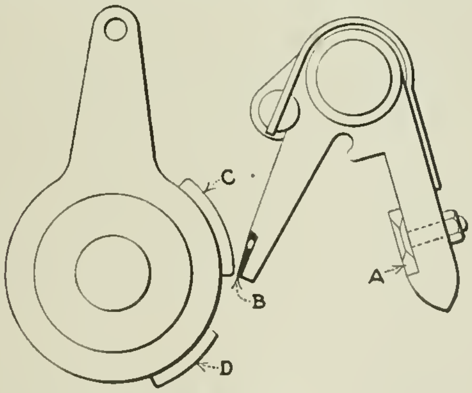
Do not place any material, tools, etc., on platforms or stairs around engine. They might fall off and injure someone below.

Never work in a gas-engine room alone; always have a helper with you.

If you find a man overcome with gas, get him into the open air at once, send for the doctor and notify the foreman.

Smoking and open lights should be forbidden around gas machinery and gas pipes; otherwise an explosion might occur.—*The National Safety Council.*

It occurs not infrequently that the steel toe B becomes worn down as shown in the illustration (reproduced from *Power and the Engineer* for Apr. 20, 1909). In order to get the desired trip after the toe B has worn down thus, attendants have been known to shorten the regulator rod so as to bring down the steel C nearer to B. This practice usually results in throwing the safety-cam or trip D out of reach of the toe B. The danger attaching to such a condition is obvious. If the governor belt should break, away goes the engine with steam being admitted full stroke, unless perchance the engine is equipped with an independent safety stop or a "governor stop." The engineer should also make sure that he does not make the safety trip inoperative by rolling the eccentric ahead, in order to get compression at the end of the stroke.—*The National Safety Council.*



SAFETY CAM TOE EXCESSIVELY WORN

Daylight Saving Advocated by United States Chamber of Commerce

Fifty-two important reasons for the prompt passing of the daylight-saving bill were recently given Congress in the report of the Committee on Daylight Saving of the United States Chamber of Commerce. The items in relation to the immediate reduction in the use of light and heat, with the attendant saving of coal, are of the most interest to engineers and manufacturers.

More than 1,500,000 tons of coal a year is the estimated saving even if the measure is in effect only for the shortest period that has been suggested; and the saving in fuel oils is equally impressive. The savings would occur in both direct and indirect ways. The amount of coal that will be saved if the clock is moved ahead one hour would differ with the method in which daylight saving is used. Calculations computed for different periods based upon the actual British experience in the summer of 1916, and modified by allowances for differences in latitude give the following savings in coal for the United States:

1. Saving of 150 hours of a yearly average of 1320 per year requiring artificial illumination in the United States, that is, by daylight saving between second Sunday in April and last Sunday in September according to the Calder bill (S. 1854) now before the House Committee on Interstate and Foreign Commerce:

	Tons Coal
In electricity for lighting	660,000
In gas for lighting	144,000
	804,000

2. Saving of 190 hours from the yearly average; that is, with clocks moved ahead one hour between Apr. 1 and Nov. 30:

	Tons Coal
In electricity for lighting	836,000
In gas for lighting	183,000
	1,019,000

3. Saving of 198 hours from the yearly average; that is, with clocks advanced one hour throughout year:

	Tons Coal
In electricity for lighting	871,000
In gas for lighting	190,000
	1,061,000

The saving in coal used for these purposes could be represented approximately by the following percentages:

1. With saving of 150 hours: Amount of coal used for lighting through gas and electricity, approximately 15,750,000 tons; amount saved, 804,000 tons; percentage saved, 5.

2. With saving of 190 hours: Amount of coal used for lighting through gas and electricity, approximately 15,750,000 tons; amount saved, 1,019,000 tons; percentage saved, 6.5.

3. With saving of 198 hours: Amount of coal used for lighting through gas and electricity, approximately, 15,750,000 tons; amount saved, 1,061,000 tons; percentage, 6.6.

These figures do not include the saving that would be obtained at isolated plants and at electric-power plants which sell power for lighting. To be borne in mind, too, is the fact that the estimate has been made on a basis which assumes that the use of electric energy and gas for lighting is spread evenly over the country, whereas as a matter of fact 57 million electric lights out of a total of 76 million in the country are in the New England, Middle Atlantic and Northern Central States, where the advantages of daylight saving will be most striking.

The saving of coal through substitution of a morning hour of moderate illumination for an evening hour of maximum use of electricity and gas illustrates ways in which very important savings in coal would be obtained.

"Great Britain, France, Italy, Germany, and eight other nations have adopted daylight saving since the outbreak of the war," says A. Lincoln Filene, of Boston, chairman of the committee that prepared the report for the United States Chamber of Commerce, "and in all of them it is a great success. In England the saving in the use of artificial light and fuel is estimated at $2,500,000 for the summer months alone. In France the saving has been estimated to be 10 per cent. of the coal ordinarily consumed by the gas and electric undertakings. Adopted as a war measure, it has resulted in such increased efficiency and such marked economy that there is no question of a return to the old ways after the war."

Supporting the daylight-saving measure are the President of the United States; Herbert C. Hoover, the United States Food Administrator; Dr. Harry A. Garfield, the United States Fuel Administrator; E. N. Hurley, Chairman of the Shipping Board; the Council of National Defense, literally scores of state and municipal civic bodies and the more than one thousand chambers of commerce and commercial organizations comprising the membership of the Chamber of Commerce of the United States.

New Jersey Boiler Inspection Bureau

A boiler-inspection bureau for the State of New Jersey was provided by the legislature at its recent session by passage of Senate Bill No. 209, which has received the approval of Governor Walter E. Edge. The act goes into effect immediately. The bureau is established in the Department of Labor, consisting of the Commissioner of Labor, as head, and the members of the Steam Engine and Boiler Operators' License Bureau of the Department of Labor that was created under the provisions of the act approved Apr. 14, 1913, and amended by the act approved Mar. 29, 1917, together with such inspectors as the Commissioner of Labor shall deem necessary. The new bureau will be in charge of the inspection of all steam boilers located within the state carrying a pressure of more than 15 lb. per sq.in. Section 3 of the law provides:

> Any person who shall be a citizen of the State of New Jersey, who has had at least five years' experience as an engineer in the care and operation of steam boilers, or who has had at least five years' experience as a boilermaker, or who has been for five years an inspector of an insurance company issuing insurance upon boilers and licensed to do business within this state, who shall satisfactorily pass the examination hereinafter provided for, shall be eligible to the office of inspector in the said Boiler Inspection Bureau.

The Commissioner of Labor is authorized to direct the members of the Steam Engine and Boiler Operators' License Bureau to hold examinations of inspectors, and he is to prescribe the rules and scope of the examinations, appoint the necessary inspectors from among the successful candidates and issue licenses to inspectors so appointed. When so licensed, inspectors are authorized and empowered to conduct inspections and examination. Inspectors shall hold office during the pleasure of the Commissioner of Labor and shall perform such duties as he may direct.

The act requires that all steam boilers within the state carrying a pressure of more than 15 lb. per sq.in. shall be inspected internally and externally and be subjected to a hydrostatic test, "if necessary," at least once in each year by an inspector of the bureau, excepting boilers that are inspected in accordance with the act by insurance companies, whose inspectors have been duly licensed by the Commissioner of Labor. The owner of any steam boiler who shall use or allow to be used a steam boiler in violation of any provision of the act shall be liable to a penalty of $50 to $100, to be collected by suit in the name of the Commissioner of Labor. Section 15 provides that all steam boilers shall conform to the regulations and standards adopted by the State Board of Boiler Rules.

Steam boilers in marine or railroad service that are subject to United States Government inspection and regulations and also fire-department apparatus and motor road vehicles are excepted.

A fee of $6 and traveling expenses of the inspector is to be paid by the owner of each boiler inspected and collected by the inspector, $1 of which is to be turned into the state treasury and $5 and expenses to be retained by the inspector as his compensation.

In addition to the annual internal and external inspection, each boiler is to be inspected externally as nearly as may be at the expiration of six months after the annual inspection. For such external inspection the owner of the boiler is to pay the inspector a fee of $2.50 in addition to the actual railroad fare.

Bituminous Coal To Be Mined Clean or Sold at Less Than Fixed Price

The United States Fuel Administration has announced the organization of an inspection system to enforce the mining of clean coal.

During last winter much of the output of bituminous coal reached the market containing a large percentage of slate and other impurities. The effect of this has been not only to reduce the heating value of the coal, but to put an additional unnecessary burden upon transportation facilities.

Under the inspection system, coal condemned by the Fuel Administration for lacking preparation or because it contains a high percentage of impurities will be sold at 50c. per ton less than the fixed Government price for the mine.

ORDER EFFECTIVE MONDAY, MAR. 11

The inspection system will be operated through the district representatives of the Fuel Administration in the various coal fields. The order became effective Monday, Mar. 11. It provides:

UNITED STATES FUEL ADMINISTRATION,
Washington, D. C., Mar. 7, 1918.

REGULATION CONCERNING CLEAN COAL

The United States Fuel Administrator, acting under authority of the Executive order of the President of the United States dated Aug. 23, 1917, appointing said administrator, and in furtherance of the purpose of said order and of the purposes of the act of Congress therein referred to and approved Aug. 10, 1917, hereby orders and directs that until further or other order, and subject to modification hereafter from time to time and at any time:

Section 1: Authority is hereby given to the district representatives of the United States Fuel Administration to appoint a sufficient number of inspectors in their respective districts to carry out the terms and provisions of this order, and to assign to each of said inspectors a particular territory.

Section II: It shall be the duty of each of said inspectors:

1. To cover his territory at as frequent intervals as may be consistent with thorough inspection; the inspectors shall be qualified by knowledge and experience of the particular district or districts in which the inspection is to be performed, and shall familiarize themselves with the conditions under which the coal is produced and prepared, so as to enable them to effectually carry out the terms and provisions of this regulation, the intent being to reinstate the cleaning of coal at the working faces of the mines; to reinstate employment of slate pickers with a view of bringing the ash contents of coal back to approximately the standard of normal times. Furthermore, where the coal in any part of the mine is found to be naturally of such character as to be unfit for market, judging from the usual standard of the district, the district representative may order the mining suspended in said part or parts of a mine until or unless proper cleaning methods be adopted; provided, however, that the workings shall not be so suspended where the nature of the mining to be done is necessary to preserve the mine from damage, or where a cessation of work endangers life or may result in serious risk of flooding, of explosions, or of squeezing.

2. To report daily to the district representative of the Fuel Administration, mines inspected, the condition of the coal as loaded; methods being employed to prepare and clean the product; whether or not the product being shipped to market is, in his judgment, a well-prepared and merchantable product. All reports of inspections shall be made in quadruplicate, one to be forwarded by mail to the Fuel Administration, Department of Inspection, at Washington, D. C.; one to the district representative; one to the operator; and one to be retained by the inspector for his personal files.

Section III: Inspectors are authorized to condemn at the mines any coal loaded in railroad cars which, in their judgment, is not properly prepared; and any inspector finding unmerchantable coal shall immediately notify the district representative and the operator by wire or in person and in writing, giving the car numbers and initials of any and all cars so rejected and stating the facts on which such action was based. A copy of such notice shall be immediately mailed to the United States Fuel Administration, department of inspection, and to the district representative. If the district representative approves the inspection report, he shall so notify the operator at once; in which case, unless the operator unloads and reprepares the rejected coal, the consignee shall be permitted to deduct 50c. per ton from the authorized price for the grade of coal with which the car is loaded, provided, however, the consignee after examining the coal may at his option pay and the operator may receive the full authorized price. Each invoice covering the sale of condemned coal shall bear the following notation, "This reduced price is fixed by the United States Fuel Administration as a penalty for improper preparation." The operator shall thereupon immediately report to the United States Fuel Administration, department of inspection, at Washington, and to the district representative the disposition made by him of said car or cars of coal, and shall accompany his reports with a copy of the invoice.

The district representative, where repeated violation of this regulation has taken place, or in flagrant cases, shall require a special written report from the operator, which report shall be transmitted by said district representative to Washington with his conclusions thereon, all of which is subject to review by the United States Fuel Administrator.

This order or regulation shall not operate to change the terms, conditions, or validity of existing contracts, but new contracts shall be made subject to this order.

Above regulation to become effective Mar. 11, 1918.

H. A. GARFIELD,
United States Fuel Administrator.

Coke Breeze for Steam Raising

In a recent paper on low-grade fuels for power, before the Liverpool Engineering Society, Mr. Kershaw, as reported in the *Power User*, pointed out that coke breeze, as the fine coke is called which is washed from the quenching tables and grading screens in gas-works and byproduct coking plants, has lately come into prominence as a useful and cheap fuel for power generation. The ash content varies from 20 to 30 per cent. and the moisture from 10 to 20 per cent., so that it may be classed as low-grade, either on account of its contents of incombustible matter, or on account of its fine state of subdivision.

The conditions required for the successful combustion of coke breeze under steam boilers are now well understood, and there are many plants in operation in this country where it is being employed either alone or mixed with ordinary bituminous fuels for steam generation. When coke breeze or coke ash containing over 30 per cent. of incombustible matter is to be burned alone, some form of external furnace of the dutch-oven type becomes necessary for its complete combustion, and in this case the advantages offered by the internal fireboxes of the marine and Lancashire type of boiler are lost. Forced draft will still be necessary to burn the fuel, and the radiant heat from the furnace can be utilized by means of hollow walls for preheating the air before it is drawn into the furnace by the fan or steam jet—the heat of the gases can be best utilized in the water-tube type of boiler. Underfeed stokers are sometimes used with this furnace, but as the proportion of ash in the fuel rises, the difficulty of obtaining anything like complete combustion of the carbonaceous matter with mechanical stokers increases.

When burning a mixture of bituminous coal and breeze, it is very important that the fuel should be well mixed. A method of burning the mixed fuels on chain-grate stokers which is stated to have given good results is to fit an additional hopper to the front of the stoker, by means of which a layer of breeze is fed on to the chain-grate before the ordinary fuel comes down upon it from the hopper above. The grate then travels forward with two layers of fuel upon it, the coke below and the bituminous above, and the proportionate depth of these two layers can be varied by altering the relative speeds at which the two hoppers deliver their fuel onto the grate.

The idea that a technical paper is dry at best, and that the English employed in it is of small consequence has long been proved incorrect. There is so much nowadays that is well written that no busy professional man will spare the time to read and digest an ill-written paper.—*Harrington in the Sibley Journal.*

Merchant Marine Conference at Boston

Problems that are expected to result in greater efficiency in the manning and operation of American merchant ships, improvements that will be welcomed by the ship operators and crews alike, were discussed in a conference of representatives of leading maritime organizations and United States Shipping Board Recruiting Service officials at Boston, Tuesday, Mar. 5.

Henry Howard, director of the Shipping Board Recruiting Service, presided. Among those taking part were Edward F. Flynn, assistant to the director of recruiting; John H. Pruett, of New York, national president, American Association of Masters, Mates and Pilots; Andrew Furuseth, president, International Seamen's Union; H. P. Griffin, president, Marine Cooks' and Stewards' Association of the Atlantic and Gulf; Thomas L. Delahunty, of New York, business manager, Marine Engineers' Beneficial Association; John Olson, of the Marine Firemen, Oilers' and Watertenders' Union of the Atlantic and Gulf; Bert L. Todd, of New York, secretary, Ocean Association of Marine Engineers; Parker H. Kemble, and Henry G. Vaughan and Edwin Reynolds of the Shipping Board Recruiting Service.

In the afternoon the delegation went on board the training ship "Governor Dingley" for luncheon and an inspection of seamanship and boat drill by the merchant marine apprentices being trained by the Shipping Board.

Effect of Poor Coal on Plant Efficiency

An interesting analysis of the effect of poor coal on power-plant efficiency was presented at a meeting of the New England Street Railway Club in Boston, Mass., Feb. 28, by Walter C. Slade, superintendent power and lines, Rhode Island Company, Providence. Rhode Island has keenly felt the shortage of bituminous coal. The two power-producing utilities at Providence have been operating of late with inadequate coal reserves and the Rhode Island Company in particular has recently been forced to operate its main power plant at Manchester St. for three or four days entirely with borrowed coal. The company operates two steam plants, one a turbine station at Providence with two 15,000-kw. units and some smaller machines, and one at Rockland, of the engine type. In 1916 these plants burned 73,100 gross tons; in 1917 the consumption rose to 90,500 tons, although the power generated increased less than 5 per cent.

The load on these stations is exclusively railway. The diversity factor which the average central station enjoys does not exist on the Rhode Island system. The turbine station generated 73,492,300 kw.-hr. in 1917 and the Rockland station 1,423,217 kw.-hr. In 1915-16 the company paid $3.32 per ton for coal alongside; discharging cost 8.5c. per ton. The average price is now over $8.35, provided there are no demurrage charges. Owing to Government regulation, the consumer absorbs not only demurrage charges, whether they occur on cars or on the boat at the loading end or at the discharging end, but also other charges such as war taxes, insurance, etc. To date the company has received about $6000 in demurrage bills on the last eleven boats, on which two-thirds was incurred at the loading end. Discharging costs have advanced to 23c. per ton, because the company is now obliged to discharge boats on overtime work to avoid the high demurrage charges. Today coal passers on the water front are getting 50c. per hour straight time, 65c. per hour overtime and 75c. per hour Sundays and holidays.

In August, 1917, the company realized that it was going to have trouble with fires in part of its stored coal, due to the rapid heating properties of some of the coal, which was of poor quality even though of high price. The fire trouble actually occurred earlier than was anticipated. About Sept. 1 shipments became less frequent, and in December the reserve-storage supply was reduced to about 7500 tons. In February the coal left was all consumed and the company was forced to borrow coal through the local fuel administration. For the last year all possible pressure was exerted to have suitable deliveries kept up to prevent the depletion of the supply.

Prior to the time when the coal-mining conditions became abnormal and transportation facilities became demoralized, the company burned New River or Pocahontas coal, with an average analysis of about 14,900 B.t.u. Even the same grade of coal, due evidently to poorer preparation at the mines and at a later time possibly to pooling of coal supplies by the Government, gave noticeably lower average B.t.u. on analysis. The spot cargoes purchased outside, consisting mainly of Pennsylvania coals, but which were expected to be of average quality, were in some instances of extremely poor quality. Of the coal placed in yard storage, 35 per cent. showed a heat value under 14,500 B.t.u., and 46 per cent. under 14,750 B.t.u. In fact, 21 per cent. was under 14,000 B.t.u., some of it containing 15 per cent. ash. Owing to the deterioration of this coal in storage before it was consumed under the boilers, the average B.t.u. value of the coal as fired was not over 14,300 B.t.u. The poor quality of coal was reflected in operating cost, in addition to the higher cost of the coal alongside. Increased boiler-room maintenance also resulted. The net result was to raise the unit cost of power for 1917 by 106 per cent., compared with the year ended June 30, 1916.

The coal factors for both stations have been growing worse since 1916, as shown:

	—Manchester St. Station—		—Rockland Station—	
	Lb. Coal Per Kw.-Hr.	Per Cent. Increase	Lb. Coal Per Kw.-Hr.	Per Cent. Increase
12 months ending June 30, 1916	2.28	....	3.49	....
6 months ending Dec. 31, 1916	2.38	4.4	3.78	8.3
12 months ending Dec. 31, 1917	2.69	18.0	3.99	14.3

The unusually high factor for the turbine plant in 1917 was due to a combination of operating conditions requiring a large number of banked hours on stand-by boilers not used in 1916, together with the necessity of burning a considerable amount of inferior coal, as well as coal damaged by spontaneous combustion. The performance will not be repeated in 1918. In fact, under favorable conditions the plant in Providence was operating for a part of January at 2.13 lb. The decrease in economy at both turbine and engine plants has been of the same relative order.

As regards the increased cost of busbar power, some comparisons may be made with the costs which apply to the year ended June 30, 1916. Comparing the last six months of 1916 and the year 1917 with this period, it is found that the cost per kilowatt-hour at the bus increased for the six months 23.4 per cent. and for the following twelve months, 106 per cent. at the Manchester Street Station. At the small Rockland plant the busbar cost increased for the same periods 31.8 per cent. and 73.5 per cent. These remarkable increases in unit cost are due primarily to the abnormally high price and also to the poor character of the fuel. Some of the coal was of such poor quality that it raised the maintenance of stokers and furnaces to an abnormal point. Steam-plant maintenance in 1917 increased 75 per cent. compared with 1916, and all other maintenance increased only 13 per cent. at the Manchester Street Station. The increase in the cost of fuel as fired was 132 per cent. and raised the fuel charge in 1917 to as much as 83 per cent. of the total maintenance and operating costs. Referring to operating charges in the same year, while fuel costs advanced 132 per cent. over 1916, wages advanced 30 per cent. and all other operating charges 25 per cent. The kilowatt-hours delivered increased only 4.9 per cent. and the pounds of coal per kilowatt-hour 18 per cent.

The majority of the existing railway plants were built at a time when 25 cycles was the only commercial frequency considered suitable for traction purposes. These plants as a rule enjoyed no diversity factor in their load. So much capital is invested in these large railway plants that even though they are able to generate less economically than adjacent central stations, it is difficult to consider anything but a continuance of operation with added improvements in the interest of economy in these railway installations. Between the average large 60-cycle central station and the average large 25-cycle railway plant there can be no interchange of power except through frequency-changing equipment, which is sufficiently uneconomical to make such an exchange feasible only for emergency service. In certain cases it appears feasible to add some 60-cycle equipment in extending existing 25-cycle plants, where intimate coöperation exists between the two classes of plant owners. The writer believes that many of the smaller railway plants of the engine-driven type should be shut down by central-station service, holding that with increasing cost of coal the balance is all in favor of the central station. It is questionable if the price of coal in future years reaches a minimum that is $1 to $1.50 a ton above prices prevailing before the war.

In ordinary times the fuel item represents from 70 to 75 per cent. of the total cost of generated power. Recently, this reached 83 per cent. on the Rhode Island system. In fact, at least 90 per cent. of the total cost was expended in the boiler room for fuel, water, wages, supplies and materials required for maintenance. The boiler plant has been too much neglected in the past, especially in employing high-priced men to operate it. Now there is a man shortage, and perhaps the best solution is to put under the chief engineer a technically trained man or at least a man who understands the theory of combustion well and who can keep a constant check on the operation of the boiler room. This type of man has been termed "combustion engineer." Even plants of moderate capacity could well afford to maintain such a man on the payroll. Working with the assistance of the necessary measuring devices, such a man could put the true spirit of industrial control into boiler-room practice. To aid the combustion engineer in effecting the desired economies, it is advisable to consider the question of making all equipment as nearly automatic as possible. Man power may be at a premium for some time to come, and at all times undue dependence upon the human element is undesirable.

Toluol from City Gas

In anticipation of the present national emergency, says *Iron Age*, there has been going on without any publicity a development in toluol manufacture which bids fair to be of the utmost importance to the nation in the supply of trinitrotoluol. Early in 1915, the Koppers Co., of Pittsburgh, which at that time was building a large number of byproduct coke plants, and in connection with which it was also building benzol and toluol plants, started in the laboratories of the Mellon Institute, Pittsburgh, an investigation into the recovery of toluol from carburetted water gas, the gas made in all large cities of the country by the gas companies for domestic use.

It has been found that every byproduct coke-oven plant in the country is producing or has arranged to produce toluol to the utmost capacity and that the remaining needed toluol must be secured from city gas. The Pittsburgh By-Product Coke Co., an operating company associated with the Koppers Co., has carried out a plan in conjunction with the gas-light company at Washington to erect the first plant at the West station of that company to effect the removal of toluol from 5,000,000 cu.ft. of carburetted water gas per day. This plant was placed in operation on July 14, 1916, and has yielded since that date 200,000 gallons of toluol. While this plant was the first to use this process, and many improvements increasing the efficiency and economy of operation have been introduced, it proved a commercial and technical success, equaling the results promised by laboratory methods. Many of these "stripping" plants are in operation in various cities, and others are in preparation.

The Belgian Coal and Coke Industry

During the years that immediately preceded the war, Belgium produced, in round figures, 24,000,000 metric tons of coal a year. About 1,350,000 tons of this was coked, yielding a trifle more than 1,000,000 tons of commercial coke, including breeze sold for domestic use. All coke was, of course, byproduct coke, as none other has been made in Belgium since 1892 or 1893.

Belgium was a pioneer in the byproduct industry. The oldest byproduct company now in existence is the Société Anonymé du Charbonnage des Produits, at Flénu, Belgium, which was incorporated in 1856 for the mining of coal and the manufacture of byproducts. That company may have become better known abroad as a coal company than as a byproduct concern, but this was due to the extraordinarily fine natural condition of its coal deposits, which enabled the company to pay big dividends earned in mining and selling coal while meeting the stress of developing the byproduct department of its business. Regardless, however, of the trying period of development, the Produits Co. never ceased for a single day, since 1856, to make byproducts; and the first aniline colors ever put on the market were made at Flénu by this company at a time when its coke and byproduct department was managed by the noted Belgian chemist, Neyrincks.

With the advent of the Coppée vertical-flue coke oven, the Produits Co. became a decided factor in the byproduct industry. That was about 1870, at a time when Germany had only beehive coke ovens and when all coke made in Belgium was produced in retort ovens of the original Coppée design. Not only was Germany later than Belgium in eliminating its beehive ovens, but even to this day there is not in Germany a single coke oven which is not of the vertical-flue kind first invented by Coppée, a Belgian, or the horizontal-flue type developed by Solvay and Semet, the former a Belgian, the latter a Frenchman, both living today. Many persons in this country, even among those engaged in the byproduct industry, believe that the byproduct oven is of German origin and development. To this day the Belgium coke ovens have always kept at least one step ahead of all others.—*Coal Age.*

Science or Art

There are times when we find it difficult to take any interest whatever in education, times when the mere word bores us, calling up dull recollections of tedious debates and the incessant repetition of those platitudes, formulas, pious hopes and bitter criticisms, which for many a long year have been the currency of educational conferences. To men thus weary of the subject, we recommend a little book by H. G. Taylor, lecturer in civil and mechanical engineering at King's College, the University of London. According to their point of view, it will make them angry or rejoice them. If they are university men, if they are mathematicians rather than engineers, they will be roused either to wrath or contempt; if, on the other hand, they are inventors or manufacturers, and, above all, if they are men who owe more to practical training than to college classes, they will applaud the author's argument.

Mr. Taylor is a whole-hearted advocate of a thorough practical training. A Whitworth scholar himself, he believes in the Whitworth method. Engineering, he says quite bluntly, is not a science, it is an art, and it is not to be learned by abstractions, but in the workshop, the factory and the field. A man, he holds, must first be an engineer by nature; he may then be taught to think scientifically, but "to be useful to him, any elementary science must become an idea over which he has complete control." With the exception of the method of training naval cadets, for which he has nothing but the highest praise, Mr. Taylor does not think any one of our universities gives this desirable control. "Without exaggeration," he writes, "for an engineer who has to make his way in life, the worst thing he could possibly do is to become educated." The training that is given in the schools lacks reality, and depends too much upon mathematical abstractions. "To a man with good mathematical knowledge and no engineering experience, all problems resolve themselves into mathematics, and his engineering credulity obtains for him the desired success."

We are disposed to agree with him. The mathematics employed in the ordinary course of mechanical and civil engineering are small indeed, and the advanced teaching is unnecessary, and in many cases even vicious, since it gives a wholly false idea of the truth and encourages a belief in mathematical dogma. Meticulous accuracy in engineering calculations is impossible, because there are always many unknown quantities and qualities. Hence broad calculations which allow a margin for error are always used in practice. For general purposes the engineer will learn more about heat from the experiments and simple arithmetic of Tyndall than from the textbooks of Rankine. The instinct that is acquired by doing things is more useful in this work-a-day world than mathematical abstractions. "The best education for an engineer," says Mr. Taylor, "is found in the natural and instinctive pursuit of manual toil accompanied by study at a technical school." We agree with him. The great engineers of the past learnt by hard experience, and the great engineers of the future will learn by the same methods. The university will never replace the workshop.

There are one or two more words that must be said on this eternal question of mathematics. We went some time ago to visit the dean of a technical college, well known to us in our youth. In our days it was a hotbed of mathematics, and the student who did not revel in the higher flights of "conic sections" had a poor chance, indeed, of achieving distinction. We found a great change. The present dean was bred in the workshop, and he holds that the drawing office rather than the classroom is the proper place to teach the science of figures. With a sly twinkle in his eye, he admitted that on more than one occasion he had found his students busy over their boards, engaged in the actual design of a machine or a structure when they ought to have been attending a lecture on abstract mathematics. His duty obliged him to pack them off straight away, but we could see that his sympathy, as a man and an engineer, went out to them. He knew that these youths had in them the making of real engineers. They were fired by that love of creating, that desire to make things, which is the call of our profession. Where arithmetic or algebra, geometry or the calculus was needed for the construction of something, they used it gladly, as they would any other instrument or tool, but they could not look upon mathematics as an end in themselves. We dare say that this professor is teaching many a man how to handle figures who would never have learned the art from the professors of the subject.

Mr. Taylor is right, we think, when he suggests that mathematics have gained too high an estimation in technical schools. We cannot conceive of an engineer who was unacquainted with the strength of material, the nature of stresses, the means for working metal, stones and timber and the general facts of physics and chemistry. These things and many others must be *known* and handled by the *mind.* But we can quite well conceive a super-perfect Babbage calculating machine that would answer by the turn of handle any mathematical proposition that might be put before it. There are certain things mathematics cannot replace, and it is those things far more than mathematics that should be given the place of honor.

No one, we trust, will run away with the idea that we fail to recognize the value of mathematics; nothing could be further from the fact. Accurate measurement is the basis of science. What we desire to convey is our conviction that good engineers, men of resourcefulness, inventiveness and imagination can be made with far less mathematical knowledge than is now insisted upon. The science of mathematics is best reserved for those who have the aptitude for it. Such men become useful calculating boxes in the hands of others whose natural bent is toward invention and creation. Where you may find a thousand engineers doing useful work in the world with no more than a decent acquaintance with arithmetic, you shall barely find one high mathematician who is also a progressive engineer. —*Random Reflections from The Engineer, London.*

Complaints of Excessive Prices for Soft Coal

Investigation is being made of complaints received by the United States Fuel Administration that operators in some of the bituminous coal fields are charging an excessive price for coal under contracts made before Aug. 21, 1917, embodying prices below those fixed by the President, which contained no sliding scale of labor charges.

Operators against whom charges have been lodged are alleged to be exacting from customers 45c. per ton in addition to the figure set forth in such contracts, and are attempting to defend their course on the ground that they were required to make the increase under the President's order of Oct. 27, 1917, allowing a 45c. per ton increase to cover wage advances for the miners.

Consumers will be protected against such practices of overcharging when their purchases were made under contracts which contained no provision for variations in price to correspond with changes in wage scales. The Fuel Administration previously announced that the President's order in no degree lessened the obligation of operators to make deliveries at prices stipulated in contracts made before Aug. 21, 1917.

Proper steps have been taken to prevent overcharging in such cases. In one case brought to light, one of the large coal companies of the country has agreed to withdraw the 45c. per ton increase which they had imposed in excess of their contract price.

Civilian Workers Wanted for Ordnance Department

Men having a high-school education, some shop training and the natural ability to adapt themselves to new work, may qualify for a Government appointment in which under Government instructors they will receive the necessary training for the following positions: Inspectors and assistant inspectors, field artillery ammunition steel; inspectors, artillery ammunition, cartridge cases, assembling, loading, forging, primers, detonators, shell and shrapnel machining; ballistic inspectors; metallurgical chemists and assistants; inspectors, powder and explosives; inspectors, cannon, forging operations; inspectors, gun carriages and parts; inspectors, gun-fire control instruments; assistant inspectors, motor vehicles and artillery wheels; engineers and assistant engineers, for tests of ordnance materials; inspectors, ammunition packing boxes; machinists, accustomed to work to one thousandth of an inch.

Those who have the required technical training will be placed and advanced as quickly as their ability justifies.

Send in your own application and urge your associates who may be qualified to do so. These positions are under civil-service regulations, but applicants will not be required to report for examination at any place. Applicant will be rated in accordance with education and general experience. No applications will be accepted from persons already in the Government service unless accompanied by the written assent of the head of the concern by which the applicant is employed. Papers will be rated promptly and certification made with least possible delay. Apply or write for further information to C. V. Meserole, Special Representative of the Ordnance Department, U. S. A., Room 800, 79 Wall St., New York City.

Our Greatest Enemy

Comparatively few persons realize how great a toll industrial accidents take of our people every year, states Secretary Redfield. If we are ever so unfortunate as to hear of the loss in a great battle of, say, 10,000 of our soldiers (10,000 killed) the nation would be moved deeply; yet every year twice, perhaps three times, that number are slain in industries of all kinds and almost without its invoking comment. If we were to hear that 1,000,000 of our men suffered wounds in this war, the nation would be troubled; yet industry takes its toll in the form of injuries to persons to an extent nearly three times that number every year. Of this we think but little. There is a real danger, therefore, that in our sympathetic and proper thought for the soldier in the field, we may lose sight of the soldier in the factory, who has his casualty risks as well as his brother in arms. Just as there is a call to service for the soldier and the financier and the nurse and the doctor and the engineer and the mechanic, there is a call to service to see that the precious lives in the country are not wasted and that the bodies of the precious people who make up this country are not crippled.—*Scientific American.*

New Publications

POWDERED COAL AS A FUEL—By C. F. Herington. Published by D. Van Nostrand Co., New York, 1918. Size, 6 x 9 in., 211 pages; illustrated. Price, $3.

The information which the author has collected in this book was largely acquired while he was employed as assistant engineer in the service of the New York Central Railroad Co. Having described the coals suitable for powdering, the preparation and feeding of powdered coal, the author proceeds to discuss the use of fuel in this form in the cement industries, in reverberatory and metallurgical furnaces, under steam boilers and in locomotives. A chapter is devoted to explosions of powdered fuel and a comprehensive bibliography given of the literature of the subject.

COMBINED TABLE OF SIZES IN THE PRINCIPAL WIRE GAGES

A new publication (Circular 67) entitled "Combined Table of Sizes in the Principal Wire Gages," has recently been issued by the Bureau of Standards, Washington, D. C. This table combines in one series the sizes in the American (B. & S.), Steel, Birmingham (Stubs'), British Standard, and Metric Wire Gages, arranged in order of diameters of wires. It gives the diameters of all the gage numbers in these five systems, in mils, inches and millimeters, also the cross-sections in square mils circular mils, square inches and square millimeters. The table is especially useful to those who wish to determine the nearest equivalent in American or British gage sizes of wires, specified in millimeters or square millimeters, or vice versa. This paper is now ready for distribution and those interested may obtain a copy by addressing a request to the Bureau.

MACHINE SHOP PRACTICE — By William B. Hartman. Published by D. Appleton & Co., New York, 1917. Cloth; 4¼ x 6½ in.; 235 pages; 132 illustrations; 10 tables. Price, $1.10.

The man who has no knowledge of machinist tools and machine-shop practice will find this volume of value in that it presents the elementary principles of machine-shop work in a simple and logical manner. Measuring tools are first illustrated and explained as to form and use. This subject is followed by a description of hand and machine-cutting tools, and finally the several machines alone and in combination with the tools are treated. Correct methods in the handling of tools and in the operation of machines are emphasized. All higher mathematics are excluded, and all calculations are confined to the use of simple arithmetic. The data tables in the appendix are such as are found in the general run of handbooks, but they will be useful to the student. The contents cover the following subjects: Chipping; filing and scraping; drills and drilling machines; lathes; straight turning; taper turning; thread cutting; lathe work; planer and shaper; boring mills; milling-machine work; and a chapter dealing with the automobile. Each chapter is concluded by a list of questions. The illustrations are confined to mechanical drawings which will assist the reader in learning to read them and as to their use.

THEORY AND OPERATION OF DIRECT-CURRENT MACHINERY. By Cyril M. Jansky. Published by McGraw-Hill Book Co., New York, 1917. Cloth; 6 x 9 in; 285 pages; 214 illustrations. Price $2.50.

This book has been prepared as a text to meet the needs of students of limited mathematical training. Elementary mathematics has been made use of quite extensively throughout the work, nevertheless the subject has been presented so that an understanding of the principles involved may be obtained even though the reader may be unable to follow the mathematical reasoning.

The book is divided into sixteen chapters embracing fundamental magnetic principles, electromagnetism, electromagnetic induction, units of measurement, transformation of energy, the continuous-current generator and motor, the magnetic circuit of the direct-current dynamo, armatures, uses of electrical energy, types of dynamos, commutation, operating characteristics of generators, operation and care of generators, operating characteristics of motors, operation of three-wire systems, selection and installation of dynamos.

Although this book was written primarily for use in the classroom, it contains much that the practical man can make good use of, especially the last eight chapters, which deal largely with the construction and operation of direct-current machinery. In the first four chapters the author has given considerable space to a discussion on the theoretical magnetic and electrical units, making it clear just what these units are and how they are arrived at.

Obituary

Findlay Clem was killed on Feb. 25 while inspecting a boiler at Owens Station, near Marion, Ohio. He was employed by the J. T. Adams Construction Co.

Personals

M. H. Collins has been appointed sales manager of the new Louisville (Ky.) branch of the Rensselaer Valve Co.

G. W. Bichlmeir, formerly connected with the supply departments of the Missouri Pacific and Kansas City Southern Railway Companies, and also secretary-treasurer of the W. L. Sullivan Machinery Co., is now connected with the machinery department of the Walter A. Zelnicker Supply Co., St. Louis, Mo.

H. A. Brassert, who has been connected with the United States Steel Corporation since its organization, has resigned as assistant general superintendent of the Illinois Steel Co. at South Chicago, in order to devote himself to his personal interests. He will act as vice president of the Miami Metals Co. and subsidiaries, consulting engineer for Freyn & Co, and in a consulting and advisory capacity with the firm of Brassert. Hardy & Tripp. His offices are in the Peoples Gas Building, Chicago.

Loyall A. Osborne, of New York, vice president of the Westinghouse Electric and Manufacturing Co. and chairman of the Executive Committee of the National Industrial Conference Board, has been appointed by the Secretary of Labor a member of a committee on industrial peace during the war. This committee, which consists of five representatives of employers, five labor leaders and two public men, will provide a definite labor program in order that there may be industrial peace during the war, thus preventing interruption of industrial production vital to the war.

Engineering Affairs

The Sinton Hotel, Cincinnati, Ohio, has been selected as the headquarters for the N. A. S. E. Convention, Sept. 16-21, 1918.

The New York State Educational Committee of the N. A. S. E. and Combined Associations of Greater New York will hold a meeting on the evening of Mar. 26, at 220 E. 15th St., New York City. Walter N. Polakov will give a lecture on "Power-Plant Management," and W. R. Marshall will give a talk on "The Operation of Steam Turbines and Their Auxiliaries." Through the courtesy of Mr. Shillcocks a visit will be made to the power plant of the Loose-Wiles Biscuit Co., Thompson Ave., Astoria, L. I. on the evening of Mar. 22.

Miscellaneous News

A Boiler Exploded at Sharp's farm, Plum township, Penn., on Mar. 8, killing one man and injuring three others. The men were drilling an oil well when the boiler exploded.

A Freight Engine Blew Up on the Wabash R. R. near Cerro Gordo, Ill., on Mar. 3, injuring four persons, wrecking 19 loaded cars, and breaking windows two miles away. The engineer was blown about 20 ft. away.

A Locomotive Boiler Exploded on the Santa Fe R. R two miles west of Williard, N. Mex., on Mar. 3, instantly killing the engineer and fireman and slightly injuring another man who was riding a horse near the scene of the explosion.

Business Was Temporarily Disrupted in St. Louis, Mo, at noon on Mar. 1, when power furnished the Union Electric Co. from the Keokuk Dam failed. The trouble was caused by the grounding of a high tension transmission line.

An Explosion in the Engine Room of the Farley & Loetscher Manufacturing Co.'s plant, at Dubuque, Iowa, on Feb. 21 seriously injured three persons and two men were still missing when the report of the accident was received. The explosion followed a fire that spread into one of the big sawdust conveyors.

The Magnesia Association of America is issuing a portfolio of all the educational publicity given its product during 1917 in the various technical and trade papers, under the title, "Let 85% Magnesia Defend Your Steam." Anybody interested may secure a copy by writing to the secretary of the Association at 702 Bulletin Building, Philadelphia, Penn.

The Bureau of Standards at Washington has purchased eight acres of land west of Connecticut Ave. and has let contracts for a new engineering laboratory, 175x350 ft. and four stories in height. The new building and its equipment will cost in the neighborhood of $1,000,000, and will increase the capacity of the Bureau by 50 per cent. The Pittsburgh laboratory of the Bureau, including the work on glass and ceramics, will be transferred to Washington. It is expected that the new building will be occupied during the coming summer.

Business Items

The Wheeler Condenser and Engineering Co. announces the removal of its Philadelphia office to the Land Title Building, with L. McKendrick as district manager.

The Ketzer Machinery Co. has consolidated with W. H. Robinson & Co., with offices in the Real Estate Trust Building, Philadelphia. Paul R. Ketzer is manager in charge.

The Permutit Co., manufacturers of water-softening and water-rectification apparatus, for several years located at 30 East 42nd St., New York, announces its removal to 440 Fourth Ave.

The Worthington Pump and Machinery Corp. announces the following appointments in its organization: William Goodman, assistant to vice president; William Schwanhausser, chief engineer; Edward T. Fishwick, general sales manager; Charles E. Wilson, assistant general sales manager; James E. Sague, vice president, in charge of engineering and manufacturing; Leon P. Feustman, vice president, in charge of general commercial affairs; Frank H. Jones, vice president, in charge of sales; all at New York City offices, 115 Broadway. Neil C. Lamont, works manager, Laidlaw Works, at Elmwood Place, Cincinnati, Ohio.

Trade Catalogs

Ammonia Fittings and Accessories. De La Vergne Machine Co., Foot of E. 138th St., New York. Catalog. Pp. 92; 6 x 9 in.; illustrated. This company has also issued a bulletin giving ammonia-compressor capacity and list of installations.

Safety Enclosed Fuses, Electrical Protective Equipment and Materials. Electric Fuseguard Co., Newark, N. J. Catalog No. 1. Pp. 54; 6 x 9 in.; illustrated. Describes this company's line of safety electrical-protective equipment and allied materials; list prices are also given.

Electrical Equipment in the Woodworking Industry is the title of a new circular just issued by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn. The publication is illustrated by views of motor-driven wood-working machinery. In the first section the general subject of motor drive is discussed. The next section is devoted to features of Westinghouse motors which make them suitable for this work. The rest of the book gives horsepower requirements and other data for many different sorts of woodworking machinery which will be of much value to those having to do with this class of industrial activity.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Mar. 14, 1918	One Year Ago	Mar. 14, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	....	....	....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Mar. 14, 1918	One Year Ago	Mar. 14 1918	One Year Ago
Clearfields....	....	$3.00	....	$4.25—5.00
Cambrias and Somersets...	....	3.10—3.85	....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows

ANTHRACITE

	Circular[1]		Individual[1]	
	Mar. 14, 1918	One Year Ago	Mar. 14, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.25—7.50
Buckwheat ..	4.30—5.00	2.75	5.50—5.80	7.00—7.25
Barley	3.25—3.50	1.95	4.00—4.25	4.00—4.25
Rice	3.75—3.95	2.20	4.50—4.80	5.00—5.50
Boiler	3.50—3.75	2.20	....	3.50—4.00

Quotations at the upper ports are about 5c. higher..

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)..................	3 65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Mar. 14, 1918	One Year One Year Ago	Mar. 14, 1918	One Year One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Mar. 14, 1918	One Year Ago	Mar. 14, 1918	One Year Ago	Mar. 14, 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.50-2.75
2-in. lump..	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Steam egg ...	2.65-2.80	....	2.65-2.80	....	2.65-2.80	....
Mine-run ...	2.40-2.55	2.75-3.00	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	2.50-2.75	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

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[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Fla., Christina—The Phosphate Mining Co. plans to rebuild its electric power plant which was recently destroyed by fire. P. H. Fuller, Nichols, Gen. Mgr.

Idaho, Dubois—The Dubois Light and Power Co., recently incorporated with $25,000 capital stock, plans to build an electric-lighting plant on Beaver Creek near here.

Ind., Richmond—J. P. Dillon, Supt. of the electric-lighting plant, has requested the City Council to appropriate $200,000 for an extension to the plant.

Kan., Bunkerhill—City is considering the erection of an electric-lighting plant.

Ky., Louisville—The Progress Laundry Co., 716-720 Broadway, plans to purchase electrical equipment including a 100 hp. engine.

Md., Baltimore—The Bartlett Hayward Co., Scott and McHenry St., has awarded the contract for the erection of a 28 x 49 ft. transformer house, to Morrow Bros., Fidelity Bldg.

Mass., Medfield—The Commission on Mental Diseases will soon receive bids for replacing main steam line to various buildings with large line and extensions. The work involves 3850 sq.ft. radiation, Jenkins valves, 240 ft. 1½ in. pipe mains to various building and large 3 in. steel pipe.

Minn., Lanesboro—City plans an election soon to vote on $15,000 honds for the erection of an electric-lighting plant. H. T. Asbre, City Clerk.

Miss., Clinton—City plans to install additional equipment in its power plant. Estimated cost, $8000. J. W. Provine, Mgr.

Mo., Concordia—The Trustees of St. Pauls College have plans under consideration for the erection of a new power plant at the institution. C. F. May, Merchants Laceled Bldg., St. Louis, Arch.

Mo., Kansas City—The Kansas City Light and Power Co. will build a 4-story, 185 x 244 ft. power plant on Front St. and Park Ave. A. N. Richardson, Gen. Supt.

Mo., Lewistown—H. H. Bronson is in the market for direct current generators.

Mo., Marshfield—The Marshfield Electric Co. plans to improve and alter its plant; a new generating unit will be installed.

Mo., St. Louis—E. W. Leverett, Supt. of the lighting system, is in the market for a generating unit and power plant equipment to replace 150 hp. equipment now in use.

N. Y., Brooklyn—The Arabol Manufacturing Co., 100 William St., New York City, is having plans prepared by H. Harlach, Engr., 451 East 144th St., New York City, for the erection of an addition to its boiler house on Sanford St., here.

N. Y., Buffalo—The Delaney Forge and Iron Co., 300 Perry St., is in the market for power plant equipment of about 500 hp.

N. Y., Buffalo—The Pullman Co., 79 East Adams St., Chicago, plans to purchase power plant equipment.

N. Y., Elmira—Hilliard Clutch and Machine Co., 4th St., plans to install a steam heating extension to its present plant. Electric motors will be purchased.

N. Y., Elmira—The Willys-Morrow Co., Toledo, Ohio, is in the market for power plant equipment.

N. C., Badin—The Tallassee Power Co. plans to build 200 additional buildings to its plant soon. G. R. Gibbons, Pittsburgh, Secy.

Ohio, Atwater—The Atwater Light and Power Co., incorporated with $10,000 capital stock, plans to build and operate an electric-lighting plant. E. P. and P. W. Whittlesey and others, interested.

Ohio, Cincinnati—J. A. Fay & Egan Co., John and Front Sts., will install power plant equipment in its proposed wood-working factory.

Ohio, Cleveland—City is in the market for 1333 electric meters ranging from 5 ampere, 110 volt single phase meter to 220 ampere, 110 volt potential transformers. E. Shattuck, City Purchasing Agent. R. Hoffman, City Engr.

Okla., Kingston—City plans to rebuild its electric-lighting plant which was recently wrecked by an explosion.

Penn., Philadelphia—The Cocoa Butter Manufacturing Co. has had plans prepared by A. F. Sauer & Co., Engr., 908 Chestnut St., for a new 1-story, 50 x 60 ft. brick power house to be erected at 2626 Martha St. Noted Mar. 12.

Wash., Bellingham—The Puget Sound Traction Co., Stuart Bldg., Seattle, plans to build a transmission line from here to the Cokedale Mine to furnish horsepower to the plant there. J. Harisberger, Gen. Supt.

Wash., Seattle—The City will build a power station for the lighting department at 14th Ave., N. W., and 49th St. The work will be done by day labor. Noted Jan. 22.

W. Va., Fireco—The Battleship Coal Co., Princeton, plans to build a central power plant at its mines, here. H. E. Hines, Pres.

Wis., Neenah—The City Council plans to purchase electric equipment for its stone quarry.

Ont., Hamilton—The Imperial Oil Co., 56 Church St., Toronto, has had plans prepared by J. L. Havill, Engr., for the erection of a pump house. Estimated cost, $5000.

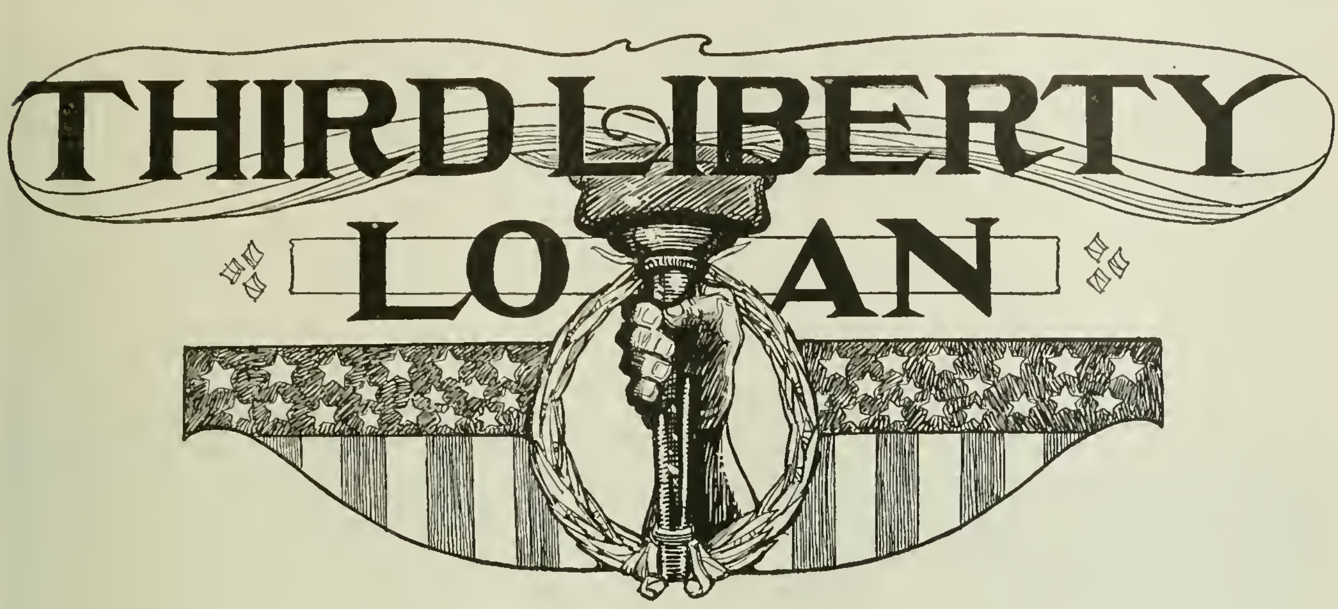
Ont., Port Dover—The Town Council plans to install a hydro system. J. Slian, Town Clk.

Que., Montreal—The Southern Canada Power Co., Coristine Bldg., is in the market for a 150 kw. and a 300 kw. motor generator set, second hand, the generator end 250 volts direct current, motor end 3 phase, 60 cycle, 220 volts synchronous motor, or separate machines of identical capacities and characteristics. L. C. Haskell, Purchasing Agent.

Que., Verdun—The Town Council will soon receive bids for repairing and reinforcing its electric-lighting and water works plants. Estimated cost, $50,000. G. A. Ward, Town Clerk.

POWER

Vol. 47 NEW YORK, MARCH 26, 1918 No. 13



The National Shibboleth

By RUFUS T. STROHM

We've long been a nation of prodigal spenders
With Luxury reigning and Wealth as her slave,
But now we must change to a nation of lenders,
For Uncle Sam needs every cent we can save.
It's time that we exercised judgment and gumption
And gave to our allies a powerful lift
By cutting out waste and decreasing consumption—
The patriot's watchword is personal thrift.

* * *

Because the expense every day runs to millions
In feeding and clothing and arming our men,
We've twice taken loans that were measured in billions,
And now we're required to do it again.
But though it may seem like a burdensome trial,
The end of it all will be certain and swift
If every true citizen learns self-denial—
The secret of winning is personal thrift.

We ought to be proud that the gold we are saving
In office and workshop, at roll-top and bench,
Is spent in behalf of the men who are braving
The hardships and dangers of billow and trench.
Though prices mount higher and war-bills grow longer,
The conflict will have but the shortest of shrift,
And people and nation be better and stronger,
If everyone practices personal thrift.

* * *

The ease-loving habit of "letting George do it"
Is criminal now and must go to the wall;
The country's at war, and to pull bravely through it
The cares and discomforts must rest on us all.
Extravagant ways are a species of treason
From which we should hasten to cut us adrift
And substitute carefulness, saneness and reason—
We'll win if we cultivate personal thrift.

Tamarack Mills Power Plant

By CHARLES H. BROMLEY

Describes the chief features of the new oil-burning plant furnishing light, heat and power to the Tamarack Mills, Pawtucket, R. I. The plant was designed solely for fuel, has a 2500 kw. extraction turbine, heats the mills with forced-circulation hot water and has the largest atmospheric cooling tower in New England. Unusually interesting performance figures are given.

PERHAPS no plant is today commanding more attention in New England than that of the new Tamarack Mills, Pawtucket, R. I., the turbine room of which is shown in Fig. 1. Certainly, no engineers were ever prouder of their plant than are Charles Teft, the chief engineer of the plant, and Jencks and Ballou, consulting engineers who designed it. To get a proper perspective of this power house one must go back to 1914, when the plant of the Jencks Spinning Co., alongside the Tamarack Mills plant, was using coal, and to 1916 when oil was introduced as fuel for this plant. With coal the results were:

	Per Ton
Fuel: Crozer-Pocahontas, 14,500 B.t.u., per lb	$4.40
Equivalent evaporation per lb. combustible, lb	12.33
Cost per 1000 lb. steam, cents.	18.2

When the change to oil was made, tests in 1916 with oil as fuel gave the following chief results, the costs including operating and overhead charges.

YEARLY SAVING WITH OIL.

Weekly kilowatt-hour output	195,400
Yearly kilowatt-hour output	10,160,000
Cost per kilowatt-hour output, exclusive of makeup water, cents	0.588
Cost per kilowatt-hour in 1913 with coal, cents	0.662
Difference in cost, cents	0.074
Yearly saving 10,160,000 × 0.00074	$7500

[Those interested who may want further cost and performance data are referred to two articles on this plant by the present writer in *Power* for Dec. 1, 1914, and Dec. 19, 1916.]

So when the Tamarack plant was proposed the management merely needed a contract for oil at a favorable price to immediately decide what fuel it should be built to burn. The management got a price of 92c. per bbl. of 42 gal. of oil, delivered and averaging as following: Moisture, 0.3 per cent.; sulphur, 3.56 per cent.; sediment, trace; specific gravity, 0.960; Baumé gravity, 15.9; flash point (closed cup), 178 deg. F.; fire point (open cup), 262 deg. F. The oil is a Mexican product. No one hopes now to close a long-term contract at this price. There is a 257,500-bbl. oil-storage station at Providence a few miles away, and oil from here is delivered to the Tamarack plant in cars. Now that the Fuel Administration controls fuel oil, one is interested to know how the contract is affected. Well, the mills are making Government war goods, and timely and adequate delivery is reasonably well assured at the contract price. The plant was designed for oil exclusively, no coal or ash-handling equipment being installed.

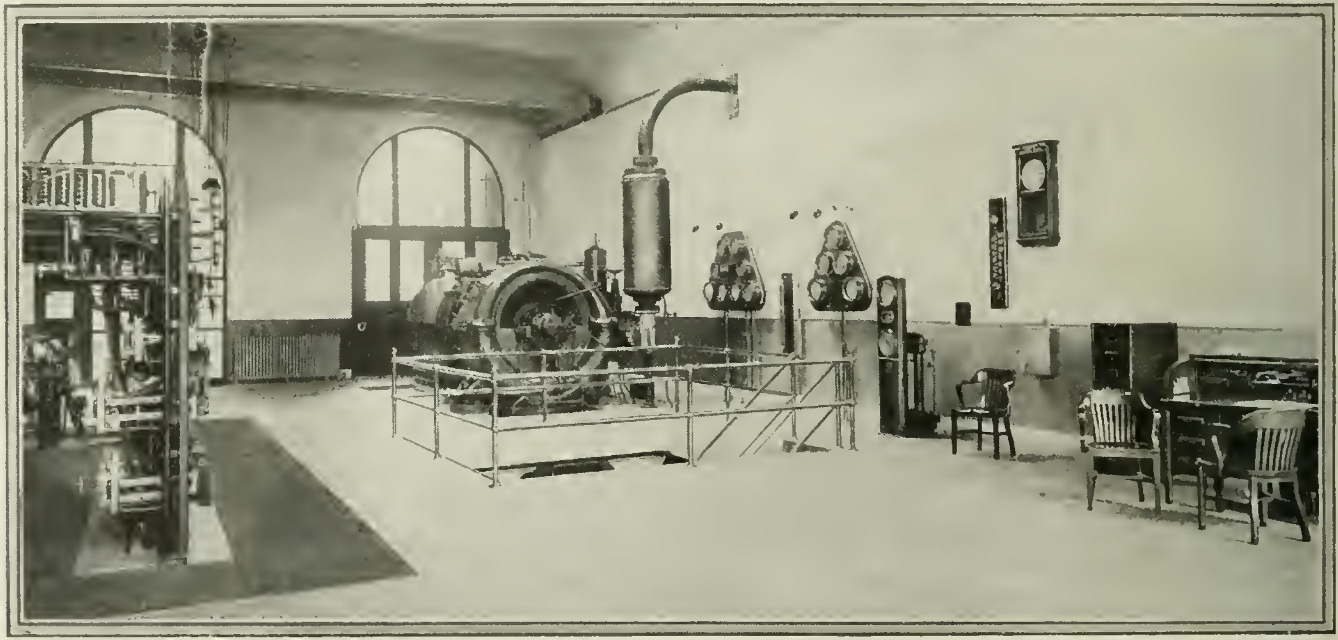


FIG. 1. VIEW OF TURBINE ROOM, TAMARACK MILLS, PAWTUCKET, R. I

The Tamarack plant consists of four water-tube boilers (B. & W. type) set with the bottoms of the front tube headers 8 ft. above the floor. Fig. 2 is a view of the boiler room. There are two furnace doors per boiler, and at each is a steam atomized (Hammel) oil burner, giving one burner for every seven tube headers. The burner produces a flat flame by reason of the impact of oil upon a renewable steel plate in each burner tip. Two oil-storage tanks, each of 24,000 gal. capacity, are used, the contents being kept at 115 deg. F. by live steam from the boilers admitted through reducing valves to pipe coil heaters in each tank. Exhaust steam from the oil-pumping outfit gives the oil a temperature of 160 deg. F. at the burner. This is 18 deg. F. below the flash point of the oil. The usual furnace draft carried is 0.2 in., the best boiler rating 40 to 50 per cent. above builders' rating, and the evaporation from and at 212 deg. F. per lb. of oil averages 15 pounds.

Throughout the plant the piping is one of the finest jobs the writer has ever seen. By great care in drawing up the specifications, the cost for extras was less than 1 per cent. of the total cost of the piping. A 16-in. lap-welded steel steam header is connected to the boilers by two 90-deg. bends (6-in. pipe) of 4 ft. radius each, having a nonreturn valve between each bend. Fig. 5 shows the exhaust piping at the spiral riveted free exhaust pipe.

All auxiliary exhaust is led to a 10-in. cast-iron main supplying exhaust steam to a closed feed-water heater of 900 sq. ft. heating surface. From the feed-water heater the 12-in. wrought-iron auxiliary exhaust main is continued to a back-pressure valve and then to the 24-in. spiral riveted free exhaust pipe. A tilting trap pumps water to a feed tank, from which the heated water enters the pump suction main. Two feed pumps are used, one a duplex 10 and 7 x 12-in., the other a three-stage centrifugal. The 6-in. discharge main is of cast iron and has a 4 x 1¼-in. venturi tube inserted in it. The branches to the boilers are of brass, and each branch has a "drop" pipe leading to each drum of each two-drum boiler. To avoid shock and pulsating flow, which would disturb the accuracy of the venturi feed-water meter, a large cast-iron air chamber is placed in the discharge main between the venturi tube and the pumps. Two-inch brass globe valves are used for controlling the feed to each boiler. The feed to the boilers averages 190 deg. F.


FIG. 2. OIL-BURNING BOILER ROOM, TAMARACK MILLS

The feed-water tank receives the condensate from the surface condenser attached to the main unit, also water from the turbine bearings and from the various drains throughout the plant. Fig. 3 is a view of the auxiliaries room.

The main four-stage turbine is of the extraction type, 2500 kw., 3600 r.p.m., 155 lb. steam pressure. Steam is bled from the second stage at from 1 to 10 lb. gage pressure for heating the water used for heating the mill buildings. More about the hot-water heating system later. The turbine is served by a surface condenser of 5000 sq.ft. As no adequate cheap water supply is available for condensing purposes an atmospheric cooling tower 20 ft. wide, 120 ft. long and 35 ft. high, handling about 5000 gal. of water per minute during cool weather, is used. The 12-in. circulating pump is of 4500 gal. per minute capacity, driven by a 95-hp. two-stage turbine. The discharge water goes to the cooling tower through an 18-in. pipe and returns to the pump suction through one of the same size. This tower has not yet had an opportunity to show what it can do under summer conditions, but judging what it will do based on winter operation, in the way of vacuum and cost of handling water, all concerned are indeed enthusiastic, especially Jencks and Ballou, the consulting engineers who designed the plant. The recording instruments are well arranged, as shown in Fig. 4. The main water connections to the tower are shown in Fig. 6.

The hot-water heating system is of considerable interest. Exhaustive investigations led to a decision between a vacuum steam heating system and forced hot-water circulation. The successful company bid on both, but guaranteed appreciably better economy for the hot-water system. The contract was awarded for the latter system. The essential facts are these: The mill is devoted chiefly to cotton spinning, and the main mill, of red brick, is 368 ft. long by 172 ft. wide, has four

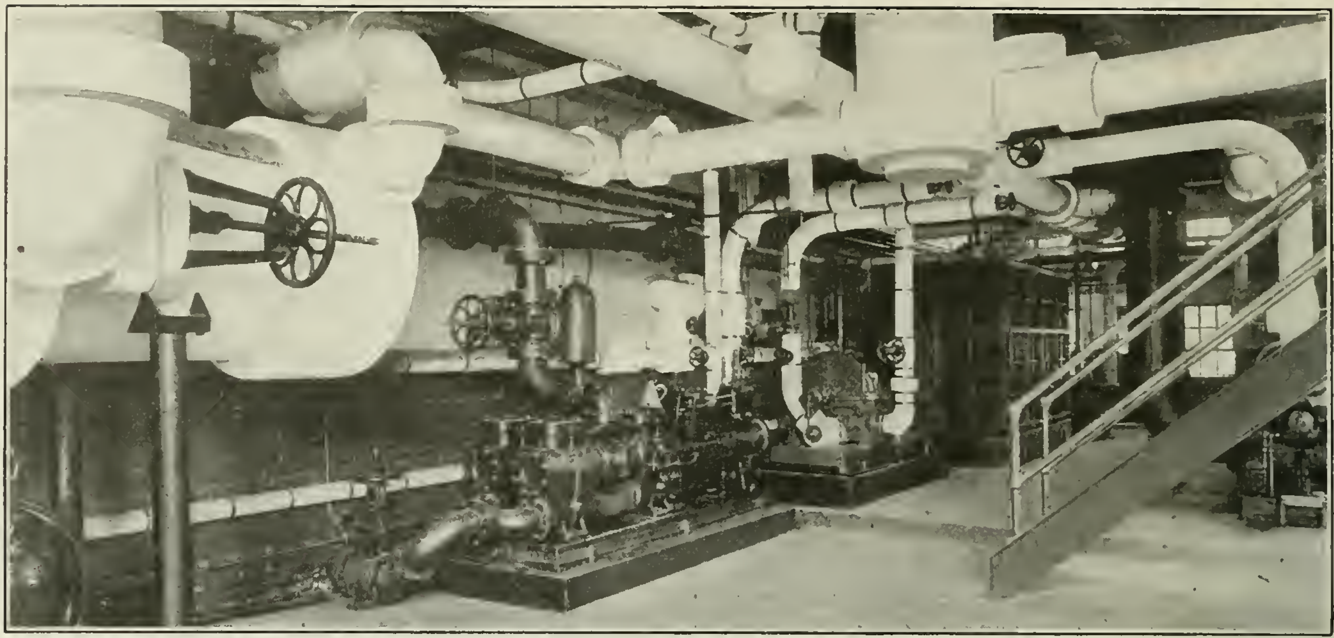


FIG. 3. ONE SIDE OF THE AUXILIARY ROOM, SHOWING PIPING AND FEED PUMPS

stories and a basement. The stories are high, ranging between 18 and 19 ft. The height of the basement varies between 8 ft. 8 in. and 13 ft. 8 in. The total floor area of the mill, including the basement, is 334,500 sq.ft., and the cubical content, including basement, is 5,720,000 cu.ft. Glass area, 43,320 sq.ft.; wall area, 40,000 sq.ft.; skylight area, 3870 sq.ft. These include three toilet towers. The radiating surface totals 22,800 square feet.

At the south end of the mill is a storehouse adjoining the power house. This structure is 78 ft. long by 172 ft. wide, the stories 9 ft. each except the first, which is 18 ft.+. The floor area is 47,200 sq.ft.; volume, 629,600 cu.ft.; glass area, 1980 sq.ft.; wall area, 6760 square feet.

For the mill, the ratio of heating surface to volume in cubic feet averages 1 to 251. The ratio varies of course for different parts of the mill, but ranges from 1 to 155 for the top story to 1 to 434 in the basement.

For the storehouse, the average ratio of radiating surface to cubic-foot volume is 1 to 547.

The radiating surface in the buildings is of 1¼-in. pipe in coils distributed overhead and on the walls beneath windows.

The main pipes extend from the mill through the storehouse and into the power house, where connection is made to the circulating pump. The latter unit is situated in the basement of the power house. The pump is of special design for this job and is direct-connected to the steam turbine. The pump has a 6-in. suction and a 5-in. discharge, and maintains a differential pressure between the suction and discharge of 25 pounds.

The steam turbine is supplied with steam at 150 lb. pressure and exhausts at a back pressure ranging from 1 to 5 lb. The exhaust from the turbine is led to the heater located in the storehouse. This is a straight tube heater of special design for this job, with capacity

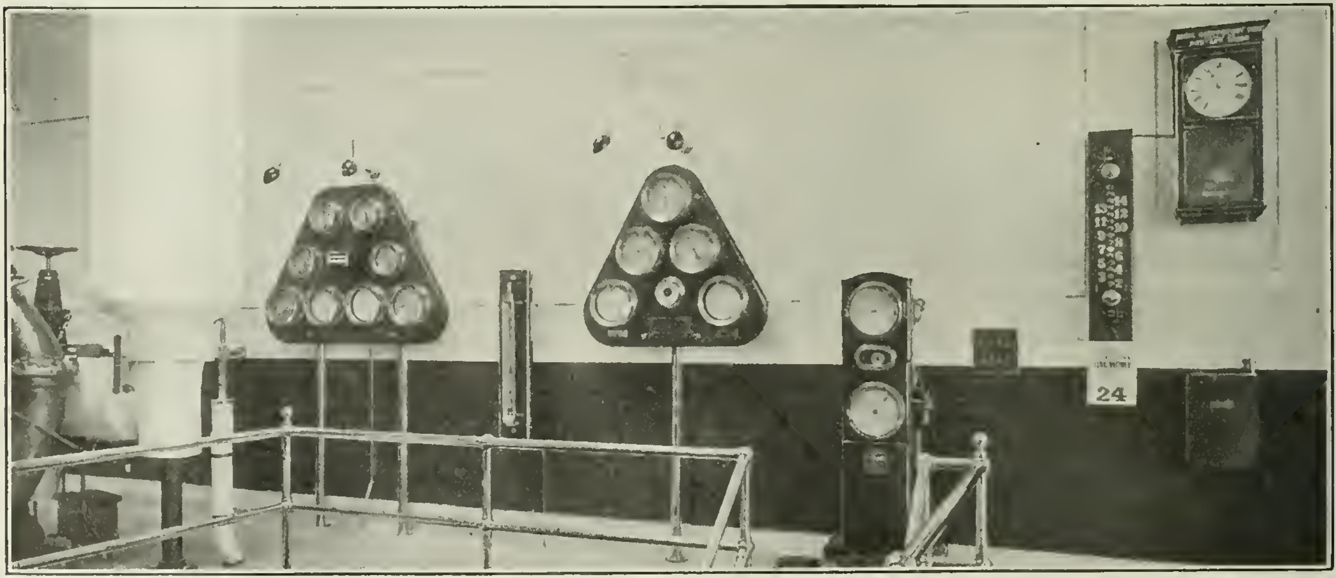


FIG 4 UNUSUALLY GOOD ARRANGEMENT OF RECORDING INSTRUMENTS

to maintain the flow temperature of water to any desired temperature ranging from 100 to a maximum of approximately 210 degrees.

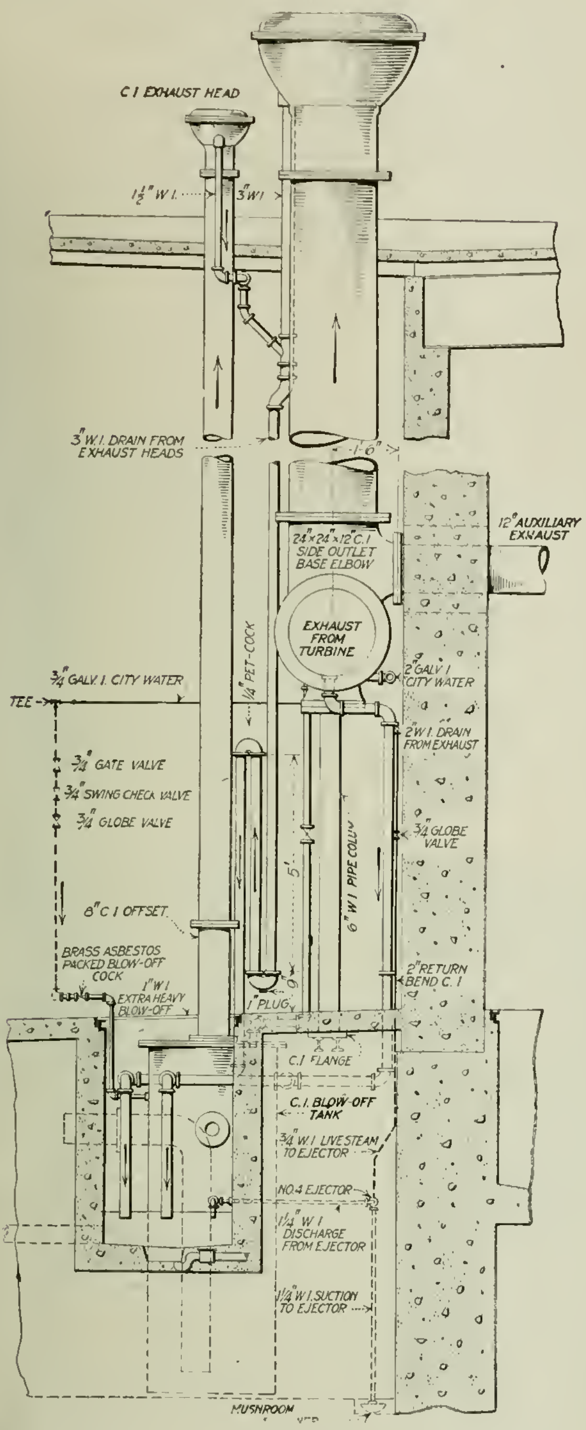


FIG. 5. EXHAUST AND BLOWOFF CONNECTIONS

The exhaust from the hot-water circulating pump turbine is also connected to the heater and there is a live-steam connection for use when the main turbine is not running. The hot-water circulating pump turbine is designed to give full capacity with steam pressure as low as 70 lb. Thus the boilers at night or on Sundays may vary in pressure considerably without interfering with the proper heating of the mill. The governor of this turbine is equipped with thumb-screw adjustment that will vary the speed of the pump from zero to maximum. In this way more or less water can be circulated, according to the flunctuating demands occasioned by the weather conditions.

The volume and pressure of the steam supply to the heater is controlled by hand to conform to the demands of the work in the mill, and to the outside temperature and other conditions. The pipe used is wrought steel. Long-turn fittings were used where the friction conditions made this advisable, but regular

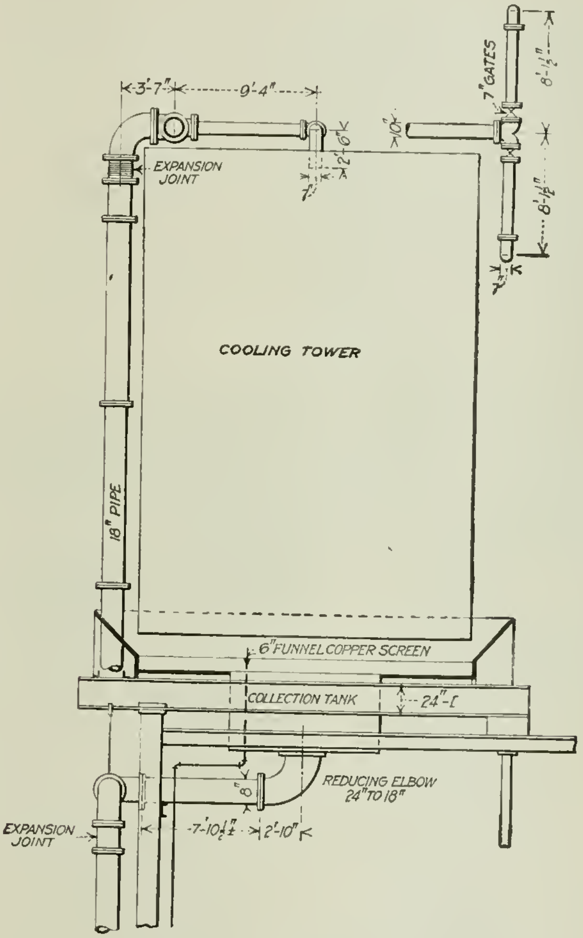


FIG. 6. WATER CONNECTIONS AT COOLING TOWER

PRINCIPAL EQUIPMENT OF TAMARACK MILLS PLANT, PAWTUCKET, R I

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
4	Boilers	Water-tube	400-hp.	Steam generation	150-lb. pressure.	Babcock & Wilcox Co
1	Turbine..	Extraction..	2500-kw	Main unit......	150 lb., 29-in. vacuum, 5-lb. extraction.	General Electric Co
1	Exciter.	Turbine-driven	35-hp	Main-unit excitation	3,600 r.p.m., 280 amp., 125 volts.	General Electric Co
1	Exciter.	Motor-driven	50-hp.. ..	Main-unit excitation	1,200 r.p.m., 48 amp., 125 volts	General Electric Co.
1	Condenser	Surface.	5,000-sq.ft	Main unit.....	Cooling tower water.	C. H Wheeler Mfg. Co
1	Cooling tower.	Atmospheric	20 x 35 x 120 ft	Main-unit condenser	Atmospheric	C. H Wheeler Mfg. Co
1	Pump	Centrifugal..	350-g.p m.	Boiler feed	Lea-turbine-driven.	Platt Iron Works
1	Pump	Reciprocating	10 x 7 x 12 in..	Boiler feed.	150-lb. pressure.	Platt Iron Works
1	Oil-burning Equipment, Complete	Steam..		Oil for boiler purposes.		Hammel Oil Burning Equip. Co
1	Heater	Closed ...	900-sq.ft...	Feed-water heating	Exhaust from all auxiliaries..	C. H. Wheeler Mfg Co.
1	Heater	Closed. ...		Mill-heating system.	Extraction steam for main turbine	General Fire Extinguisher Co
	Heating system.	Hot-water.....		Heating mills ..	Forced circulation .	General Fire Extinguisher Co
1	Pump	Centrifugal......	725 gal. per min...	Hot-water circulation	1,550 r p m., 54-ft. head	Goulds Mfg Co
1	Turbine	Steam..		Hot-water pump drive. .	1,550 r p.m..	D. E. Whiton Machine Co
1	Turbine. ..	Steam...		Feed-pump drive	2,800 r p m.	D. E. Whiton Machine Co
1	Meter.	Venturi....	4-in	Feed water		Builders Iron Foundry Co
1	Switchboard	Direct-control				General Electric Co

fittings were used to a great extent, especially on the smaller sizes of pipe.

The system was designed to guarantee the following temperatures with outside temperature at 5 deg. below zero: Main mill, 65 deg.; toilet towers, 55 deg.; opening room, 60 deg.; storehouse, 40 degrees.

In the severe weather of this winter, with the temperature often lower than 10 deg. below zero, this system maintained satisfactory temperatures, thus exceeding the guaranteed temperatures.

Uniform circulation has been produced without any changes in the design of the piping since the system was first started.

This plant is commanding the attention of all New England, particularly that of the textile industry. Its performance portends much for the future of fuel oil in New England.

The water, light and power industry in January had 6 per cent. more employees and paid 5 per cent. more wages than in December. As compared with the corresponding month of one year ago, the group as a whole reported in January, 1918, an increase of 13 per cent. in the number of employees and 27 per cent. in wages.

In a paper read recently at Chicago, Major R. A. Millikan, professor of physics in Chicago University, stated that war was 85 per cent. science and engineering and 15 per cent. actual fighting. As one application of science he mentioned that it had proved practicable to locate the position of a heavy gun within 50 ft. by observations on the sound waves set up on its discharge.

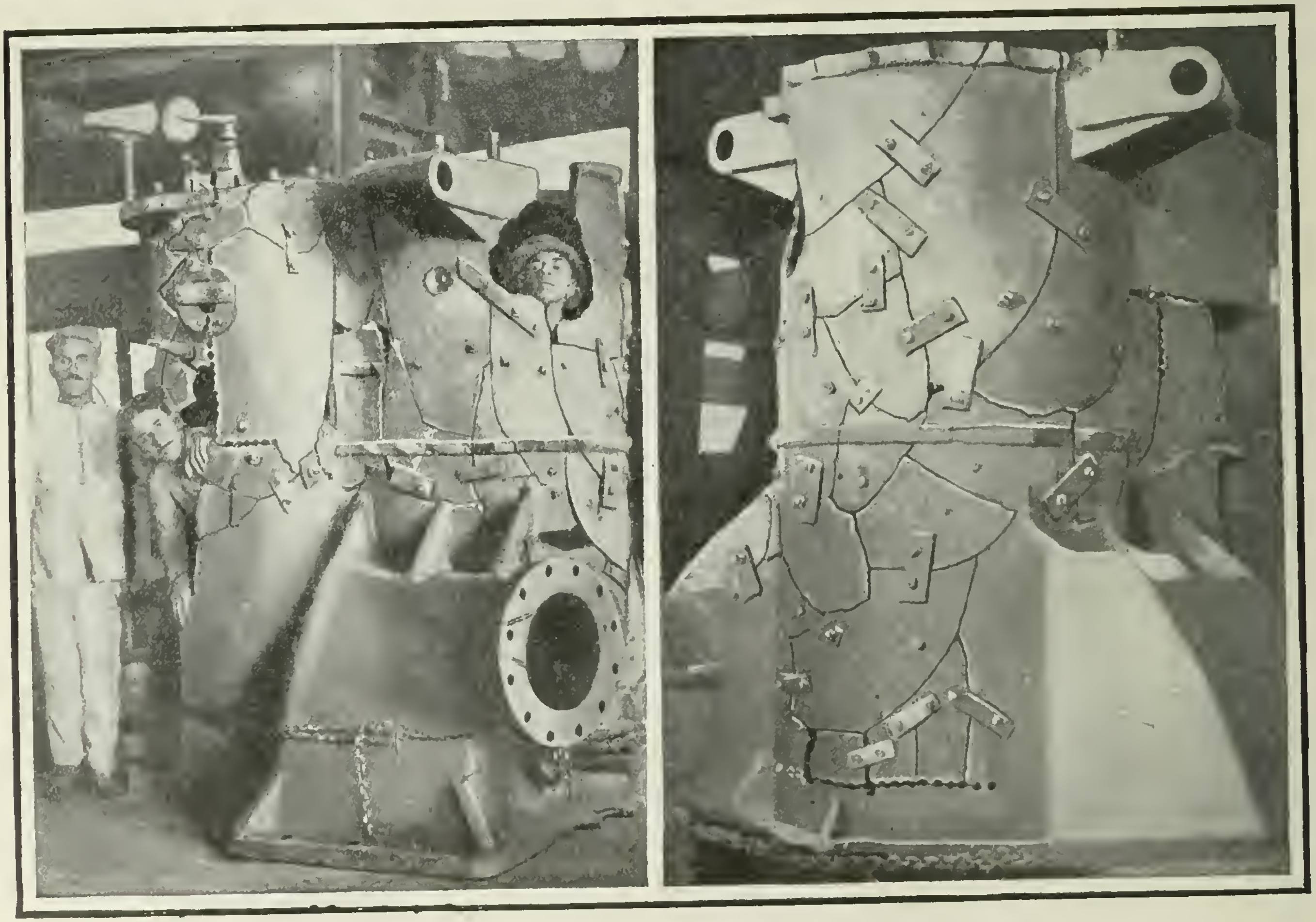
Kultur Mit Sledgehammer

The illustrations, reproduced from *Engineering* (London), show the damaged high-pressure cylinders of one of the German merchant ships interned in Brazil and illustrate the thoroughness of German destruction.

The 45 vessels which are interned, totaling 235,000 gross tons, had all been more or less seriously damaged, particularly the propelling machinery. In some cases new cylinders throughout had to be made; in others only portions of the cylinders had been destroyed. In one instance nearly 8000 holes must have been drilled in order to effect complete destruction. As it was found that the repair work could be carried out in the naval arsenal of Brazil, it was decided by the Ministry of Marine to proceed immediately with the recasting of the damaged cylinders and liners, and great credit is due to the engineering officers of the Brazilian Navy and to the personnel of the arsenal, not only for executing the work, but for the expedition with which it was carried out.

The cylinders illustrated had been broken into hundreds of small pieces, and in order to make new cylinders to suit the set it was necessary to assemble as many pieces as possible so that their dimensions could be measured accurately.

It is an interesting fact that most of the broken parts of the machinery were carefully stored between decks, evidently in order to be used as scrap in Germany in the event of the return of the ships to the "Fatherland."



WHAT "SCHRECKLICHKEIT" DID TO AN INTERNED GERMAN STEAMER IN BRAZIL

Distinguished Engineers of New England

New England is the home of many distinguished engineers. It was there that George H. Corliss made his engine, which became a famous type. E. D. Leavitt, of Boston, had become a distinguished engineer before he died, and among the boys that Leavitt had in his office some are today holding positions of appreciable magnitude. Edwin Reynolds, who designed the last of the great reciprocating engines, was a New Englander. And there are so many others who have "drunk their cup a round or two before and one by one crept silently to rest" that it is regrettable that space here does not permit of saying something about them and others, who, fortunately, are living. There follow brief sketches of some engineers in New England who are well known for their interest in and contributions to the art.

CHARLES T. MAIN

CHARLES T. MAIN, Boston, President of the American Society of Mechanical Engineers, was born in Marblehead, Mass., Feb. 16, 1856. He is a graduate of the Massachusetts Institute of Technology, and after graduation was an assistant in the department of mechanical engineering in that institute. In the late 70's he became draftsman for the Manchester Mills, Manchester, N. H. Later he became engineer for the Lower Pacific Mills, Lawrence, Mass.; in 1886 he became assistant superintendent, and in July, 1887, was made superintendent.

In all Mr. Main put in eleven years in these mills, having charge of all engineering and of the reorganization and operation of the mechanical department. After a year in Providence, R. I., he formed an association with F. W. Dean, whose photograph, by the way, should appear here were it not that Mr. Dean is serving the Government and unavailable at this writing. These engineers became famous for their textile-mill work, which later extended to general engineering. The association lasted for fourteen years, or from 1893 to 1907. The small waterwheel installations grew to great hydro-electric projects. Mr. Main has engineered four hydro-electric developments aggregating 280,000 hp. for the Montana Power Co. He is president of the Engineers' Club, Boston; member of the American Institute of Consulting Engineers; Boston Society of Civil Engineers, and other technical societies. He became a member of the American Society of Mechanical Engineers in 1885, served as manager for three years, and was elected president at the last yearly meeting in December, 1917. He has long been active in public life. As president of the American Society of Mechanical Engineers he is sure to play a laudable part in America's war against the Hun. The society has been called upon by the Government to assist in solving many knotty problems related to the war, and it is fortunate that a man of Mr. Main's capacity and experience is guiding the society through these propitious times for the engineer.

JOHN R. FREEMAN

JOHN R. FREEMAN, Providence, R. I., is, perhaps, New England's most distinguished engineer. Born in West Bridgeton, Me., July 27, 1855, he graduated from "Tech" in 1876. In 1904 Brown honored him with the degree of Sc.D., and Tufts' did the same in 1905. From 1876 to 1886 he was engineer with the Water Power Co., Lawrence, Mass.; from 1878 to 1886 assistant consulting engineer to Hiram F. Mills, and for the following ten years chief engineer, Associated Factory Mutual Insurance Co. He was also consulting engineer on water supply and mill construction for various corporations and for New York, Boston, Los Angeles, Baltimore and San Francisco. He was civilian engineer, Supplies Board, War Department, in 1902; advised on the Panama Canal locks and dams and for the Canadian government on water-power conservation. He is trustee of the Massachusetts Institute of Technology; was president (1893), Boston Society of Civil Engineers, vice president (1902), American Society of Civil Engineers, president (1905), American Society of Mechanical Engineers, member Providence Chamber of Commerce and fellow of the American Academy of Arts and Sciences. In 1899 he made extensive investigations of New York City's water supply; he was chief engineer of investigations for the Charles River Dam, Boston Harbor, in 1903, and in 1903-4 was consulting engineer on drainage and sanitation for the Boston Metropolitan Park Commission. He planned the hydro-electric development on the Feather River, Calif., in 1905, also developments along the St. Lawrence and Long Sault. He was in charge of the water-power investigations of the New York State Water Supply Commission. At one time he was a member of the Water Commission of Winchester, Mass. Mr. Freeman has always been active in general business and financial matters, being president of the Manufacturers, Rhode Island, Mechanics, State, Enterprise and the Associated Factory Mutual Insurance Companies; director Rhode Island Trust Co., Providence Gas Co.

DR. IRA N. HOLLIS, Worcester, Mass., is the President Wilson of the American Society of Mechanical Engineers. His utterances when president of the society are full of the same lofty, substantial vision and comprehension of events in engineering as President Wilson's are of the changing social fabric. Born in Mooresville, Ind., 1856, he graduated from the Louisville, Ky., high school, took up the machinist's trade and later entered the United States Naval Academy. He served on cruisers "Quinnebang," "Alert," "Hartford," "Richmond" and "Charleston." In 1884 he was a member of the advisory board that designed the ships of the famous White Squadron. Following this he served under the late Admiral Melville, chief engineer, United States Navy. In 1893 he resigned to become professor of engineering, Harvard University, where he remained for twenty years or until he became president of Worcester Polytechnic Institute. Since the outbreak of war Dr. Hollis has been of most valuable assistance to his Government in engineering problems of the war.


DR. IRA N. HOLLIS

PROF. EDWARD F. MILLER is one of the most widely known men in the field of power-plant engineering. He is head of the Department of Mechanical Engineering, Technology, which department is maintained by Harvard University and the Institute; he is also director of the engineering laboratories of "Tech," from which he graduated in 1886. He planned the greatest part of "Tech's" new engineering laboratories. He is a master at harnessing theory and practice to give the best teamwork. The engineer officers now instructed by him for the Shipping Board's merchant marine will swear to that. He is author of valuable engineering literature. Professor Miller is a member of the American Society of Mechanical Engineers, American Society of Refrigerating Engineers, American Society of Civil Engineers, American Academy of Arts and Science, Boston Society of Civil Engineers, and honorary member of the National Association of Stationary Engineers. He is Chief Instructor in Engineering for the Shipping Board, member Boiler Code Committee.


PROF. EDWARD F. MILLER

GEORGE HALE BARRUS, of Boston, is closely identified not only with the development of power as applied particularly to the textile and paper industries of New England, but with its development nationally. He is a graduate of the class of '74, Massachusetts Institute of Technology. Mr. Barrus has conducted investigations and experiments in steam engineering for the United States Navy and for marine purposes generally. Under the late and well-known Prof. Channing Whitaker he supervised the erection of the steam-engineering laboratory of old Technology, the first of its kind in the United States. His works on boiler and engine tests are known internationally, and he is chairman of the power-test committee of the American Society of Mechanical Engineers. Mr. Barrus was vice president and member of Council of that society from 1905 to 1906; is a member of the Boston Society of Civil Engineers, New England Water Works Association, Society of Naval Architects and Marine Engineers, Bostonian Society, Engineers' Club of New York and the Technology Club.


GEORGE H. BARRUS

JOHN A. STEVENS, Lowell, Mass., was born in Galva, Ill., 1868. He left school at the age of 7, but later graduated from the East Saginaw, Mich., high school, and spent a year at the University of Michigan. He served as machinist in the Pere Marquette Railroad shops, and as engineer on the Lake steamers, "Sappho," "Byron Whittaker," "W. H. Stevens," "Roman" and "Cambria." At 27 he held a marine engineer's unlimited license, and was engineer on the ocean steamships "Indiana," "Illinois," "New York," "St. Louis" and "St. Paul." In 1896 he became chief engineer, Merrimack Manufacturing Co., Lowell, appointed to the Massachusetts Board of Boiler Rules by Governor Curtis Guild in 1907, reappointed by Governor Draper in 1910, studied European engineering practice in 1909 and later engaged in consulting work, appointed chairman Boiler Code Committee, A.S.M.E., in 1911, and to his dynamic personality the Code owes much for its success. He was one of the early users of stage and exhaust steam from turbines; one of two inventors of a 25,000 hp. water-tube boiler.


JOHN A. STEVENS

I. E. MOULTROP, Boston, widely known in engineering circles, began his career as an apprentice machinist with the Whittier Machine Co., later to become that company's chief draftsman. Twenty-six years ago he resigned this position to go with the Boston Edison Co., with which he has served ever since. His first job with the Edison company was to lay out and install the steam equipment for the old Atlantic Avenue Station, commonly known as the third station. Since then he has grown with the development of power generation and transmission. For some years he has been assistant head of the construction bureau of the Edison company, directly responsible for work of all character on power stations, substations, office buildings, etc., and indirectly responsible for the construction of the transmission lines, underground and overhead. Mr. Moultrop has been manager and vice president of the American Society of Mechanical Engineers, and for five years was chairman of the membership committee of that society; he also serves on the Boiler Code Committee. He is a prominent member of the National Electric Light Association.


I. E. MOULTROP

WALTER A. DIMAN, Manchester, N. H., is the son of George H. Diman, consulting engineer, American Woolen Co. Born in Woonsocket, R. I., 1879, he was educated in the public schools, Lawrence, Mass.; entered the Naval Academy, Annapolis, September, 1898, graduated in 1902; performed service in the Navy at the Asiatic Station from 1902 to 1905, when he returned for duty at the Bureau of Steam Engineering, Navy Department, Washington, D. C. After a tour of duty here he was detailed as engineer officer of the President's yacht "Mayflower," returning to duty at the Bureau of Steam Engineering; detailed for duty at the Naval War College, Newport, R. I., and then transferred in 1910 as engineer officer of the U. S. S. "New Jersey." He resigned from the Navy October, 1911, to become superintendent of power, Amoskeag Manufacturing Co., Manchester, N. H. He is a member, American Society of Mechanical Engineers, the American Society of Naval Engineers and belongs to several clubs.


WALTER A. DIMAN

GEORGE A. LUCK, chairman, Massachusetts Board of Boiler Rules and chief of the commonwealth's Boiler Inspection Department, was born in London, Eng. He served his apprenticeship to the machinist's trade there, and when a young man came to America. One of his first jobs was as watch engineer in the old Boston Electric Light Co. That was when the electrical industry was still in swaddling clothes. Later, he was engineer for the Reece Buttonhole Machine Co., Boston, the Franklin Brewery, Boston, and later became engineer for the Hamilton Mills, Amesbury, Mass. Following this he went to Chicopee to take charge of the power plant of the Dwight Manufacturing Co. In 1906 he took the civil-service examination for state boiler inspector, and in September, 1907, was appointed, together with five others, a law having passed the legislature increasing the number of inspectors from ten to fifteen. Joseph McNeil was then chairman of the Board of Boiler Rules and chief boiler inspector. Mr. Luck was assigned to the district embracing the suburbs of Boston. In July, 1912, he became acting chief and chief in June, 1914.


GEORGE A. LUCK

WALTER H. DAMON, superintendent of power generation, United Electric Co., Springfield, Mass., typifies the purposeful, persistent New Englander. Compelled to face the world practically alone before he could with dignity wear long pants—at 11, to be exact — he has fought a long fight, and won. Like most boys whom the Fates have cast up and would make of them derelicts, young Damon tried his hand at various things until one momentous day he got a job wheeling coal into the little boiler room of the United Electric Co. That was twenty-six years ago. He had not been on the job long before he got his hands on—well, it was a copy of *Power*. Friend Walter says the world unfolded. Mr. Damon is a member of several engineering societies, including the American Society of Mechanical Engineers and the National Electric Light Association. He has held most of the chief offices in the National Association of Stationary Engineers; he was elected national president of this association in 1915.


WALTER H. DAMON

FRANK W. TOWNSEND, of Providence, R. I., is a chief operating engineer of the new school. Born in the country, he was always fascinated by the blacksmith shop and the thumping engine down at the old stone mill. He laid the foundation for ability as an operating engineer by getting machine-shop experience at the start. He attended night school and studied hard the few engineering books that came his way. Then came a job in a machine shop doing marine work. Of course he soon went to sea, started somewhere in the stoke-hole and after seven years had his marine chief engineer's unlimited license and commanded the mechanical equipment of a large ship. Not that swimming through bilge-water to start a balky pump took the romance from a ship's engine room, no, that is what gives it; but the shore had a stronger call. He is now chief engineer of the famous South Street Station, Narragansett Electric Lighting Co., Providence, an 80,000-kw. turbine plant having a 45,000 kw. compound turbine.

FRANK W. TOWNSEND

EDWARD H. KEARNEY is one of the best-known operating engineers in New England. Born in North Billerica, Mass., he graduated from the Howe Academy there, later serving three years as apprentice machinist. His apprenticeship served, he put in four years as journeyman and erecting engineer, and completed the four-year course in mechanical drawing in the night schools of Boston. He served as instructor in steam engineering for three years in Franklin Union, Boston. He held the position of assistant chief engineer for the Jordan Marsh Co.'s large department store, Boston, and for twenty years he has been chief engineer for the John Hancock Mutual Life Insurance Co. In the N.A.S.E. he has held the following important offices: state deputy for Massachusetts, chairman state educational committee, national vice president in 1911, national president in 1912 and secretary of the national educational committee in 1913, 1914, 1915 and 1916. Mr. Kearney has contributed largely to the technical press.

EDWARD H. KEARNEY

New England's Water Power

Most of the interesting figures relative to New England's water power which follow are given by Henry I. Harriman, of Chace & Harriman, Boston: In New England there are eight large rivers having considerable fall: Penobscot, 1500 ft.; Kennebec, 1000 ft.; Androscoggin, 2200 ft.; St. Croix, 400 ft.; Saco, 1900 ft.; Merrimac, 269 ft.; Connecticut, 2000 ft. and the Housatonic with 900 ft. These rivers drain 35,000 of the 60,000 square miles of New England. The Bureau of Corporations estimates that 600,000 hp. of water energy is now in use in New England and that these same developments can be improved to give 200,000 hp. additional. The minimum water power capable of development is placed at 1,000,000 hp., with a possible 2,000,000 hp. In developed and undeveloped water power Maine has nearly 1,000,000 hp.; New Hampshire, Vermont and Massachusetts, 200,000 to 300,000 hp. each; Connecticut, 160,000 hp. and Rhode Island, 16,000 hp.

The present water-power developments in New England total more than two billion kilowatt-hours.

Most large New England streams vary greatly in their maximum and minimum flow. At the Vernon plant, Connecticut River Power Co., the variation is from 1500 cu.ft. per sec. to 150,000 cu.ft. per sec., or 100 times the minimum. The extremely low flow occurs on relatively few days, and in an average year the plant has sufficient water to carry full load for nine months.

Among the large hydro-electric developments in New England are the plant of the Rumford Falls Power Co., on the Androscoggin at Rumford, Me.; the plant of the Androscoggin Power Co., on the same river, near Lewiston; the plants of the Cumberland County Power and Light Co., on the Saco River, near Portland; the plants of the Bangor Railway and Electric Co., near Oldtown and Ellsworth; the plants of the Central Maine Power Co., near Waterville; the plant of the Turners Falls Co., on the Connecticut River at Turners Falls, Mass.; the plant of the Connecticut Power Co., on the upper Housatonic; the plant of the Connecticut River Power Co., on the Connecticut River near Brattleboro; and the plants of the New England Power Co., on the Deerfield River. These various plants have an aggregate capacity of about 250,000 hp. Nearly all of them have been constructed within the last five years and indicate the rapidity with which our streams are being utilized and their energy transmitted to distant cities and towns.

Considerable progress has also been made in the development of storage and the consequent conservation of the flood waters of the spring. A dam at the outlet to Moosehead Lake impounds a total in excess of thirty billion cubic feet and is capable of more than doubling the minimum flow of the Kennebec River at Augusta. Storage reservoirs on the Rangeley Lakes and in the upper waters of the Androscoggin have assured a minimum flow of 2000 sec.-ft. at Rumford Falls and Lewiston, and a reservoir created in Somerset, Vt., is now storing enough water to produce in existing plants approximately 25,000,000 kw.-hr. which would otherwise be wasted.

Training Engine-Room Crews for America's New Ships

By HENRY HOWARD

Director of Recruiting Service, United States Shipping Board, Custom House, Boston.

WITH the recent putting into commission at Boston of the first of a squadron of training ships for training men to man the new Government-owned cargo fleets, the United States Shipping Board Recruiting Service has greatly increased its activities. It is planned to train 25,000 Americans, 21 to 30 years old, for sailors, firemen, coal-passers, oilers, watertenders, cooks and stewards in the new merchant marine.

There are now two training ships in commission at Boston, the "Calvin Austin" and the "Governor Dingley," formerly in the coastwise passenger trade. Each is a 3800-ton ship, having reciprocating engines of 2700 hp. Each ship accommodates from 500 to 600 apprentices, divided between the engine department, the deck department and the steward department. A third ship, the former Army transport "Meade" will soon be ready.

SOME OF THOSE WHO ARE HELPING AMERICA TO MAN HER SHIPS

Front Row (left to right)—Capt. Eugene E. O'Donnell, Supervising Inspector, Fifth District, U. S. Steamboat-Inspection Service; Capt. Robert M. Lavender, National Trustee, American Association of Masters, Mates and Pilots; Henry Howard, Director of Recruiting, United States Shipping Board; William S. Brown, National President, Marine Engineers' Beneficial Association; Capt. Arthur N. McGray, Secretary-Treasurer, Neptune Association, also representing the Masters, Mates and Pilots of the Pacific Coast.

Middle Row—Capt. Ulster Davis, National Trustee, American Association of Masters, Mates and Pilots; Capt. Luther B. Dow, Business Manager, American Steamship Licensed Officers Association, Inc.; George W. Willey, Business Manager, Marine Engineers' Beneficial Association, No. 59, of Boston; James J. Raftery, Jr., President, Marine Engineers' Beneficial Association, No. 59, of Boston; Capt. Irving Sparks, Boston Agent, Neptune Association.

Back Row—Winfield M. Thompson, Field Agent, U. S. Shipping Board Recruiting Service; Edward Clarence Hovey, Jr., Chief, Sea Service Bureau; Bert L. Todd, Secretary, Ocean Association of Marine Engineers; Thomas A. King, Chairman Board of Directors, Ocean Association of Marine Engineers; Henry G. Vaughan, Sea Service Bureau; Edward F. Flynn, Assistant to Director of Recruiting, U. S. Shipping Board.

Apprentices accepted for training are taken only after careful physical examinations. They sign an agreement to serve in the merchant marine for the duration of the war. It is expected that most of them will win promotion and remain in the service many years after peace is restored, for the United States is to maintain its rightful place among foremost maritime nations. Opportunities for advancement will be many.

Here is the program established for the men in training: 6 a.m., all hands tidy room; 7 a.m., breakfast; 8 a.m., general work; 9:30 a.m., discipline and instruction; 10 a.m., inspection; 10:30 a.m., boat drill; 11:45 a.m., clean up; 12 noon, dinner; 1 p.m., fire drill; 2 p.m., seamanship; 3 p.m., boat drill; 4 p.m., general work; 4:45 p.m., clean up; 5 p.m., supper; 6 p.m., muster and liberty; 6-9 p.m., recreation, bathing, etc.; 9 p.m., all lights out. There is one instructor for every ten apprentices.

The plan of training inexperienced young men on training ships evidently hit a popular chord from the first. In 48 hours after the announcement was publicly made that the "Calvin Austin" had been chartered as a training ship, more than 500 applications for enrollment on her were received at the national headquarters of the United States Shipping Board Recruiting Service at the Boston Custom House. Only American citizens are accepted for the training ships. All the instructors are American seaman to man American ships. The apprentices are paid $30 a month while training. The course is five to seven weeks.

Since the summer of 1917 the United States Shipping Board Recruiting Service has successfully trained engineer officers for the new merchant marine, finding its material among men already experienced as assistant engineers, firemen, oilers and watertenders. This work has been carried on at schools conducted by the Shipping Board at eight leading technical institutions in different parts of the country, with Prof. Edward F. Miller, of the Department of Mechanical Engineering at Massachusetts Institute of Technology, as chief instructor in engineering. The schools will continue until a sufficient number of officers are trained for the new Government-owned cargo ships.

The free Government Schools conducted by the Shipping Board are located at the Johns Hopkins University, Baltimore; Massachusetts Institute of Technology, Cambridge; Armour Institute of Technology, Chicago; Case School of Applied Science, Cleveland; Stevens Institute of Technology, Hoboken; the Tulane University, New Orleans; The Bourse, Philadelphia; and the University of Washington, Seattle.

The course ordinarily lasts about four weeks. Instruction is free to those who qualify for admission, but students have to pay their own living expenses. On graduating from an engineering school, a student goes to sea for two months' special training as a junior officer at $75 a month, if necessary. He is then free to go into the merchant-marine service at prevailing rates of wages.

The Shipping Board Recruiting Service conducts a Sea Service Bureau, with headquarters at the Boston Custom House and branches at other ports, for placing its graduates. This service is free.

Ever since the Recruiting Service was established, it has conducted free Government navigation schools for the training of experienced seamen as deck officers. Forty-one of these schools have been established, from the Atlantic to the Pacific, wherever the demand seemed to justify them. The enrollment headquarters for all the United States Shipping Board Recruiting Service activities are at the Custom House, Boston.

These may qualify for training as chief engineer, ocean-going, in a Shipping Board engineering school: First assistant, one year, ocean or coastwise steam vessels; second assistant, two years, ocean or coastwise steam vessels; fireman, oiler or watertender of three years' engine-room service, ocean or coastwise steam vessels, may qualify as chief on ocean steamer of 500 tons or under; chief, one year, lake, bay or sound; first assistant, two years, lake, bay or sound.

These may qualify as first assistant engineer, ocean-going: Second assistant, one year, ocean or coastwise steam vessels; fireman, oiler or watertender of three years' engine room service, ocean or coastwise steam vessels, may qualify as first assistant, 1000 tons or under; first assistant, one year, lake, bay or sound; second assistant, two years, lake, bay or sound; apprentice to machinist trade, with three years' service on marine, stationary or locomotive engines and one year at sea; graduate in engineering, nautical schoolship, with six months at sea; graduate in mechanical engineering at a technical college, with six months at sea; locomotive engineer, two years, with one year at sea; stationary engineer, two years, with one year at sea.

These may qualify as second assistant engineer, ocean-going: Third assistant, one year, ocean or coastwise steam vessels; chief, six months, lake, bay or sound; first assistant, six months, lake, bay or sound; second assistant, six months, lake, bay or sound; third assistant, one year, lake, bay or sound; stationary engineer in full charge of a 1000 hp. plant; locomotive engineer, one year, and six months at sea; stationary engineer of plant of less than 1000 hp. who has had six months at sea; apprentice to the machinist trade who has had six months at sea; graduate in mechanical engineering at a technical college, with three months at sea;[1] graduate in engineering, nautical schoolship, with three months at sea.[1]

These may qualify as third assistant engineer, ocean-going: Fireman, three years; oiler or watertender, two years (or combined service of two years in these grades), ocean or coastwise steam vessels; chief, six months, lake, bay or sound; assistant, six months, lake, bay or sound; graduate in engineering, nautical schoolship; chief, one year, river; assistant, one year, river; journeyman machinist who has been engaged in construction or repairs of marine engines.

Increasing the Life of Economizers

Throughout New England particularly, the average life of an economizer may be estimated as about 18 years. During this time, because of internal and external corrosion, there is a gradual thinning down of the walls of the headers and tubes. How serious this becomes depends upon the local conditions in each case, but on the average it may be assumed that the walls of the tubes become so thin that they are liable to fracture after the economizer is about 13 or 14 years old. This liability to fracture is greatly increased by any sudden shock, such as a water-hammer.

After a period of 16 or 17 years the walls of the tubes become so thin that it is impracticable to carry the usual high boiler pressure. To overcome this difficulty C. W. E. Clark, of Boston, and J. V. Santry, of Schumaker-Santry Co., Boston, have patented the application of a three-stage centrifugal pump in connection with these older economizer installations. The water is pumped from the primary heater through one stage of the pump to the economizer at about 40 to 50 lb. pressure, then from the outlet of the economizer to the suction of the second stage of the pump, the pressure being increased to the required boiler pressure. So far as the writer knows, George Diman, of Lawrence, Mass., was the first to propose this method of feeding water to economizers.

The application of this type of pump has materially increased the life of several economizer installations. In one case where the repairs had become excessive a pump of this type was installed and the pressure cut down from 175 lb. to 40 lb. This prolonged the life of the machine for a period of four years, and practically all the repairs due to tube and header fractures were eliminated during this period. The accompanying illustration shows all this so plainly that further description is unnecessary. During these times of high fuel costs and fuel shortage this method of feeding the water should effect worth-while savings in any plant where the economizer is out of service because it will not stand boiler pressure, but would hold if the pressure were reduced. The advantage of feeding, as shown in the full-page illustration, is that no boiler will "rob" the other of water; each will take what it needs without interfering with the other's supply.

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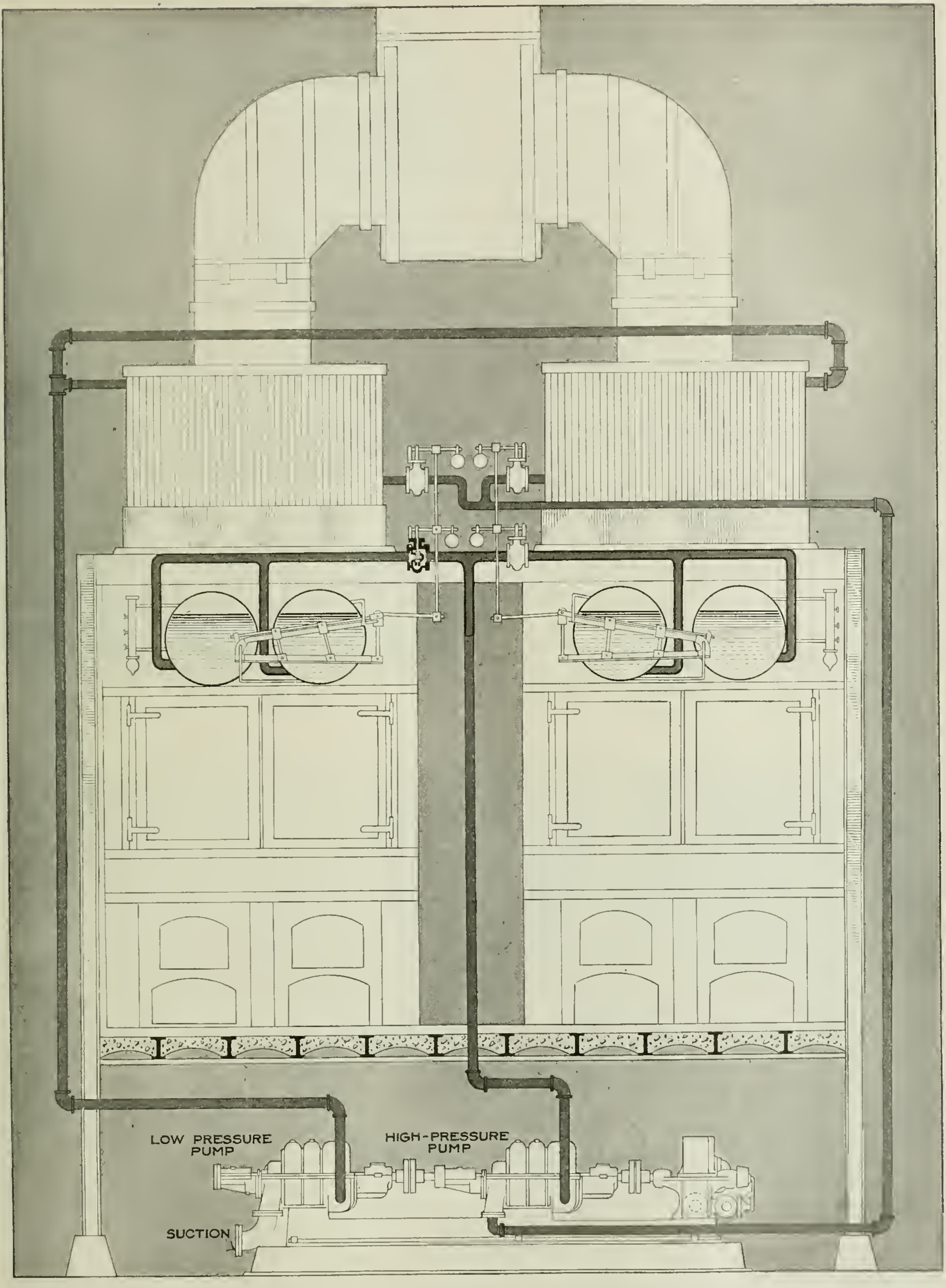
[1] This three months' service at sea may be obtained after graduation from the school and before taking United States Steamboat-Inspection Service examinations, for license as an officer



FEEDING WATER AT LESS THAN BOILER PRESSURE TO OLD ECONOMIZERS AND REGULATING FLOW AS REQUIRED TO EACH BOILER AND ECONOMIZER

Foreign Substances in Coal

The photograph, Fig. 1, shows of a pile of slate and rock which is a sample of the material received as coal and paid for as such by one of the largest manufacturing companies in Connecticut. The pieces are so large as to convince one that they were not left accidentally with the coal as it came out of the mines, for the reason that it was not in one or two cars, but many. It causes no end of trouble with the coal crusher, continually breaking gears and pinions, smashing bearings, etc. These breakdowns occurred so frequently that it became necessary to prevent them; this was accomplished, after trying various methods, by installing a set of overload relays. A 20-hp. induction motor is used for each crusher; only about 60 per cent. of the horsepower is required to crush the coal under ordinary conditions; the relays were set about 15 per cent. above the usual required power for the crusher. Cast steel is now used for the crusher gears.

While the average monthly cost per pound of steam for the year 1916 was $0.00027, it has greatly increased until it reached a figure of $0.00042. It would not be fair, of course, to charge this increase to bad coal only because the cost of labor and material has increased.

Sticks, stones, chains—most anything of that nature—in coal will cause serious delays. damage and possible service interruptions in a power plant. Protest by mail to the mine owners, when bought direct, is of no avail. As New England ordinarily gets two-thirds of its coal by water, Fig. 2 is of particular interest, for it shows what comes in with the coal in barges.

The company from which the photograph was received now sends such pictures, without comment, to the mine, and since doing this the foreign substances in the coal have greatly decreased. Try it.

FIG. 1. SLATE AND STONE TAKEN FROM COAL SOLD IN NEW ENGLAND. NOTE THE TWO-FOOT RULE

FIG. 2. SOME THINGS THAT COME IN COAL AND DAMAGE THE CRUSHER AND STOKERS

Bonus For Power-Plant Employees

By WARREN B. LEWIS
Consulting Engineer, Providence, R. I.

Bonus paid to power-plant employees does not mean that they must originate saving on which the bonus is based. The author bases the bonus on the saving in power-plant costs per unit output of product manufactured and gives detailed directions for enabling the management to quickly determine by reference to a curve, the bonus due employees.

THE term "bonus" generally means something over and above a fixed compensation or price, based on the net saving effected. It means that if the operator can reduce the cost per unit of product, he should receive a proportion of the savings. It does not mean that he is to originate the methods to be employed. A course of instruction may be, and generally is, necessary, but methods having been established, the employee receives a proportion of the savings effected because he maintains the standard set.

Establishing a Base-Line

In establishing a bonus there must be a starting point, which should be a reasonable efficiency. Call this a base-line. If the plant as a whole has been well operated, then its cost for a period of two or three years might be taken as the base-line. If there have been glaring faults, these should be corrected before the base-line operating costs are established.

The start must be made with the sum total of power-plant expenses, which must bear some definite relation to the product turned out in the plant as a whole. There are few cases where the cost of power (and I refer now to all the items under the general heading of power) does not bear a definite relation to the product manufactured. If the plant is operated at 100 per cent. capacity, the power-plant cost should bear a definite relation to the product in terms of pounds, bushels, yards, tons, etc. If the plant is operating at 50 or 20 or 80 per cent. of its capacity, the cost of power for each will have a relation unlike the others.

It is possible, then, to establish a curve that will show what the power-plant costs per unit of product should be at any given output, and this is the measure most satisfactory, as it includes every factor that enters into power costs. The manager need not worry about boiler or engine efficiencies, uses of steam or economical heating and lighting of buildings, but can group these under the general heading of "Cost per Unit of Product Manufactured," and the weekly or monthly report showing the power-plant costs need be simply divided by the product of the plant to determine whether the set standard is being maintained. He can then compare this cost with those of other plants with which he is familiar or to whose costs he has access.

The first step in establishing a base-line is to divide the power-plant costs into two items—those which bear little or no relation to the volume of product and those more or less proportioned to the volume of product. In every industry there are cost items that are fixed. Some of these are familiar to the accounting department and some are not. The familiar ones are interest, depreciation, taxes, insurance, etc., which are termed "overhead"; but there are others which are as definitely fixed. If the power plant is ready to serve the factory with any amount of power up to its maximum, then the other fixed charges consist of cost of labor, fuel required to bank fires and to keep engines, generators, pumps, etc., turning over but developing no useful power, certain amounts for lubricants, water, ash removal, etc. To a great extent the heating of buildings is an overhead charge against the power plant and is not affected materially whether the plant is running at 25 per cent. or 100 per cent. capacity. In some cases heating may have to be divided into the two elements, but in most cases it is a fixed charge. A certain amount of lighting comes under the head of fixed charges and is not affected by the volume of output.

We have, therefore, to determine, first, what the real fixed charges are on any individual power plant, and one proceeds as follows: Make an appraisal of the plant, determine the value of the land and buildings occupied, of the complete boiler equipment, engines, pumps, heaters, piping, generators, switchboards—everything concerned in the production of power, steam, light and heat, not forgetting the sprinkler systems, lighting systems, etc., which apply wholly to the power plant; also the main lines of pipe running to production centers in the manufacturing buildings, as well as main lines of wires, etc., these being a part of the power plant. Generally, the branch lines and pipes in manufacturing departments are considered as a part of the department and are not concerned in the establishment of power-plant costs. This appraisal having been made, certain charges are entered such as are commonly called overhead; namely, interest, depreciation, taxes, insurance, etc.

Determining Stand-by Losses

The second step is to determine what may be called "fixed costs regardless of output," or *stand-by losses*, in some such manner as follows: If the boilers are maintained at the usual pressure, engines turning over at normal speed, generators excited but delivering no current to the lines, or, in case of mechanical drives, shafting turning but all productive machinery stopped, a certain quantity of coal is being used which may be considered as a fixed cost regardless of production. This includes coal used in banking fires and rebuilding fires which have been cleaned. If one wants to be very accurate, the amount of ash resulting from the burning of this fixed amount of coal is determined, and the cost of removing that ash added.

Next determine what lubricants are used irrespective of production, and certain supplies such as pump and engine packings, boiler gaskets and numerous other things that are not affected by production. Current used for lighting main passageways, the yard, the engine and boiler rooms, etc., is a fixed charge. Coal used on Sundays and hoildays and that used at night is also a fixed charge.

The heating of buildings may in most cases be considered as a fixed factor. In some plants a decrease in the output carries with it the possibility of decreasing the number of departments to be heated; but in most cases the heating will be a fixed item and will not vary generally with the percentage of production of the plant.

Practically all labor employed in the power plant is a fixed item.

A considerable proportion of the total costs is as truly a fixed charge as are the usual overhead items; and the natural result is that if the plant is operating at 50 per cent. capacity, the cost per unit of these fixed charges is twice what it is when the plant is operating at 100 per cent. capacity. It is this that makes the final cost per unit of product not proportional to the volume of product.

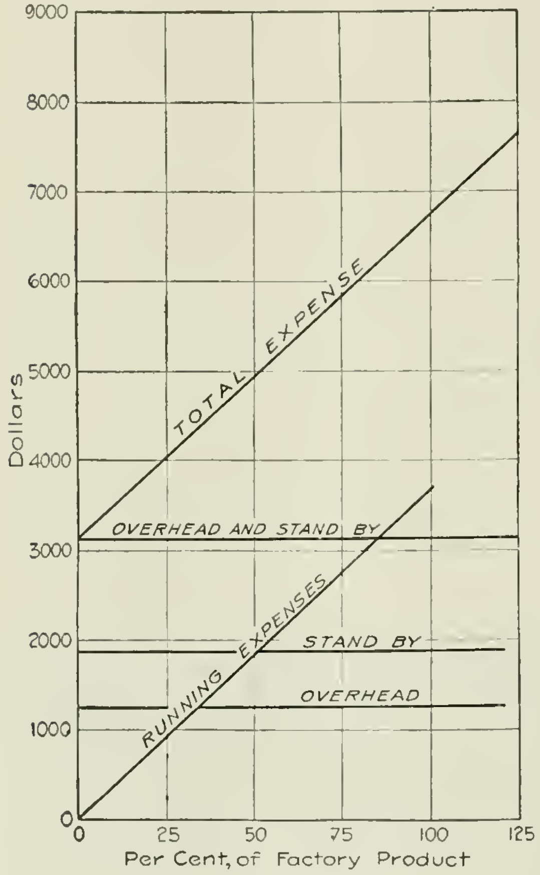


FIG. 1

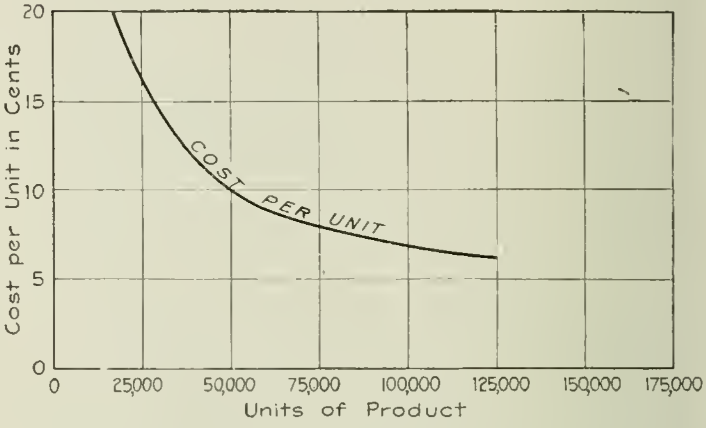


FIG. 2

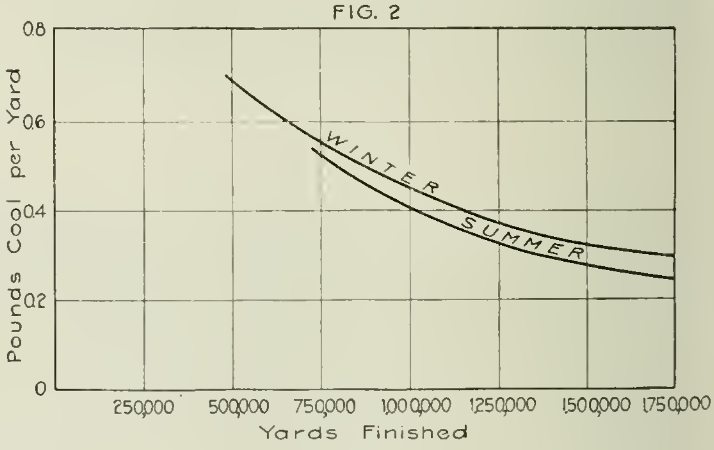


FIG. 3

FIGS. 1 TO 3. CURVES PLOTTED WHEN PLANNING A BONUS SYSTEM

Fig. 1—Expense Chart. Fig. 2—Unit Cost Curve. Fig. 3—Coal Consumption Per Unit of Production.

The third item to determine is the variable costs of the power plant, those which change with the product. As the amount of power required increases, the coal will increase in fairly direct proportion, assuming that the prime movers have a fairly flat water rate. If they do not, it is a simple matter to plot the relation between coal and product as a slight curve rather than as a straight line. If the boiler-feed water is purchased, it will be an item varying with the factory output. A certain part of the ash and a certain percentage of supplies will also be directly affected by the output. We have, therefore, a group of items which increases nearly proportionally to product, and in many instances may be considered as a straight line. If we now combine these two sets of costs, we get a line that shows the actual variation in cost as the productiveness of the plant varies.

To illustrate: Assume a power plant of the simplest character, of 1000 hp., where mechanical power is the only thing required and the equipment is concentrated. The plant is appraised at $100,000; and for the first item we have the overhead, which may be taken at 15 per cent., covering interest, depreciation, insurance and taxes, which is equivalent to $1250 a month. This overhead has no relation to the volume of output and in Fig. 1 is plotted as a straight line.

The next item is the stand-by losses, which are affected by the output. These consist of the following items in dollars per month: Labor, $606; coal, $1170; oil, $37; supplies, $25; repairs, $40; water, $10; total, $1888. The items of supplies and repairs represent the materials used to keep the machinery in good working order, whether it is developing one horsepower or a thousand. The item of $1888 is drawn as a horizontal line because in every respect it is practically the same as overhead. The sum of these two items is plotted as a horizontal line at $3138.

The third item is the expenses which are proportional to product, made up as follows, if the plant is delivering 1000 hp.: Coal, $3510; repairs, $40; water, $100; total, $3650. This is plotted as a diagonal line, with the figure $3650 against 100 per cent. output with proportional amounts against lower outputs; namely, $2737.50 at

75 per cent. output, $1825 at 50 per cent. output, $912.50 at 25 per cent. output, and 00.00 at 0 output. If this diagonal line is now added to the item of overhead plus standby, the total costs are plotted as a diagonal line beginning at the figure $3138 for 0 output and ending with $6788 for 100 per cent. output. If the plant runs a month at 25 per cent. output, the cost would be $4050.50. If it runs a month at 75 per cent. output, the cost would be $5875.50. This chart shows at once the tremendous influence that the stand-by and the overhead have, and how necessary it is to keep them at a minimum. The importance of this is frequently overlooked. In this assumed case they are nearly 50 per cent. of the total maximum cost at 100 per cent. factory output and are more than 60 per cent. of the total cost at 50 per cent. factory output. If we divide the cost for any given week by the productiveness for that week, we establish the power-plant cost per unit of product output.

Fig. 2 illustrates the ratio between product and cost. Instead of using percentages, we may convert this into thousands of units, such as pounds, bushels, yards, etc. Taking the total operating cost at 100 per cent. output of $6788 and considering that 100 per cent. output means 100,000 units, then the cost per unit is 6.788c. At 75 per cent. output, or with 75,000 units, the cost would be 7.83c.; at 50 per cent. output, or 50,000 units, the cost would be 9.9c.; at 25 per cent. output, or 25,000 units, the cost would be 16.2c. per unit. If this chart is kept before the management, it is only necessary to pick out on the curve the proper cost for any given output to determine whether the standard has been maintained. In making such a chart the records of total cost of power should be divided by the output for each period and plotted regularly.

It may take many weeks to check up such a curve. If the factory is operating at about a certain definite percentage of capacity, the opportunity will not be presented to find the actual ratio at some other percentage until the rate of percentage goes up or comes down. In some cases it has taken nearly a year to check up a curve with actual performance; and even then the curve is bound to be a mean between certain extremes.

STAND-BY-LOSSES SHOULD BE WATCHED CAREFULLY

In those industries where steam, hot water and other evidences of power are distributed about the plant, it will be found that the stand-by plus the overhead is a much larger proportion of the whole. In some cases it has been as high as 70 per cent. at 100 per cent. production and a correspondingly larger amount at lower rates of production. This makes it doubly important to watch the stand-by losses even more carefully than the variable running expense. If the industry is such that the influence of the out-of-doors temperature is considerable, then two curves should be established, one for summer and one for winter conditions, the transition from one to the other being more or less arbitrary and depending somewhat upon the climate.

Fig. 3 illustrates two curves that actually apply to an industry where large quantities of steam and water are used and the cost of heating water in winter is much greater than in summer. In this plant the bonus is figured on the coal consumption alone. The curve shows the ratio between production and pounds of coal per unit of production, and well illustrates the rising cost of coal per unit when the factory output is increased. It is evident that it is quite impossible to judge fairly from a week's operation. It is almost impossible in many industries to get the actual product for one week. Materials may be put into process which do not reach the packing room for several weeks, and more goods may be shipped than are in actual process in any given week. It is therefore necessary to figure costs over a longer period, say four weeks, or by calendar months; and at the same time determine with a fair degree of accuracy what is the actual output of finished product.

The curve, then, becomes the basis of a bonus system of payment. Some engineers have argued that it is not a fair one, that all that the operating engineer can do is to make steam efficiently, run his engines, pumps, heaters, etc., as well as he knows how, and that he has no control of the situation beyond his department. That is partly true and partly not true. The functions of the chief engineer should extend beyond the confines of the engine and boiler rooms. He should spend at least one-third of his time around the plant, and he should have an inspector going around the plant continually watching out for improper use of power, light, steam, etc. The chief engineer should be directly concerned in seeing that the process machinery is maintained in an efficient condition. This is particularly true with regard to apparatus that uses steam in any form. If we include in the power plant all the equipment which in any way affects the use of fuel, it becomes a comparatively simple matter to place upon the chief engineer the responsibility for the efficiency of the entire power-making and power-using equipment, and for its cost per unit of production.

SPECIFIC APPLICATION TO BLEACHERY PLANT

An instance of the specific application of the theory herein advanced is that of a cotton-cloth bleachery and finishing plant. Here the measure was the number of yards of cloth finished in a given period, and it was found that an average of the number of yards put into process and of the yards shipped could be taken as the basis of production. Distributed over a period of four weeks the inaccuracy due to the possible holding up of goods in the plant was shown to be more or less reduced. From records extending over a period of two or three years it was found that for any given production the amount of coal burned did not vary much notwithstanding a great variety of processes carried on and continually changing methods of handling goods. This was accounted for largely by the fact that the fixed operating costs, as before explained, were a large part of the whole. The ratio between the coal burned and the yards finished was not a constant one by any means, but varied with the volume of the product, so that a curve could be produced which would show the actual ratio under any given conditions. This curve was based on costs as they had been for a considerable period of time. The employees of the power plant were offered a certain percentage of any saving they could effect. The chief engineer did not accept the offer with any interest, explaining that he did not believe that a material saving could be made. The company employed a consulting engineer to study the conditions in the power plant, with the result that with the coöperation of a new engineer the costs were greatly reduced and the employees received substantial rewards. The saving came not only through the better operation of the machinery, but through the reduction in the use of steam all over the plant.

Two factors must be recognized, one of which has been already mentioned—that of proper advisory service and a process of education. By far the most important is the attitude of the management toward the whole plan. There must, first of all, be a keen desire to reward the power-plant force for their efforts and a genuine feeling that a man's earnings should be based on what he saves his employer rather than on what some other man gets. Because $30 a week is a recognized standard for a certain class of help is no reason why a man should not get $10 a week additional if his employer can make $10 or $20 or $30 a week additional out of the man's effort. The bonus paid the first year will come from the actual reduction in costs of operation. The bonus paid after that will be due, not so much to still further reducing costs, as to keeping them down to a minimum; and it is certainly worth as much to keep the costs down as to bring them down in the first place.

Work of the Massachusetts Boiler Inspection Department

In the accompanying Tables II and III, are given the chief items of interest in the work of the Boiler Inspection Department of the State of Massachusetts since preliminary investigations by Thomas Hawley, of Boston, in 1893 and 1894 up to 1917. The tables should be of considerable interest to all those interested in boiler legislation, construction and operation.

The total number of Massachusetts standard boilers and air tanks constructed, received into the state and reported during the last five years, are given in Table I.

The following insurance companies are authorized to insure and inspect boilers in the Commonwealth: Employers Liability Assurance Corp.; Fidelity and Casualty Co.; Hartford Steam Boiler Inspection and Insurance Co.; Maryland Casualty Co., Mutual Boiler Insurance Co., Royal Indemnity Co.; and Travelers Indemnity Co. The 148 insurance inspectors, certified by the state, inspected 19,607 boilers and 376 air tanks in 1917.

It is interesting to note some of the violations of the various laws enforced by the boiler inspection department during the last year: assaulting an officer, 1; causing a boiler to be operated by person not properly licensed, 2; causing boiler to be operated without necessary safety appliances, 1; operating boiler without certificate of inspection, 4; failure to pay boiler inspection fee, 3; operating steam plant without proper license, 5; operating electric derrick without license, 1. It is seen that violations are few.

When the German steamship, the "Kronprinzessin Cecile" was interned in Boston, members of the department took charge of the mechanical equipment aboard. Since the outbreak of the war three members have entered service under the flag.

TABLE I. BOILERS AND AIR TANKS INSTALLED DURING LAST FIVE YEARS

Year Ending Oct. 31	Mass. Std. Boilers	Mass. Std. Air Tanks	Total
1908 (from May 1)	519	.	519
1909	1,365	.	1,365
1910	1,642	.	1,642
1911	1,604	.	1,604
1912	2,002	.	2,002
1913	2,860	.	2,860
1914	2,738		2,738
1915	2,291	214	2,505
1916	1,665	178	1,843
1917	1,788	216	2,004
Totals	18,474	608	19,082

TABLE II. EXAMINATIONS AND FEES PAID TO STATE TREASURER

Year Ending Oct. 31	—Inspections— Boiler Inspec. Dept.	Insurance Companies	Total	—Examinations— Engineers and Firemen	Operators of Hoisting Machinery	Total	Fees Paid to State Treasurer
1893	171*	...	171	.	.	.	....
1894	405*	....	405	.	..		.
1895	306	....	306	1,605	.	1,605	$15,263
1896	719	....	719	11,703	....	11,703	6,628
1897	1,528	....	1,528	9,274	...	9,274	8,699
1898	1,961	...	1,961	5,655	. .	5,655	9,590
1899	2,626	....	2,626	5,981	....	5,981	13,142
1900	2,364	....	2,364	6,472	...	6,472	11,438
1901	2,814	....	2,814	6,389	...	6,389	13,203
1902	2,583	....	2,583	6,518	...	6,518	11,447
1903	2,448	....	2,448	5,873	.....	5,873	10,977
1904	2,441		2,441	5,850	....	5,850	10,628 53
1905	2,555	4,080	6,635	5,725	....	5,725	12,832.00
1906	2,363	12,000	14,363	6,612	....	6,612	15,382.50
1907	3,043	12,467	15,510	7,140	....	7,140	18,801.00
1908	3,698	13,739	17,437	7,129	....	7,129	22,066.00
1909	3,763	16,032	19,795	6.657	...	6,657	23,735.00
1910	3,837	15,972	19,809	6,867	.	6,867	23,356 00
1911	4,510	15,986	20,496	6,948	161	7,109	25,036 00
1912	4,334	16,766	21,100	6,737	291	7,028	22,604 00
1913	5,403	17,006	22,409	6,404	134	6,539	25,558.00
1914	6,746	18,010	24,756	6,490	147	6,637	27,457.20
1915	6,987	19,456	26,443	5,364	141	5,505	27,698.00
1916	7,360	19,254	26,614	5,174	116	5,290	27,766.00
1917	6,892	19,983	26,875	5,022	93	5,115	26,635.00
Totals	81,857	200,751	282,608	147,590	1,083	148,673	$409,942.23

* Preliminary investigations.

Original Boiler Inspection Law (Chap. 418, Acts of 1895)' May 29, 1895.

Original Engineers and Fireman's License Law (Chap. 471, Acts of 1895), June 5, 1895.

Original Operation of Hoisting Machinery Law (Chap. 656, .Acts of 1911), July 11, 1911.

Original Air Tank Inspection Law (Chap. 629, Acts of 1913), May 8, 1913.

Original Ammonia Compressor Safety'Valve Law (Chap. 467, Acts of 1914), May 2, 1914.

TABLE III. BOILER EXPLOSIONS INVESTIGATED BY THE BOILER INSPECTION DEPARTMENT OF THE MASSACHUSETTS DISTRICT POLICE

Year	Explosions	Kinds of Boilers	Locations	—Number of Persons— Killed	Injured	Causes of Explosion
1895	1	48-in. horizontal-tubular	Webster	0	0	Ignorance of fireman
	1	60-in. horizontal-tubular	Woburn	5	Large number	Stuck safety valve
	1	48-in. horizontal-tubular	Fall River	4	Several	Lap crack
	1	48-in. horizontal-tubular	New Bedford	1	0	Overpressure
1896	0			0	0	....
1897	1	72-in. horizontal-tubular	New Bedford	2	0	Lap crack
	1	72-in. horizontal-tubular	New Bedford			Explosion of other boiler
1898	1		Hubbardston (icehouse)	3	1	Defective flue
1899	0					
1900	0				..	
1901	0				.	
1902	0				..	
1903	0			.	.	...
1904	0					.....
1905	1	72-in. horizontal-tubular	Brockton (Monday morning, Mar. 20)	58	117	Fracture of shell plate at longitudinal joint
1906	1	72-in. horizontal-tubular	Lynn	0	17	
1907	1	60-in. horizontal-tubular	Hubbardston	1	0	
	1	Cast-iron sectional		0	0	Defective casting
1908	0				...	
1909	0			..	...	
1910	1	42-in. horizontal-tubular	New Bedford	0	4	Fractured shell plate at longitudinal joint
	1	35-in. locomotive-type	Pittsfield	17	0	Over pressure
1911	0			..	....	....
1912	0			..	.....	....
1913	0			..	......	....
1914	0			..	......	....
1915	1	60-in. horizontal-tubular	East Weymouth	1	8	Fracture of shell plate at longitudinal joint
	1	Cast-iron sectional	Beverly	0	0	Explosive in combustion chamber

The Forcible Shutting Down of Isolated Power Plants

BY PERCIVAL R. MOSES

A complete account of the various events which led up to the hearings now being held before the Public Service Commission for the First District of New York, to determine the advisability of shutting down isolated plants and substituting central-station service, in order to save coal.

THE Public Service Commission is holding a series of hearings which are technically directed to the question of the rates for breakdown and auxiliary electric service and which are largely an investigation of the possibility of establishing an off-peak rate for electricity which shall induce owners and operators of private power plants to shut down such plants when the use of fuel in them is greater than it would be if the electricity were derived from the New York Edison Co. or some other public utility.

The history of the case is as follows: In November of last year, when the threat of fuel scarcity became imminent, I wrote the Fuel Administration in Washington, suggesting that a great measure of fuel conservation would be obtained if coöperation between public utilities and the owners of private or isolated power plants could be enforced. This letter, which clearly outlines my position, is as follows:

366 5th Ave., New York City, Nov. 9, 1917.

United States Fuel Administration,
Washington, D. C.

Dear Sirs: I have written you before, suggesting that a very large amount of fuel could be saved by enforcing coöperation between the public utilities and the owners of private, or isolated, power plants. I have not heard from you further in the matter, and I assume that the immense amount of work you have had to do prevented a careful consideration of the matter, because there can be no possible dispute as to the facts. What I want to see accomplished is the supply by the public utility of all electricity which it can most efficiently supply, and the supply by the private power plant of all the electricity it can most efficiently supply.

That there are distinct fields for each type of plant is evident on the slightest consideration of the subject. A large building needs coal to heat it. The heating is accomplished by steam at low pressure. By adding 3 or 4 per cent. to the amount of heat in the steam, the steam can first be made to drive engines and dynamos making electricity and afterward be used for the heating. In this way all the energy delivered by the coal to the steam is utilized, whereas in the public-utility plant of the best type not over 15 per cent. is utilized. On the other hand, during certain periods of the year and certain periods of the day and night the more efficient plants of the public-utility company should be utilized and the engines of the private plant should be shut down, as such engines are, of course, inefficient except when their exhaust steam can be utilized.

I have estimated that 100,000 tons of coal a year could be saved in New York City alone by carrying out this coöperation to a reasonable extent. A practical example will show that this idea is not a theoretical one. The Columbia Trust Co. owns a building at 60 Broadway, about 20 stories high, 60 x 150-ft. plot. Electricity was purchased one year in the winter and the next year it was generated in the building. The same kind of coal was used under the same conditions of firing. Less coal was used during the months of December, January, February and March in the year when the electricity was being generated than was used in the same period when electricity was being purchased. Approximately 150,000 kw.-hr. of electricity was generated during the period, and this would have required of the Edison company, allowing for wastes and distribution, over 200 tons of coal, so that by this change in one building a saving to the community of 200 tons of coal was effected.

This same condition has been shown to exist in a number of other instances where a number of tests have been made with and without electric generating plants. For example, we made a test for the Mutual Insurance Co., Richmond, Va.—24 hours with their own plant and 24 hours with purchased electricity, running their own steam plant, during the winter season—and the results were the same as I have mentioned at the Columbia Trust Co.; that is, less coal was used when the plant was running than when the plant was not running. On the other hand, it is a well-known fact that the engines used in private plants are far less efficient than the turbines of the big central stations, so that in the summer months the use of coal by the private power plant for a given quantity of electric current must be more than in the central station, so that from the point of view of the community it would pay during the summer months to have the electricity generated at the central-station plant. This coöperation could be easily obtained by a system of rates for electric current which would make it economical for a private-plant owner to use electric current during the summer and other light-load periods. The advantage to the public utility must be obvious, as an additional load would be obtained which would involve practically no additional investment.

This letter received a prompt reply from the United States Fuel Administration, referring it to O. P. Hood, chief mechanical engineer of the Department of the Interior, who was working for the Fuel Administration. Mr. Hood requested a more detailed statement of my suggestion, which I sent him within a few days. This was acknowledged on Dec. 6, stating that the matter had been referred to another and that the desirability of coöperation was not questioned, but that the difficulty appeared to be that of getting a definite knowledge of conditions.

In another letter of Dec. 26, Mr. Hood said that it seemed to be better to bring the matter to the attention of the local fuel administrators, and this was done by me in a letter of Jan. 2, to Mr. Wiggin and Mr. Schley, state and county administrators, to whom I submitted a brief plan, as follows:

OUTLINE OF PLAN OF COÖPERATION

Hundreds of thousands of tons of fuel could be saved if through coöperation between the public-utility plant and the private power plant each of these could be operated to its utmost efficiency. While this cannot be entirely realized, there is a very simple plan by which it can be realized in large measure.

First, private plants should be shut down during the summer months and during the balance of the year with the exception of the very cold winter weather during the so-called "off-peak" period, which in the vicinity of New York is from 10 p.m. to 6 a.m. That is, I would advocate the shutting down of private plants except those which are utilizing their exhaust steam for manufacturing purposes during the nonheating season—May, June, July, August, September and October—and during the other months, with the exception of December, January, February and March, from 10 p.m. to 6 a.m., with the possible exception of hotel plants, as in these plants exhaust steam is largely used for heating water and for drying purposes; hence, high efficiency is obtained.

These plants may be shut down without hardship to the owners provided a rate is made by the public-utility company which would not exceed 2c. per kw.-hr. for moderate consumers—that is, consumers up to 1,000,000 kw.-hr. per year—and possibly 1½c. per kw.-hr. to consumers of larger quantities.

The public-utility company can easily afford to make such a rate because the current it would supply during these periods would be off-peak current, which could be furnished without any increase in investment in plant or in underground mains or in real estate; hence, the only increases to which the public utility would be subject would be increases in operating expenses and the small cost of connections from the underground mains to the buildings. In most cases it will be found that connections are already in, so that in reality the only increase to the public utility would be the increase in operating expense. This will be found to be less than one cent per kilowatt-hour.

Second, private power plants should be encouraged to develop their market for steam and electricity in their immediate neighborhood during the heating season up to the extent of their present capacity, as in this way the most perfect utilization of fuel and labor can be obtained.

Reasons for the Suggested Changes

The reason why these changes should be made is that in the winter months when the private power plant is operating, supplying electricity and steam for heating, almost perfect utilization of the heat contained in the steam is obtained, as the steam is first used at high pressure to generate power and electricity, and then afterward as exhaust steam is used for heating purposes. During this same period the public utility is generating steam at high pressure and is wasting a large part of the latent heat in the exhaust steam because it has no place to use it.

On the other hand, during the summer months in such plants as cannot use their exhaust steam for drying or manufacturing purposes or for heating water, the private plant wastes 95 per cent. of the heat contained in the steam, whereas the central plant on account of its high efficiency equipment and condensers wastes only 85 per cent.

In so far as the off-peak load is concerned, the public utility would benefit because it would obtain a load which would bring its average load up to a more efficient point; that is, the private-plant load would help fill in the valleys of the public-utility load, or as it is usually expressed, the load factor would be bettered.

Shutting down private plants during the off-peak period would shut them down when they are least efficient, in the use of both fuel and labor. I have known cases where the coal per kilowatt-hour ran to 30 lb. during these light-load periods, and 20 lb. is quite common. It results, therefore, that if a plan such as that just outlined should be adopted, instead of obtaining from 200 to 250 kw.-hr. per ton of coal burned, there would be obtained from 700 to 800 kilowatt-hours.

The danger of making suggestions to bankers and others with but little knowledge of engineering matters was demonstrated strikingly by the circular sent out by Albert H. Wiggin, state fuel administrator, on Jan. 14, 1918, urging owners of private power plants having breakdown-service connections to utilize to the fullest extent their connection with the Edison company, and on Jan. 15 I wrote to Mr. Wiggin pointing out the error of his suggestion and that instead of fuel being conserved by obtaining electricity from a central source in winter months fuel would be wasted.

Many of these letters were sent to the Public Service Commission of the First District with the request that they start a series of hearings looking to the establishment of an off-peak and summer rate for current and urging the necessity of quick action so that an equitable rate might be made and the new methods go into effect at the close of the heating season.

These hearings started on Feb. 25, and so far the commission has simply asked the public-utility officials to state their side of the case, which they have done at great length with practically no cross-examination.

Mr. Wiggin's letter and other indications apprised me of the fact that influence was apparently being brought to bear to take advantage of the country's necessity in an attempt to shut down private power plants generally, winter and summer, regardless of the fact that during the winter months and during such other periods of the year when exhaust steam can be fully utilized the private power plant is the most efficient means of production.

A circular letter was therefore addressed by me to a great number of owners of private power plants, calling attention to this condition, and a number have agreed to join with me in properly presenting the facts as we see them and as I have outlined them already to the Fuel Administration.

Benefits To Be Derived by Use of Plan

My position in the matter is that if the plan as outlined is carried out, the public utility will benefit by obtaining a large additional amount of profitable business at a minimum of cost. The country will benefit because the minimum amount of coal will be used for the generation of electricity. The private-plant owner will benefit because he will obtain the electricity used by him during summer and off-peak periods at not more than his present cost and he will be relieved of the necessity of operating the private plant.

I estimate that the saving in fuel in New York City alone if the plan outlined was carried out in full would be in excess of 200,000 tons per year, and if the plan was extended throughout the country the conservation of fuel would mount up certainly over a million tons per year. In addition to this a certain amount of labor would be released for other service, and this under the present conditions is equally important.

The facts as I have presented them seem to be indisputable. The plan presented is practical, and it is merely an attempt to apply a correct economic solution to the problem of the supply of light, heat and power. It is presented neither on behalf of the owner of the private power plant nor on behalf of the public-utility company, and for the reason that it is not an ex parte proposal it should be considered on its merits

Editorials

Investing in Liberty

JUST what is this thing called liberty in which and for which we are asked to invest billions? For the individual liberty is simply the ability to react to impulse, to the impulse of hunger or thirst, of self-defense or self-preservation, as well as to those higher impulses of self-determination with which we usually associate the word. With a complete lack of liberty life would cease. It is as necessary to life as air and light and water and food—in fact, more necessary, since in the last analysis it means access to these things. And up to a certain point, as in the case of all these things, the less liberty the less vitality. One may exist on a little liberty, as on a little air or a little food, but one cannot support normal life on it unless it is abundant.

But there is such a thing, also, as too much liberty, as of all the other necessities of life. And furthermore, it is not a thing whose supply is inexhaustible. Like air or light or water, it can be so restricted by monopoly that untold suffering and death result to those whose access to it is cut off. Look at Belgium or Germany itself.

The Prussian Junker would hardly consider as liberty the restrictions which we in this country impose upon our conduct. He would miss here that superabundant liberty to which he has become accustomed in the land of the Kaiser—to saber civilians who make faces at him, to elbow women off the sidewalk, to radiate arrogance with impunity. He would scoff at our sensitiveness to the rights and feelings of our neighbors, at our habit of chivalry and of kindness and compassion toward those weaker or more helpless than ourselves. This thing which we call liberty in America, this everyday conduct hedged about by law and conscience and the dictates of humanity, to the German Junker seems a mockery of the word. But by liberty he means a monopoly of liberty, and we, its proper distribution.

It is to secure and preserve for every inhabitant of the United States his share of liberty, that greatest of life's necessities, that we have declared war against the Hun Monopolist, that we are sending hundreds of thousands of our boys to the firing line in France, that we have bought billions in Liberty Bonds, and are now to begin the third loan campaign on April 6, to multiply that great investment. It is worth every cent of the mighty effort and much more. Would you fight for a water hole after a day's ride across the desert? And if you could not fight, would you give your all for access to that elixir of life without which you must go mad or die? Then fight for liberty; it is equally precious. And if you can't fight, give—give your all, or, rather, in this case, lend it at a good rate of interest. For, happily, your forefathers have so fortified your position in this world that you are bound to receive your contribution back with interest.

It is impossible to pay too much for, to invest too much in, liberty. The need is great that every man, woman and child in this country put everything he is and has into this vital struggle, once for all to smash the would-be monopolist and all his breed. We have floated two mighty loans already, now comes the third. As our artist has depicted in the colored supplement to this issue, the Kaiser is tottering on his pedestal. Therefore, again with Uncle Sam, *one, two, THREE, NOW, ALL TOGETHER!*

Inefficiency in Refrigerating Plants

IN last week's issue of *Power* an interesting paper on the economy of refrigerating plants was presented Apparently, conditions in this field are far from ideal, as the author ventures the opinion that "of all power plants the refrigerating plant is most wasteful." By and large this statement is probably true, and as to the reasons, there are several having an important bearing. Although the refrigerating cycle is not particularly difficult to understand, as it is practically the reverse of the condensing steam plant, there are many factors entering into the ultimate economy. This multiplicity of factors, each a source of possible waste, and the proper correlation of the various elements of the refrigerating and steam plants, make economical results more difficult to obtain. Further reasons are a decided scarcity of good refrigerating engineers and general inability on the part of the management to realize the possibilities of the plant.

As expressed by the author of the paper, there is a wonderful future in the refrigerating field, but before any great headway can be made, men must be developed, who can safely and economically operate the plants. The management must be educated as to what results might reasonably be expected and be made to realize the importance of proper selection, promotion, competition, training and salary based upon results. This in itself is a big task, worthy of the efforts of the various refrigerating and ice-making associations.

With plant examination and supervision where it is needed by well-posted refrigerating engineers, progress may be expected. This, of course, entails constant touch with the operating force by means of complete records and the checking of results from day to day. Inefficiencies will immediately show and may be corrected. From a study of existing conditions and the operating data, characteristic curves for each plant may be prepared. These curves should cover all factors relating to economy and should be used as a guide and basis of comparison for future operation.

Briefly, the engineer is the big factor in the problem. He may be educated as suggested in the previous paragraph, but until the management realizes the need of competent men and the necessity of salaries commensurate with their engineering knowledge, it is quite probable that the refrigerating plant will continue as a model of inefficiency.

Bonus for Power-Plant Employees

ON OTHER pages of this issue appears an article on "Bonuses for Power-Plant Employees," by Warren B. Lewis, a consulting engineer well known in New England and particularly familiar with mill power-plant practice in that section of the country noted for its industrial activity. The impressive feature of the article is its scope; the author embraces all power-plant employees as those who should share in the bonus. This, while unquestionably most equitable, is uncommon. Usually, bonuses are paid only to boiler-room crews on the assumption that they have greatest influence over the source of heaviest loss. Where a plant is large, and especially if it is one supplying heat and power, as to a bleachery or other large consumer of steam for industrial purposes, it certainly is best for the management to provide a bonus system wherein all power-plant employees will share in the savings effected.

Mr. Lewis says that because the employee (and he means everyone in the plant from the chief engineer down) shares in the bonus "does not mean that he is to originate the methods [of saving] to be employed." When considering the application of a bonus system to power plants, managers are too likely to predicate consideration on the premise that the employee should originate the means of saving. That is too often taken for granted. As saving, to the management as well as to the employees, is the prime object of paying a bonus, it is obvious that the method that gives the greatest return is worth while whether it comes through the management's own staff or after survey of the plant by a consulting engineer.

It is of interest that the system of paying bonuses, as told of by Mr. Lewis, presupposes that the management "include in the power plant all the equipment which in any way affects the use of fuel," and that when this is done "it becomes a comparatively simple matter to place upon the chief engineer the responsibility for the efficiency of the entire power-making and power-using equipment, and for its cost per unit of production." Needless to say, this assumes that the chief engineer be a high-grade man, one who is capable of meeting and discussing problems with department heads, who has a good working knowledge of relative values, of cost accounting and apportionment of charges—these along with a most thorough knowledge and understanding of his plant and of the availability of equipment, materials and supplies which the market affords. Even though the company retains a consulting engineer, these qualities in the chief engineer in charge are highly desirable.

Mr. Lewis is aware that many will criticize his accounting of power-plant performance on the unit of product of the works or mill turned out per unit of power-plant cost. But he meets the probable criticism very well, we think.

When Contracts Go Begging

During these days when everybody is talking in millions and even billions of dollars, the fellow with a few paltry thousands of dollars does not cut much of a financial figure, if the *Mining Journal*, of Marquette, Mich., is correct in the publication of an article relative to the placing of an order amounting to forty-five thousand dollars for new equipment. It reads as follows:

> The superintendent of the light and power department and the department's engineer have gone a-journeying to see if they can find anyone who will condescend to consider the small matter of an order for forty-five thousand dollars of electrical and hydraulic machinery. They have gone because their tentative inquiries among manufacturers brought, in most instances, no response at all, and in others only a languid interest. In normal times the announcement that Marquette was seeking to place an order for forty-fiv thousand dollars of machinery would have meant an eager charge on the city officials, by most resolute agents, and another besieging of the city hall during the period of consideration of the proffers, such as has frequently been seen in the past. But these are not normal times; they are war times. An individual, or city, that ventures to raise a voice about a mere matter of forty-five thousand dollars of machinery finds that he raises it in vain. The magic word "million," at least, has to be used to secure a hearing.

The foregoing is doubtless true at present, but there is coming a time when a forty-five thousand dollar contract for power-plant apparatus will look as good as a full coal bin did this winter.

The Alien Employee and the Labor Turnover

ONE of the most perplexing problems in industrial plants at the present time is that of the many millions of aliens now employed. This is a matter calling for careful and delicate handling, and it would be helpful to large employers generally to know what others are doing to solve this problem. The columns of *Power* are open to a discussion of this subject.

The excessive cost of labor turnover resulting from unsettled war conditions is another matter that is causing the employer considerable anxiety. Many plants find that costs run from ten to one hundred dollars for each employee broken in and that the annual total is enormous. What methods have you adopted to reduce this cost and what results are you getting? Give others the benefit of your experience through the columns of this paper.

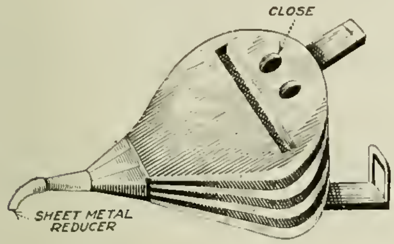
The McGraw-Hill Company, Inc., publishes ten papers. Each of these papers has its own half dozen, more or less, distinctly separate departments, such as advertising, editorial, subscription, circulation, makeup, with one centralized mail department for all. It would considerably facilitate matters for those charged with expeditiously distributing to the proper persons or departments the hundreds of letters that come in daily, if our correspondents would remember to mention, when they know it, the name of the paper for which their communications are intended, as well as the department connected with it. Thus, for instance, matter addressed to Editor of *Power*, Advertising Manager, Subscription Department, etc., will be dispatched more quickly and have more prompt attention than that addressed merely to the McGraw-Hill Co., which has to be read through, very often passed through many departments and hands, previous correspondence, if any, looked up, and a great deal of valuable time and energy wasted that might otherwise be spared, in an effort to get it to the proper person to be efficiently and satisfactorily taken care of.

Correspondence

Removing Drill Chips by Vacuum

The following is a useful kink when drilling holes, reseating valves or similar work where it is difficult to remove the chips. On the nozzle of an ordinary molder's hand bellows solder a reducer of the size and shape desired and close up the regular air-inlet valves in the bellows. To operate, close the bellows, place the nozzle near the chips to be got rid of and open the bellows quickly. The rush of air will carry the chips into the bellows, after which they can be easily blown out again. **W. H. Bennett.**

Mount Vernon, Wash.



BELLOWS FOR VACUUM

A Wooden Tank Repaired

It does not seem that the wooden tank repaired as described on page 164 in the issue of Jan. 29, 1918, could be considered safe to have over one's head. Atmospheric moisture and minute seepage will collect between the cement coating and the wood, and it will not be long before the planks, weakened by decay, will give way under the load.

"Safety first" would surely require a new tank.

Lynn, Mass. **P. P. Fenaux.**

[The repair job referred to, when finished, would appear to be a concrete tank reinforced by the original planking banded with iron hoops. No doubt a time will come when the wood will have become decayed to such an extent as to afford no support or backing between the bands and the concrete, but this does not seem to be its present condition.—Editor.]

Care of Electrical Equipment in Cold Weather

A few words may be in order concerning the care of electrical apparatus, particularly motors and generators which are exposed during cold weather.

It is very easy for machines to get "wet" during cold weather, even though not exposed directly to rain or snow. Condensation is at the root of the trouble. If a cold machine is brought into a warm room, the atmospheric moisture condenses on the machine's cold surfaces, just as it does upon one's spectacles under similar conditions. It is possible for a great deal of moisture to be formed and absorbed by an electrical machine in this way. It may also happen that condensation will occur while a machine remains out of doors covered and unmolested, a sudden change from low to higher temperature being responsible. This is particularly liable to occur with large machines, the internal temperatures of which change but slowly.

The preventive of trouble lies in removing the cause. Store machines in a warm place if possible and do not move them from a cold into a warm place suddenly, but bring about the change gradually. If a machine is stored outside, protect it well and provide resistors or other means to keep it moderately warm, particularly whenever a change from cold to warm weather is expected.

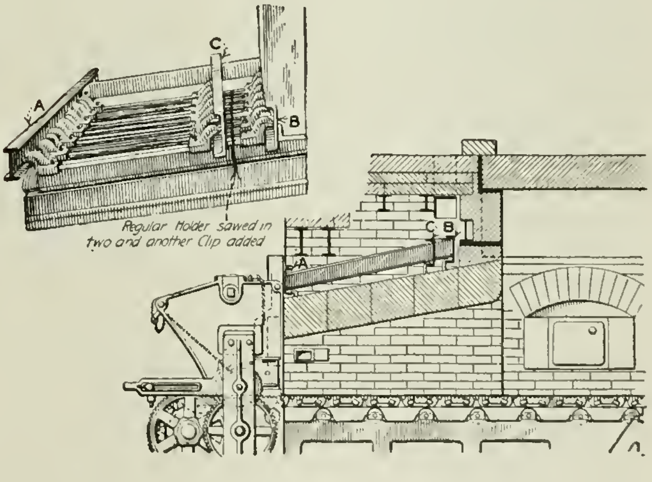
When a piece of electrical equipment has absorbed moisture, it should be dried out before use. The methods for doing this are quite familiar (see *Power*, p. 46, Jan. 8, 1918). The drying should be continued until insulation resistance, as measured by a megger or other means, indicates that the machine is in good condition again and safe for use. **Gordon Fox.**

Chicago, Ill.

Holding Up the Curtain Wall of a Stoker

The illustration shows my way of holding the curtain wall of a Green chain stoker in place, independently of the arch. The old way was to use the channels marked *A* and *B* to hold the T-bars (suspended under them) on which the arch brick are hung and upon which the curtain wall is built. But when the arch burns out, down comes the curtain wall also. By adding another channel, marked *C* in the illustration, and cutting the T-bars and adding another clip, then bolting a 6-in. angle iron on the back of *B* so as to support the curtain wall independently of the regular support, the curtain wall will always be held in place and the arch can be replaced without disturbing it. **J. J. Neville.**

Chicago, Ill.

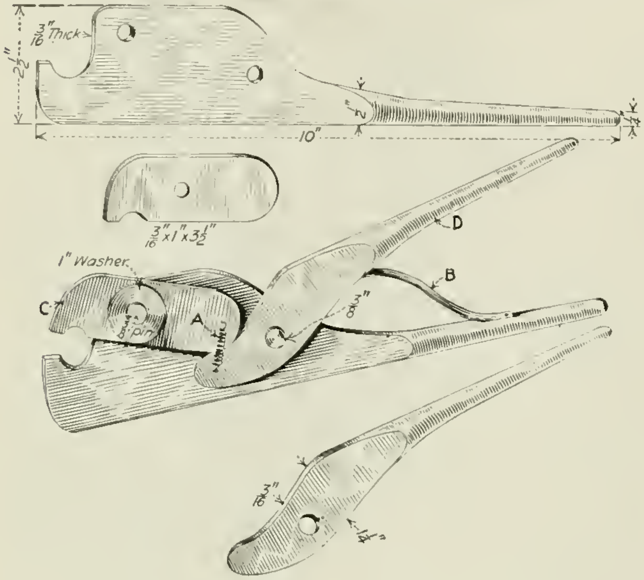


CHANGE IN SUPPORT FOR ARCH AND CURTAIN WALL

Cutter for Large-Sized Wire

Cutting iron wire or large copper conductors is impractical with shears and impossible with ordinary cutting pliers. A powerful and very compact cutter, which anyone can make in his spare time, is shown in the figure. This tool is made of $\frac{3}{16}$-in. steel, hardened on the cutting edges, and will cut copper wire up to $\frac{7}{16}$ in. diameter, or even larger if the handles are made longer than those shown. The spring *A* holds the cutter *C* against the lever handle *D*, while the spring *B* holds the handles apart. M. P. BERTRANDE.

Ozone Park, N. Y.



PARTS AND ASSEMBLY OF WIRE CUTTER

Combustion in Boiler Breechings

As considerable interest seems to be centered on the subject of combustion in the fuel bed of hand-fire furnaces and in the gas-producer action of fuel beds, and with explosions in boiler furnaces, I am telling the following points from experience in our boiler room.

When the writer took charge, two of the boilers were fitted with ordinary stationary flat herringbone grates and natural draft and two were fitted with a forced-draft system employing hollow grate bars through which the air was blown, the bars having narrow slots on the upper surface through which the air reached the fire. The breeching over the latter boilers was badly warped and showed plain signs of overheating.

It was soon found that when heavy loads were being carried, a gas flame was present in the breeching after every firing, gradually dying out as the fires burned clear. The coal used was of high volatile content and southern Illinois origin. The boilers were of the Heine type, and the baffling was in good condition, so that there was no question of the fire going directly through the tubes to the breeching. The firemen reported also that the furnaces would occasionally "puff" badly, especially if a door were opened wide a short time after firing.

The breeching not infrequently became red-hot, and because of the warping it did not make tight connections on top of the boilers. It soon became evident that the combustion of the gas was supported by the air drawn in at these openings. It was also found that the flame did not occur if the furnace doors were left open about an inch for a minute or two after firing. If the flame was permitted to start by keeping the doors closed, it could be extinguished at once by slightly opening them. This showed that the trouble was caused by insufficient air in the furnace. As long as we had the forced-draft grates, we kept the doors open a little for a minute or so after each firing.

The air forced into the furnace from the grates at high velocity made a very hot fire close to the grate, but it was not sufficient for complete combustion, and the fuel bed acted like a shallow gas producer. The flame in the breeching was caused by the burning of the producer gas so generated, enriched by the gases distilled from the green coal just after firing.

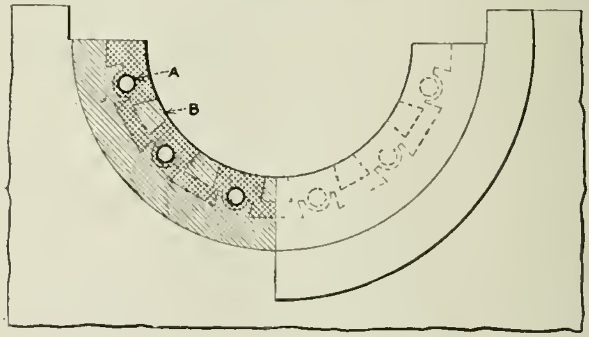
I believe that this condition is likely to occur in other hand-fired forced-draft plants and that it would be well for operators of such plants to be on the lookout for trouble in this direction. C. H. SONNTAG.

Cape Girardeau, Mo.

Hot Gas-Engine-Bearing Remedy

On a 1200-kw. gas engine direct-connected to a generator, the main bearings ran hot although they were water-cooled by means of a series of brass pipes shown at *A* in the figure. The pipes were connected by return bends and embedded in the babbitt metal.

We tried different mixtures of babbitt in the bearing and various pressures on the cooling water, but these did not remedy the trouble, the worst part of which was that the babbitt wore down quickly, throwing the generator's armature out of the polar center, consequently changing the magnetic pull between the field poles and the armature. We finally made a series of soft-bronze grids, or strips *B*, and poured the babbitt around them as shown. The bearings, where necessary, were scraped to a good fit. Since making this improvement, no trouble has been experienced. These strips help the babbitt to stand up under the heavy pressures, and the babbitt particles embedding themselves in the bronze faces form an excellent lubricant.



SECTION THROUGH GAS-ENGINE BEARING SHOWING LOCATION OF BRONZE STRIPS

I would like to hear an expression of opinion from *Power* readers on why the bronze strips are so effective in remedying the trouble. I believe that mixed-metal bearings have proved very satisfactory where used.

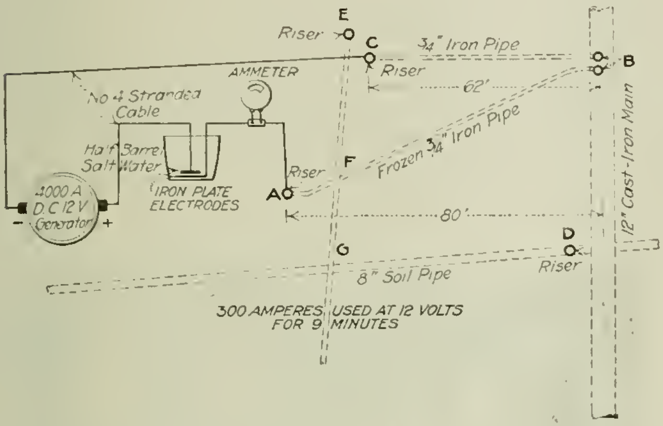
Chicago, Ill. C. A. MERTON.

Thawing Frozen Water Pipes by Electricity

During periods of extremely cold weather the frost penetrates deeper into the earth than usual and frequently freezes embedded water pipes that are ordinarily considered as being below the frost line or pipes which under normal cold-weather conditions would be protected by means of wrappings, conduit, etc. In and around the plant it is generally easy to get enough heat to thaw a frozen pipe, but the first problem is to get into contact with the pipes in order to concentrate the heat so as to make it effective.

It is no easy job to dig down through two or three feet of frozen earth or tear out insulating coverings to get at piping; in fact, by far the greater amount of time and labor is employed in getting at the pipes so that the actual thawing may be done.

For such cases as the foregoing, the electrical method of thawing saves all this unnecessary labor. Many power-plant engineers are aware that pipes are being successfully thawed by electricity, and while they have knowledge of its being done in the cities by lighting and power companies, it is associated in their minds with special apparatus and transformers and with the belief that alternating current is necessary.



LAYOUT OF PIPING AND THAWING EQUIPMENT

It is preferable to use alternating current for this work, because greater amperage can be obtained from commercial circuits by means of a step-down transformer. The use of the transformer in the electrical system charging the pipe line also insulates the high-voltage circuit from the low-voltage, thereby reducing the danger of shock and grounds with gas piping, etc. However, direct current can well be used because it is the heating effect only that is required.

The necessary equipment to use a direct-current circuit for thawing water pipes consists of a water rheostat, which may be a barrel of salt water with two electrodes made of pieces of iron plate or other metal and a length of stranded cable sufficiently heavy to conduct the current used without excessive loss. An ammeter is also desirable, since too great a current may damage the piping.

Data on the number of amperes and the time required is likely to be misleading, for the reason that all the current may not traverse the pipe being thawed as there is liable to be current leakage through the damp earth to other piping. For instance, in a particular case in which an electroplating generator was used to supply 300 amperes at 12 volts, it was estimated that 50 amperes was bypassed, therefore only 250 amperes was used effectively. The apparatus used consisted of a water rheostat made from a half-barrel filled with salt water, two 9 x 12-in. iron plates for electrodes, about 75 ft. of No. 4 stranded wire and an ammeter. The entire length of the circuit was about 230 ft., and the time to produce running water was 9 minutes.

The figure explains the conditions of the case in question. Pipes *AB* and *CB* were tapped directly into the 12-in. main. The vertical distance between any two pipes was small and all were from two to three feet below the surface. At *C* the ¾-in. riser terminates in a sink without sewer connections. The pipes were not disconnected from the risers for the reason that all were short runs. *A* terminated at a humidifier on the second floor of the building and was practically insulated from the earth, thereby presenting an isolated condition. This was also true of riser *D*, which terminated in a watering trough. The water rheostat was short-circuited when the current was in use.

Meter readings taken from *A* to *D* and *D* to *B* showed that there was considerable current leakage, and it was estimated that about 50 amperes was diverted by way of *F*, *G*, *D* and *B*. However, in this case the freezing was between points *A* and *F*, therefore the leakage was of no consequence. The following figures were obtained in connection with an alternating-current portable pipe-thawing outfit operated by a central-station company. The primary of the transformer was connected to their distributing line and the 110-volt secondary to the pipes to be thawed on the premises.

Size of Iron Pipe, Inches	Length	Amperes	Volts	Time in Minutes
¾	60	350	110	20
¾	70	300	110	30
¾	100	150	55	12
1	250	480	50	15

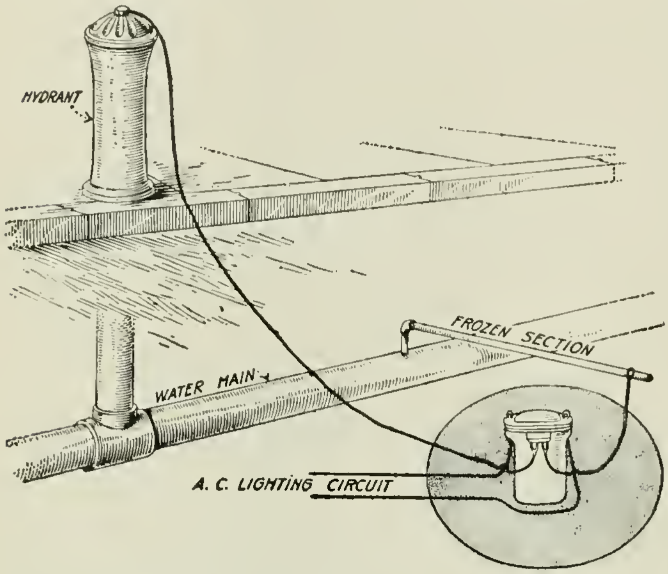
The writer has also used a 200-ampere-hour 12-volt storage battery for thawing water pipes with satisfactory results. MATHEW KING.

Passaic, N. J.

It is quite generally known that a heavy current of electricity passing through a frozen water pipe will heat it sufficiently to melt the ice. It is not, however, so generally known that enough current can be taken from an ordinary lamp socket to accomplish this result provided the circuit is an alternating-current one and a small transformer is available.

The writer recently thawed out a ¾-in. service pipe, which was frozen solid for a distance of about 25 ft., with a 5-ampere current at 110 volts, taken from a house circuit. The current was passed through a 500-watt transformer having a 1 to 12 ratio, thus delivering at the secondary a current of approximately 60 amperes. The secondary wires were connected directly to the frozen pipe line and hydrant, as shown in the figure so as to include the frozen section between the connections. No resistance was necessary on account of the low voltage of the current. The current was left on for nearly two hours before water came, but the time required was longer than it otherwise would have been on account of it being necessary to make one connection to a hydrant 150 ft. away from the frozen pipe, as a connection with the frozen section could not be had in less distance without digging in the ground. This, no doubt, caused considerable leak of current through the ground that otherwise would have passed through the frozen pipe.

Any small transformer having a capacity of 500 watts or more will do the trick. An ordinary sign-lighting transformer of 500- or 750-watt capacity is convenient, and is also useful for other purposes, and the cost is only slightly more than an electric-light company charges for one thawing job.



TRANSFORMER CONNECTION FOR THAWING FROZEN SECTION OF WATER PIPE

These transformers are foolproof, and there is not the slightest danger in using them. They can be short-circuited on the secondary side without injury. They take current from a lighting socket on the primary side at 110 volts at about 5 to 8 amperes, and deliver current on the secondary terminals at 10 volts and from 50 to 75 amperes. They may also be obtained for use on a 220-volt circuit. A 10-ampere fuse should be used in the circuit on the primary side, and if this blows the current must be kept down by means of a water rheostat connected in series in the circuit, so that a new fuse won't blow.

The water rheostat need only consist of an iron bucket to which one wire is attached and the other wire connected to a piece of metal and placed in the center of the bucket in the salt water with which the latter is filled. The current can be increased by moving the metal electrodes toward the side of the bucket.

Care should be used to see that the pipe to be thawed is disconnected from all other piping in the building. If this is not done, there is a possibility that the major portion of the current may be bypassed around the freeze and the job will be a failure or require considerable more time than necessary.

If alternating current is not to be had, one or more 110-amp.-hr. storage batteries can be utilized at a high discharge rate, but care should be taken not to use a rate which would damage the batteries. Slight freezes can be taken care of in this way, but several batteries would be needed if the heating required more than half an hour. **William R. Bryans.**

New York City.

Repairing a Steel Stack

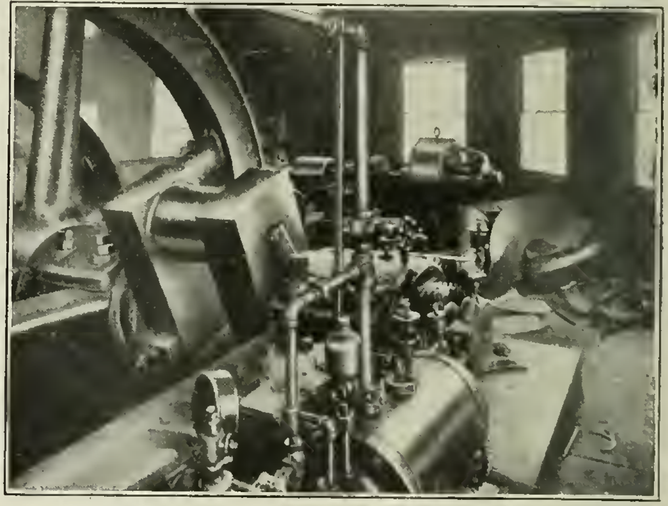
Some time ago in our plant a steel stack rusted off at the base, and we were confronted with the problem of how to put in a new section without taking down the whole stack. The difficulty was overcome by building a scaffold around the stack and lifting it by a block and tackle to a sufficient height to allow the new section to be put in; then the top part was let down and riveted to the new section, thus making the repair without the extra work of lowering and raising the entire stack.

Philadelphia, Penn. **D. R. Hibbs.**

Piston, Striking Head, Wrecks Engine

The engine wreck shown in the illustration is similar to many others that have occurred in the past and, like many others, was due to neglect and lack of lubrication of the main-crank bearing, which caused the engine in time to get too much lateral motion in the main moving parts and allowed the piston to come in contact with the cylinder head, resulting in the general wreck, as shown. The engine cylinder was 16 x 24 in., the speed 150 r.p.m. and the working compression 260 lb. The balance weights, which were distributed over the plant, weighed approximately 3600 lb., and a connecting-rod, which was thrown some distance, weighed about 1500 lb. The accident not only wrecked the machine as shown, but cracked the main bedplate in several places. **C. R. McGahey.**

Atlanta, Ga.



WRECK CAUSED BY PISTON STRIKING CYLINDER HEAD

It is better to wear a Liberty Bond button on your coat than the print of the Kaiser's heel on your neck.

Do you believe in Democracy? Do you believe in America? A purchase of a Liberty Bond is a test of your faith in American Democracy.

When you lend money to the Government it does more for you than you do for it. The Government pays good interest and protects your life and property.

Inquiries of General Interest

Burning of Clean Water Tubes—What would cause clean tubes of a water-tube boiler to become burnt or blistered below the water line of the boiler? L. G.

The material of water tubes or other heating surfaces of a boiler is likely to become burnt when the fire is driven so hard that the rapid generation of steam drives the water away from the heating surface, as that condition causes the surface to become overheated from much slower transfer of heat than when the water is directly in contact with the heating surface.

Mean Forward and Mean Effective Pressure—What is the meaning of "mean forward pressure" and "mean effective pressure"? W. P. S.

"Mean forward pressure" is a term used to designate the average pressure acting on a piston with a tendency to move it forward, or in the direction corresponding to that necessary for performance of useful work. It is the reverse of mean back pressure, which is the average pressure that resists the motion of a piston in performance of useful work. "Mean effective pressure" is the mean net pressure that urges a piston forward, and therefore is equal to the mean forward pressure minus the mean back pressure.

Inches of Water Pressure—What is meant by an inch of water pressure; and how many pounds or ounces per square inch would a pressure of 2½ in. of water be equivalent to? N.A.

An inch of water pressure signifies the intensity of pressure due to a column of water 1 in. high. As 1 cu.ft. of water at 62 deg. F. weighs 62.355 lb., the weight of 1 cu.in., or the pressure per square inch exerted by a water column 1 in. high, would be $62.355 \div 1728 = 0.03609$ lb. Hence 2½ in. of water pressure would be equivalent to $0.03609 \times 2\frac{1}{2} = 0.09022$ lb. or $0.09022 \times 16 = 1.4435$ oz. per sq.in.

Discharge from Broken Gage-Glass—If in case of breakage of a water-gage glass of a boiler under steam, the top connection is closed but the bottom connection cannot be closed, would escape of hot water and steam from the broken glass be prevented by opening the valve on the blowoff pipe to the column or glass? H. W.

Discharge from the broken glass would not be prevented, as opening a blowoff valve would relieve only part of the pressure holding the water up in the column. The water level in the column would become lower and as soon as the level dropped below the open gage-cock, steam would blow through the cock and it would be discharged from the broken gage-glass at the full pressure of the boiler.

Exhaust-Steam Heating with Back-Pressure Valve Open—Can an exhaust-steam heating system, supplied with exhaust from a noncondensing engine, be operated with the exhaust back-pressure relief valve left open? C. P. C.

The purpose of a back-pressure relief valve is to hold sufficient pressure to satisfy the heating system, to relieve excessive back pressure and to act as a check valve to prevent admission of air in case the heating system draws the pressure below the pressure of the atmosphere. Hence the back-pressure valve may be left open so long as the pressure of the exhaust at the point where the heating supply is taken off is high enough for the heating apparatus, or the effect of the heating apparatus is not to reduce the pressure at the back-pressure relief valve below the pressure of the atmosphere.

Setting Valve of Single-Valve Automatic Engine—What is the method of setting the valve of a single-valve automatic shaft-governor engine? J. W. M.

The valve setting will consist mainly of adjustment for equalizing the cutoff. If cutoff takes place earlier on one end of the cylinder than the other, then with other portions of the valve gear properly assembled, the cutoff can be equalized by lengthening or shortening the valve-rod connections to obtain diagrams that would be desirable when the engine is driving the average load. If indicating is not available, the cutoff can be approximately equalized by blocking the governor to a position of about one-half its range of motion and adjusting the valve-rod connections to obtain closing of the steam valve at the same fraction of stroke from both ends, when the engine is turned over.

Kerosene as Boiler-Scale Remover—What are the advantages and disadvantages of using kerosene for removing scale from a boiler?

In cases where boiler scale is of such a nature that it can be softened by introducing kerosene along with the feed water, the oil has the advantages of being a cheap and conveniently applied scale remover. The leading objections to its use are that the presence of oil in a boiler is likely to cause leaks at joints and rivets; steam-joint gaskets of rubber and many other materials disintegrate and leak from presence of oil; and deposits of heavier oils may be formed which, combining with material contained in the feed water, may cause the heating surfaces to become burned. Boilers containing traces of mineral oils, especially when the oil has been liberally added to the feed water, should be thoroughly washed, drained and ventilated before being entered, as highly inflammable hydrocarbon gases are likely to be present.

Failure of Corliss Engine-Governor Belt—What would result if the governor belt of a Corliss engine should break or come off the pulley? W. F.

The governor would stop, and with the governor balls no longer acted upon by centrifugal force, they would drop to a position of support. If permitted to drop to the very lowest position for which the governor is designed, the safety cams, if properly set, would be drawn around to a position for which the steam admission valves are not opened, and the engine would come to rest. But if the governor is hindered from dropping far enough to bring the safety cam to this position, as for instance, from resting on the starting pin or other device used to support the governor for holding it up to a starting position, then the valves will be operated to admit steam without the governor's regulation of the cutoff. Under these conditions, unless the supply of steam is shut off by hand or by some form of automatic safety stop, the speed is likely to increase sufficiently to wreck the engine.

Drilling and Reaming Boiler Rivet Holes—Why are boiler rivet holes required to be drilled or reamed in place of punching the holes to size? J. R. L.

Punching lessens the tensile strength of the material around the holes, and the pressure of the punch, and difference of diameter of the punch and die, cause jagged-edged holes and burrs that reduce the holding power of the rivets. In addition to this, holes punched in two or more thicknesses that are to be riveted together seldom come in correct register. By first punching the holes smaller than required for receiving the rivets, the rough edges and distorted material can be removed by drilling the punched holes to size, and the holes of two plates that are to be riveted together may be brought into alignment by drilling the holes full size with the plates bolted in position. The strength of the remaining material is considered to be unimpaired for plates over 5/16 in. thick when the diameter of the punched holes does not exceed ¼ in. less than the finished diameter, and for plates not exceeding 5/16 in. thick, when their diameter does not exceed ⅛ in. less than the finished diameter.

ERRATUM: The result of the computation given in the first item, page 377, Mar. 12 issue, as "about 9000" should have been "about 49,000 lb. of steam per hour."

Coal Saving by Lighting Curtailment*

BY PRESTON S. MILLAR

The author points out that the coal used in the production of electric light is less than 2 per cent. of the total coal output of the country, and that any practical curtailment is about 7 per cent., which means about 840,000 tons of coal per annum, or a trifle more than 0.1 of 1 per cent. saving. It is possible to effect much larger savings by other methods with less disadvantage to the public.

THE most important thing is to win the war. Need for directing money, energy and materials toward the prosecution of the war makes it imperative that waste and extravagance be eliminated. The first consideration is how best to contribute to victory. Economy, in lighting, as in other things, is one means toward that end. Economy in lighting in the present circumstances depends upon:

Securing best accomplishments of the results which the lighting is intended to bring about, subject to the need for reducing the consumption of fuel by the elimination of unnecessary lighting and by reduction of other lighting so far as the emergency warrants. Emergency reduction should be undertaken after due consideration of:

a. The amount of fuel saving that can be accomplished.
b. The disadvantages involved in the reduction.
c. The practicability of saving the same amount of fuel otherwise with less disadvantage.

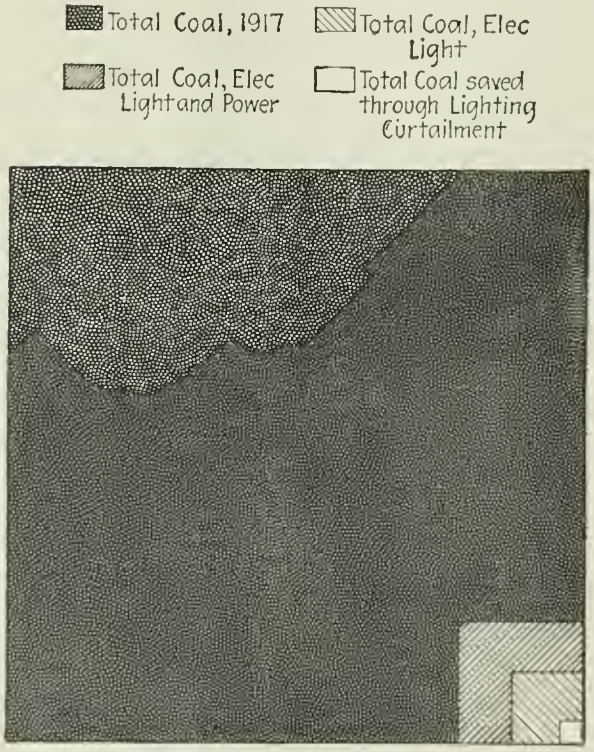


FIG. 1. TOTAL COAL PRODUCTION AND COAL CONSUMPTION OF THE COUNTRY FOR LIGHT AND POWER

The cost of artificial illumination of all kinds is 0.5 to 2 per cent. of the total expenditure of the people. It compares with certain other expenditures as follows: Illumination, $500,000,000; liquors, $665,000,000; and tobacco, $490,000,000.

The significant figures to have in mind in discussing this subject are as follows, all being rough approximations: Total coal output of the country, 640,000,000 tons; total employed in production of electric light and power (traction excluded), 36,000,000 tons; total employed for production of light by electricity, 12,000,000 tons. According to these estimates, about 2 per cent. of the coal consumption of the country goes into electric light. Fig. 1 gives a graphic comparison between the foregoing figures and the estimated coal saving possible by lighting curtailment.

Some comparison may assist to provide a proper perspective for the consideration of these data. Coal shortage, the equivalent of which must be saved, 50,000,000 tons, estimated savings in coal during 1914 if all private plants could have been replaced by central-station power, 13,000,000 tons. Estimated saving in coal by maintaining temperature of building interiors at 67 deg. F. instead of 70 deg., 10,000,000 tons.

It is evident, therefore, that the total consumption of coal in the production of all electric light is relatively not a very large item in the coal consumption of the country. If the entire electric lighting of the country were cut off, the saving in coal would be only 24 per cent. of the required saving, and no more than would be accomplished by a reduction of readily practicable extent in the heating of buildings. In considering lighting curtailment, therefore, it is important to bear in mind that even if every candle power of electric lighting were wasted, the loss of coal involved would not be the great outstanding coal waste of which this country is guilty. As relatively little light is wasted, it is evident that the amount of coal which can be saved by electric-lighting curtailment is small.

RECOMMENDED ADJUSTMENT OF ILLUMINATION INTENSITIES IN VIEW OF THE WAR AND THE FUEL SHORTAGE

Class of Lighting Service	Per Cent. Distribution	Desirable Adjustments in Intensity Per Cent.
Street	15	— 5
Public building	3	— 10
Industrial	18	+ 50
Protective	1	+200
Commercial	20	— 20
Residence	26	— 20
Recreational	7	— 40
Advertising	5	— 80
Miscellaneous	5	— 10
Total	100	Net — 7

The author has prepared the rough estimate given in the table, showing the adjustment of illumination intensities, which according to expert opinion of several men engaged in the lighting business ought to be made from standards existing before the war, in view of the war and the coal shortage. The table also shows the manner in which artificial lighting is distributed among the several classes of service adopted as a classification for this purpose. There are no general statistics on this subject. Therefore, these figures should not be accepted as anything more than a rough approximate, although they are probably reasonably indicative of expert opinion on this subject at the present time.

The first adjustment of artificial lighting which ought to be made at the present time depends on the one hand upon the need for obviating extravagant lighting and eliminating waste, and on the other hand upon the importance of promoting industry and safeguarding lives and property. The net adjustment based upon the estimates of opinions summarized in the table is in the order of —7 per cent. Adjustment in particular classes of service range from a maximum curtailment of —80 per cent. in advertising lighting to a net increase of 200 per cent. in protective lighting. In the opinion of lighting experts, electric lighting, which to obtain most desirable value ought to be increased by 73 per cent. before the war, ought now to be decreased by 7 per cent.

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*Abstract from a paper presented at the special meeting of the Illuminating Engineering Society in New York City on Feb. 14, 1918, and at a meeting of the Philadelphia section of this society on Feb. 15, 1918.

Various methods of reducing artificial lighting as a war measure have been proposed as follows:

Remove unnecessary lamps, extinguish all lamps when they are not in use, extinguish some of the lamps when possible, substitute smaller sizes of lamps, and replace inefficient by efficient lamps.

There is every reason for emphasizing the desirability of eliminating the unnecessary use of light. Fuel administrators and lighting companies have urged this expedient very prominently. Bulletin V of the Committee on Coal Conservation of the Chamber of Commerce of the United States, entitled "Conservation in Use of Coal," is an excellent presentation on this general subject which should be distributed generally.

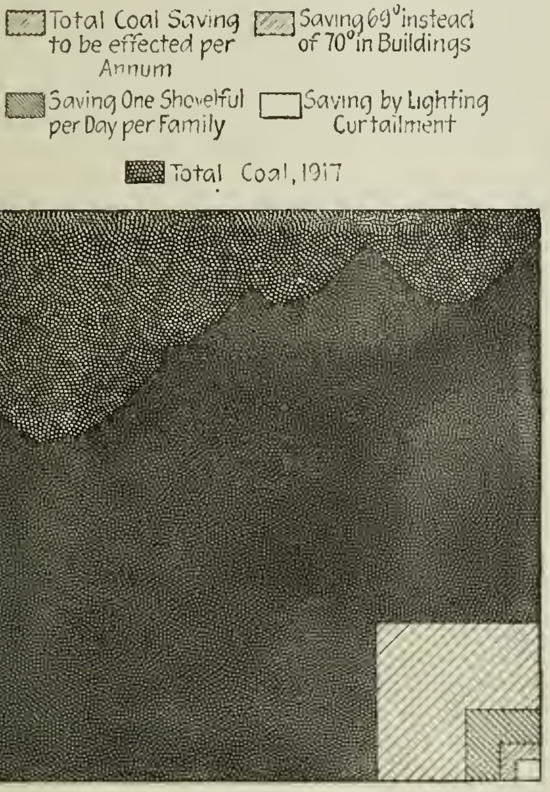


FIG. 2. TOTAL COAL PRODUCTION AND COAL SAVINGS BY DIFFERENT CURTAILMENTS

To arrive at suggestions for saving fuel used for lighting purposes without deleterious effects, one should consider the elements of inefficiency in lighting and the possibility of eliminating them. Such a line of consideration brings the following to the fore:

Good utilization of light, good maintenance of lighting equipment, use of good reflecting surfaces, daylight saving, utilization of water power, and elimination of small power plants.

The adoption of summer daylight saving, as now proposed, is estimated to be capable of reducing the coal consumption of electric central station steam plants by 230,000 tons per annum for the entire country. A suggestion to advance the period of activity by one hour the entire year round, which is now attracting considerable attention, is estimated to afford about the same saving to the public in lighting bills, but to result in a somewhat greater saving of coal on account of the more favorable load factors for the power plants, which would result in the winter months.

The inherent lower efficiency of small plants, together with less expert operation, which in general they receive, is estimated to be responsible for the use of one-third more coal than necessary. This element of waste is even more serious in England than in this country, as is evidenced by a recent report (April 16, 1917) of the Coal-Conservation Sub-Committee of the Reconstruction Committee, in which, after pointing out that the average capacity of English generating plants is 5000 hp., it is stated that "the present coal consumption if used economically would produce at least three times the present amount of power."

If a proportional amount of coal saving equivalent to 7 per cent. of the total electric light produced be assumed, this would mean a reduction in coal consumption of 840,000 tons per annum. This is the maximum extent to which it is believed that the best interests of the public requires coal to be saved through electric-light curtailment. Such a saving compares with other possible annual savings as follows:

Total savings which must be accomplished, 50,000,000 tons; net savings thought desirable through curtailment of electric lighting, 840,000 tons; savings if one degree lower temperature is adopted for building interiors, that is, 69 instead of 70 deg. F., 3,000,000 tons; and saving if each family decreased by one shovelful its daily use of coal, 15,000,000 tons. A graphic comparison of these figures is given in Fig. 2.

The saving which is possible in the heating of buildings looms large. Our practice in this respect is to heat buildings to a considerably higher temperature than is done in Europe. The coal which might be saved by operating buildings at temperatures which prevail in Europe, instead of at the temperature which we affect, would be more than the equivalent of the entire consumption of coal in electric lighting. Even the saving of one shovelful of coal per day makes any practical saving through electric lighting curtailment seem very small

New York State Legislation Affecting Power Interests

A synopsis of the more important bills affecting power interests introduced in the Legislature at Albany follows:

Senate Print No. 1. Amending the Public Service Commissions law, by providing that whenever a gas or electric corporation or a municipality files with the commission a new schedule of rates or a change in form of contract as to rates, service or facilities, the commission may, upon complaint or of its own initiative and upon notice, hold a hearing concerning the propriety of the proposed change and pending a decision may suspend it for not exceeding 120 days from the date when it would otherwise take effect. On Feb. 13 this bill was on the calendar in the Senate for final passage, but was recommitted to the Public Service Committee and has not since been called out.

Senate Print Nos. 66, 67 and 68 are three companion bills providing for the erection of a state owned and controlled hydro-electric power plant at Niagara Reservation. They provide for the issue, after approval by a referendum, of $3,000,000 of tax-exempt bonds, empower the Niagara State Reservation to construct such power plant and to operate it under their own management or under lease and provide for the manner of construction. Neither one of the measures has as yet been reported for consideration.

Senate Print No. 271. Amends the Public Service Commissions law relative to complaints as to quality and price of gas, by providing that upon written petition of not less than 100 users of gas or electricity in first- or second-class cities, and not less than 50 such users in third-class cities and 25 elsewhere, the mayor, village trustees or town board, as the case may be, must complain to the proper commission regarding the matters specified in the petition. This bill has not been acted on in the Senate. The same bill introduced in the Assembly under print number 404 on Mar. 7 was reported to second reading.

Senate Print No. 475. Amends the Public Service Commissions law by empowering the commission to raise or reduce rates and charges for gas and electricity, notwithstanding a rate may be fixed by statute or otherwise. No action has been taken on this measure.

Senate Print No. 428. Creating a state hydro-electric power commission to consist of the Governor or a representative appointed by him, Lieutenant-Governor, Attorney-General, State Engineer and the Conservation Commissioner, to investigate costs and method of development, transformation, transmission and distribution of the water powers of the state, formulate a definite and fixed policy of utilizing same, including canals; prepare and recommend proper legislation for carrying out such plan and urge upon the Federal Government proper recognition of the state's inherent right to full control of the boundary waters; and may authorize the Attorney-General to bring action against the Federal Government to determine such rights. One hundred thousand dollars is appropriated. The commission may maintain a bureau at Washington, D. C. This bill is the result of the labors of the Thompson water-power investigating committee which has been busy the last two years. At this writing it cannot be determined what action the Legislature will take in regard to the passage of the measure.

Senate Print No. 430 authorizes the Superintendent of Public Works with the approval and direction of the Canal Board, to lease the use of surplus waters impounded by canal dams and flowing into canals; authorizing the Canal Board to compromise and adjust claims and demands of water-power claimants and owners of water-power rights and privileges, appurtenant to state canal dams, constituting part of improved canals. The surplus waters of canals are to be leased to the highest bidder whether it be a person, corporation or municipality. Leases must not be for less than the appraised value of such water, and every ten years the value is to be reappraised. The Legislature has taken no action on the passage of this measure, but it will undoubtedly come up for discussion before the adjournment.

Senate Print No. 542. Authorizes the state through the Canal Board to build and equip canal boats and other craft, or to purchase or lease them for a period not longer than one year after the war. The state may lease such craft to individuals or corporations for operation or may operate them itself through the Department of Public Works, which is empowered to fix transportation rates. The Canal Board may organize one or more stock companies for constructing, purchasing or leasing such craft and for their operation, the aggregate capital not to exceed $2,000,000. If the state remains stockholder, it must retain at least 51 per cent., selling the remainder to the public at par. The Canal Board may with the governor's consent sell the entire issue to the public. One million dollars is appropriated. This measure is said to be favored by the Governor and will undoubtedly meet with the serious consideration of the Legislature before its adjournment. It bears upon the question of transportation and coal supply.

Senate Print No. 597. Amends the second-class cities law by permitting a municipality to construct, own, maintain and operate an electric power plant with necessary equipment for supplying electric power and light to the municipality itself.

Senate Print No. 744. Amends the railroad law by prohibiting the use of a locomotive engine not equipped with a vestibule cab so constructed as to attach to the sides of and inclose all openings between the engine cab and the water tank or coal tender. It strikes out the provision that mechanically operated doors are not required on doors of locomotives equipped with mechanical stokers. This bill has not been reported from committee.

Senate Print No. 747, by Senator Wagner, is a municipal-ownership public-utilities bill introduced as the outgrowth of campaign pledges in the recent New York mayorality campaign. It amends the general city law giving all cities power to own, construct, acquire, purchase, maintain and operate plants, facilities and property of every kind for supplying light, heat, power and transportation for both municipal and private use. Intention to exercise such power must be evidenced by resolution of the local administrative body declaring it in the public interests to do so and giving general description of the facilities or property to be constructed or acquired. The propositions must be submitted to the electors of the city. The value of the property to be acquired must be ascertained in the first instance by the Public Service Commission. There are various other provisions. What action the Legislature will take on this bill is largely a matter of conjecture.

Senate Print No. 842. Amends the labor law by extending the provisions for boiler inspection by the Industrial Commission to include all boilers for generating steam or heat, which carry a pressure of over 15 lb. to the square inch instead of 10 lb. as at present, and whether used for factory purposes or otherwise, except boilers subject to inspection by the United States Government or Public Service Commission; requiring such inspection at least once a year.

Senate Print No. 889. Amending the Public Service Commissions law by authorizing incorporation of gas corporations for acquiring natural gas and distributing and selling same, giving such corporation the right to acquire necessary artificial gas to augment its supply by purchase, manufacture or otherwise, and empowering the public service commission to order such augmentation when necessary for adequate service to customers.

Senate Print No. 902. Amending the Public Service Commissions law by requiring the commission to establish gas-testing stations for each individual gas corporation at points remote from the gas plants, and providing a schedule of fines based on the percentage of inferiority in gas, such penalties to be in the form of rebates to the customer.

Assembly Print No. 54. Amending the Transportation Corporations law by prohibiting electric-light corporations from collecting rent from meters. This law already applies to gas meters.

Assembly Print No. 472. Appointing Benjamin B. Odell State Ice Comptroller and regulating the storage and distribution of natural and artificial ice. It prohibits the manufacture of artificial ice in New York City, on Long Island and the counties bordering the Hudson River between Mar. 1, 1918 and Feb. 1, 1919. This bill passed both houses of the Legislature and became Chapter 4 of the Laws of 1918.

Assembly Print No. 645. Amends the conservation law by creating a division of hydro-electric power in the conservation department. This is a socialist measure and calls for the development of the Niagara River, the Long Sault Rapids and all inland waters and streams. Twenty million dollars of 4½ per cent. bonds are to be issued if the people approve of their issue at a referendum to be submitted to them this fall. The measure has to pass the Legislature, however, before it can be thus submitted.

Assembly Print No. 346. Provides for a terminal improvement commission in New York City, consisting of the mayor and comptroller, two public-service commissioners, First District, designated by the Governor, and three other members appointed by the Governor with the consent of the Senate to adopt plans for comprehensive terminal facilities for freight and for terminal markets in Manhattan. The commission may enter into an agreement with the New York Central and other transportation corporations, or if an agreement cannot be reached it may order compliance with plans adopted by it. The commission may order joint usage of facilities by different corporations. Until the Legislature determines that adequate terminal facilities have been completed, the commission is to exercise all the powers of the Public Service Commission over such terminals in Manhattan. When so completed the commission's existence is terminated. Provision is made for the condemnation of property, lease or exchange of lands with city, and for enforcement by courts.

Assembly Print 1098. Empowers the Public Service Commission by order to require two or more telephone corporations to establish continuous and through lines of communication, as in the case of telegraph corporations as at present.

Assembly Print No. 334. Empowering the Public Service Commission to raise or reduce rates and charges for gas or electricity, notwithstanding a rate may be fixed by statute or otherwise.

Steam Heating at Camp Funston

Before the Kansas City Chapter of the American Society of Heating and Ventilating Engineers, B. Natkin read an interesting paper on "Heating of Army Camps and Cantonments," dealing in particular with the installation at Camp Funston. Of the 16 National Army cantonments the following four are mainly heated by steam: Camp Custer, of Michigan; Camp Devens, of Massachusetts; Camp Funston, of Kansas; and Camp Grant, of Illinois.

All were installed under the same general plan with minor alterations to suit local conditions, so that a description of the heating plants at Camp Funston will practically apply to the other three camps.

Camp Funston is situated three miles from Fort Riley in the central portion of Kansas on a Government reservation of about 1200 acres. There are erected on these grounds 1400 wooden buildings, inclusive of barracks, latrines, medical quarters, officers' quarters, stables, garages, heating plants, exchange stores, warehouses and amusement buildings. Of this number, 650 buildings are heated from a central steam plant, while the balance have individual plants, stove or furnace heat, with the exception that the stables, garages and warehouses have no heat.

For heating these buildings there are 18 separate boiler plants, each taking care of about 35 buildings. Steam is supplied by a system of overhead mains supported on poles, and the condensation from each building is wasted. Steam in the main line is carried at 50-lb. pressure and is reduced at each building to about 5 lb. A 2½-in. reducing valve is used in each barrack and two 1¼-in. valves in each latrine, one for the radiators and the other for the hot-water tank. There is a total of 965 reducing valves in the camp. The poles are 20 ft. apart, and the steam main is suspended about 15 ft. in the air from trapeze hangers. The average size of the main is about 5 in. and the average run is 1200 ft. The drop in pressure at the end of the main is about 20 lb. Expansion is taken care of by slip joints at 200-ft. intervals. Branches to the various buildings are taken off at the bottom of the mains. By this means the lines are drained approximately every 75 ft. The steam mains are covered with 1 in. of asbestos air-cell covering, then 1¼ in. of wool felt, over which is wrapped waterproof roofing paper securely wired.

Overhead lines were used in preference to underground because this system was cheaper to install, could be readily got at for repairs, and material could be obtained more readily. As no return-line system was installed, a single line served the purpose. If the system was laid underground it would necessitate miles of trenching, suitable underground covering, such as wood log or insulated tile, a parallel return main with traps to take off the condensation in the mains and a drainage system for keeping the line dry. Then there would be the greater difficulty of repair. The condensation in the overhead line is little greater than generally occurs in an underground line.

Lack of an abundant supply of water, together with its large percentage of scale, has made it necessary to install a return-line system to save the condensation. These lines are now being installed. They run to a central low point in each unit, where the condensation is collected by an electric-driven pump and receiver, which in turn discharge the water to the boiler room. It is quite probable that had the Government engineers foreseen this necessity of underground return lines, they might have put the steam lines also underground, as it would have proved less expensive than the present system of overhead lines and underground returns.

Each boiler house has four 72-in. x 18-ft. hand-fired tubular boilers rated at 150 hp. each and served by individual 34-in. steel stacks 60 ft. high. Each plant takes care of about 35,000 sq.ft. of radiation, there being a total of 600,000 sq.ft. in the 18 units. Outside of the boilers, the only equipment in the boiler house is a 6 x 4 x 6-in. duplex boiler-feed pump and a small heater built of 8-in. pipe utilizing the exhaust steam from the pumps. Three boilers are fired as a rule, with the fourth in reserve for extreme cold weather.

The organization used to handle the central plants at Camp Funston is made up as follows: Two firemen are employed for each boiler, each man taking his turn for a twelve-hour shift. Two foremen are employed to watch groups of three plants. Over the foreman is the superintendent of the heating plants, who works under the head of the Department of Camp Utilities. The civilians employed in the various boiler plants are fast being replaced by soldiers, who will eventually handle the plants.

Barracks are two-story buildings 140 x 43 ft. The radiation installed in the barracks is all of the three-column, 38-in. high, cast-iron type. Three or four radiators in a row are connected together at the bottom by a 2-in. pipe, the steam feeding from one radiator into another. One valve controls the three or four radiators that are connected together. A steam main ends at each corner of the barrack and is connected into a steam trap, discharging upon the ground under the building.

The second-story squad rooms are heated by 14 radiators, totaling 810 sq.ft. Using a factor of 88 B.t.u. loss per hour per square foot of glass, 24 B.t.u. for exposed wall and 1.43 B.t.u. loss per hour per cubic foot of contents, these squad rooms would require 762 sq.ft. of radiation to heat them to 70 deg. in weather 10 deg. below zero. The loss through the roof is disregarded, as there is a dead-air space of about 4 in. between the beaver board and the roofing through which the air does not circulate, thus forming a fairly good insulation. The first-story squad room is heated by seven radiators, totaling 385 sq.ft.

The radiation installed in the barracks has been keeping the soldiers comfortable during the cold snaps that have occurred this winter. At night all upper windows in the squad room are opened, and trouble was experienced during the cold weather from radiators freezing. To conserve the water and fuel and prevent freezing, the steam is now turned off the barracks after the soldiers have retired for the night.

Besides the 18 central heating plants there are 42 individual steam-heating plants for officers' quarters and infirmaries, carrying loads of from 280 to 3900 sq.ft. each. These buildings are heated on the two-pipe gravity plan using cast-iron boilers and radiators.

Near the center of the camp is the big amusement zone, which comprises four blocks, 150 x 250 ft., with buildings of a permanent character, having stuccoed fronts. There are theaters, restaurants, dry-goods stores, pool hall, shooting gallery and other buildings which contain a total of 45,000 sq.ft. of radiation. For this zone a two-pipe vacuum heating system is used. Steam is supplied from a central heating plant of 600-hp. capacity, having four 72-in. x 18-ft. return-tubular boilers set in a battery. The other boiler-house equipment consists of one 700-hp. feed-water heater, two 6 x 4 x 6-in. boiler-feed pumps, two 10 x 14 x 12-in. vacuum pumps, one 3000-gal. per hour hot water heater, one 3000-gal. per hour deep-well pump, one 48-in. x 24-ft. pressure tank and one large receiving tank.

Boiler connections of 6 in. diameter lead into a 12-in. drop header. From this two 5-in. leads are taken, each of which passes through a 5 x 10-in. pressure-reducing valve in the boiler house. The 10-in. lines supply heat to the various buildings. No piping is run exposed outside of the buildings. The steam and hot-water supply mains are run in the attics or on the ceilings of the buildings and drop under the streets in wood conduit in a trench back of the buildings.

Builds Small Hydro-Electric Plant

North Wilkesboro, a small town in North Carolina, will soon be operating its own hydro-electric lighting station with a day and night service. The new plant is nearly completed and the only remaining machinery to be installed is the electric apparatus, which has been selected with a view to fulfilling the needs of the city for a long time to come. Although the town has a population of but about 2000, it is setting an example worthy of many others to follow, in that an available water site is being utilized for producing electrical energy.

Heretofore there has been trouble in generating sufficient energy by steam power, which was not only expensive, but could not be generated in quantities sufficient for both day and night service, on account of the scarcity of coal. With the water-power plant in operation the question of coal will be a thing of the past and power will be generated from a source that has been allowed to go to waste day after day, while valuable coal has been burned in producing power that could have just as well have been generated by water.

Forty-seven Coal Dealers Indicted

In response to *Power's* editorial request, in the issue of Feb. 26, for the names of Tennessee operators and dealers indicted for fuel-law violations, a correspondent has sent in a copy of the Knoxville *Journal and Tribune* for Feb. 15, containing a report from which the following is abstracted:

Violations of the Lever fuel control act and price-fixing regulations of the National Fuel Administration are charged in 23 indictments, naming 47 separate defendants and containing 163 counts, which have been returned by the Federal grand jury. Some of the largest coal companies and best known mine operators, wholesalers and retailers of coal in east Tennessee are made defendants. Charges against the defendants include conspiracy to violate the Lever law, filing of false and fraudulent reports with the Federal Trade Commission and the sale of coal at unlawful prices.

Should the defendants be found guilty, they are subject to maximum fines of $5000 on each of the 163 counts, or imprisonment in the United States penitentiary at Atlanta for not exceeding two years, or both fine and imprisonment.

Evidence in the cases was gathered by Arthur J. Delvin, D. H. Littleton, F. S. Shipp and Ernest Hawkins, special agents of the Department of Justice during an investigation which lasted more than two months. Further investigations are to be made, and, if developments justify, the results will be presented to the Federal grand jury which meets in Knoxville on the fourth Monday in May.

John Q. Barker and William C. Barker, of the Barker Lumber Co., coal brokers, of Knoxville, and E. Scott Miles and the Sequatchie Coal Co., coal brokers, of Chattanooga, are named as defendants in an indictment containing 19 counts, one of which alleges conspiracy. John Q. Barker and William C. Barker are made defendants in separate indictments on a charge of having filed false and fraudulent reports with the Federal Trade Commission, reporting the coal handled by them.

The following companies and individuals are named as defendants in an indictment containing 27 counts, two of which allege conspiracy to violate the Lever act: A. Gatliff, T. B. Mahan, E. C. Mahan, N. B. Perkins, L. F. Pratt, C. G. Ellison, N. A. Archer, Gorman Jones, Wiley W. Thomas, J. D. Williams, Southern Coal and Coke Co., New Caryville Coal Co., Sun Coal Co., Gatliff Coal Co., Mahan-Jellico Coal Co., Southern Mining Co., Golden Ash Coal Co.

D. C. Campbell, of the D. C. Campbell Coal Co., is named as defendant in a 14-count indictment, alleging the sale of coal at unlawful prices.

The Superior Coal Co., S. T. Buffet and W. C. Whitaker are named as defendants in a 10-count indictment, alleging the sale of coal at unlawful prices.

The Hackney Coal Co. and Walter M. Miller are named as defendants in an indictment charging the retail sale of coal at unlawful prices.

Hugh B. Miller and Beatrice Hutchens, of the Knoxville Coal Co., are named as defendants in an indictment charging the sale of coal at a retail price of $10.40 per ton when the Government price was not exceeding $6.25.

The Sun Coal Co. is named as defendant in an indictment of 8 counts alleging the sale of coal at unlawful prices.

The New Caryville Coal Co. is named as defendant in a 6-count indictment alleging the sale of coal at unlawful prices.

The Terry, West Coal Co. and A. C. Terry, of Oneida, are named as defendants in a 13-count indictment alleging the sale of coal at unlawful prices.

Tallman Sexton, Clifford Sexton, R. S. Barnes and B. L. Sadler, doing business as the Oneida Coal Exchange, of Oneida, Tenn., are named as defendants in an 11-count indictment alleging the sale of coal at unlawful prices.

The Southern Jellico Coal Co. and Walter L. McKinney, of Jellico, are named as defendants in an 11-count indictment charging the sale of coal at unlawful prices.

Wymer B. Siler, of Jellico, is named as defendant in a 7-count indictment charging the sale of coal at unlawful prices.

Ray Buell, J. L. Lindsay, of Jellico, and Clyde Rhodehaver are named as defendants an indictments charging the sale of coal at unlawful prices.

I. C. Stonecipher, of Scott County, is named as defendant in a 3-count indictment charging the sale of coal at unlawful prices.

W. M. Pierce, of Jellico, is named as defendant in a 3-count indictment charging the sale of coal at unlawful prices.

T. C. Williams, of Jellico, is named as defendant in a 3-count indictment charging the sale of coal at unlawful prices.

John C. Pemberton, of Oneida, is named as defendant in an 18-count indictment charging the sale of coal at unlawful prices.

J. T. Moore, of Jellico, is named as defendant in a 5-count indictment charging the sale of coal at unlawful prices.

These indictments cover a wide field of alleged violations of the Lever act, says District Attorney Kennerly, from conspiracy to violate that law to alleged violations of the prices fixed by President Wilson regarding the sale of coal at wholesale, in car lots, down to small retail sales of from three to five bushels.

Recently, the Federal grand jury at Covington, Ky., returned indictments against 61 coal operators, operating mines and handling coal in eastern Kentucky. Many of these Kentucky defendants, it is claimed, operated in connection with the Knoxville coal brokers and dealers, selling their output, which was marketed through the agency of some of the defendants named in the Knoxville indictments.

How to Join the Army Engineers

The Kaiser has placed the keenest engineering talent of his own and allied empires into the imperial armies of the Central Powers to defeat the world. During these last three years the best engineering skill of France, Great Britain, Russia and Italy and their Allies have been matched against the enemy. American employers are paying engineers such attractive salaries that voluntary enlistments of the high-class technical men in the United States Army are below requirements. This deficiency is also probably due in part to the lack of proper information concerning the engineering branch of the service. Few civilians know that it is possible for them to perform in the Engineering Corps almost exactly the same kind of work in which they are at present engaged.

The best results in any organization are obtained only when the energies of all the men in it are concentrated along the lines for which they are best suited by natural ability, education and training. The First Replacement Regiment of Engineers was organized at Washington Barracks, D. C., on December 14, 1917, with the express idea of accomplishing this end. Its specific purpose is to keep all engineering units of the Army at full enlistment strength during the period of this war. This régiment has not only the responsibility of finding men to fill up depleted ranks, but it must also fit them to step into the work of trained, efficient and disciplined soldiers.

The preliminary work of the recruit is first a thorough training in military drill, for the engineer soldier must be prepared to lay down his shovel and take up his rifle at any time. Infantry drills gradually give way to engineer work and more specific technical training. The engineer soldiers must know how to tie all the important kinds of knots and lashings, to build spar and truss bridges, to construct revetments, dig trenches, place wire entanglements, construct machine-gun emplacements, build pontoon bridges and to construct roads. They must also know the methods of demolition, sapping and mining. Specialized training in lithography, zincography, surveying, mapping, photography, carpentery, blacksmithing, electricity and machinery are also given to those qualified for further training in any of these branches.

The Replacement Regiment will be called upon to furnish men for the following organizations: Camouflage regiments, crane-operating and maintenance regiments, depot detachments, electrical and mechanical regiments, forestry (sawmill) battalions, forestry (auxiliary road, camp and bridge) battalions, gas and flame service, general construction battalions, mining regiments, quarry regiments, sapper regiments, searchlight regiments, supply and shop battalions, surveying, ranging and map-reproduction regiments, water supply companies.

Engineers are called upon to perform such a wide range of work that practically every man with any technical training or mechanical ability can find a place in this organization. Every male citizen in the United States who is physically fit, and between the ages of 18 and 21, and 31 and 40, is eligible to join the regiment by voluntary enlistment.

The applicant should write to the Commanding Officer, First Replacement Regiment Engineers, Room 107, Headquarters Building, Post of Washington Barracks, D. C., for application blank. If the blank shows the man to be eligible, an enlistment card is filled out and sent to the recruiting officer nearest to the applicant's place of residence, with instructions to enlist the man for service in this regiment.

United States Steel and Pig-Iron Output

According to the *Iron Trade Review*, Cleveland, Ohio, the steel-ingot production in 1917, as estimated by the American Iron and Steel Institute, will be 42,600,000 gross tons and the pig-iron output, 38,500,000 tons. The former figure will mark a new record; the latter will mark a drop from the total pig-iron production of 1916. The ability of the steel industry to make a new production record in the year in which the United States entered the war will arouse great satisfaction among the country's friends. Germany's steel output sagged heavily after she opened hostilities, and yet she had a clearer appreciation than any other nation of the colossal tonnages of iron and steel which modern warfare demands. German "efficiency" could round up an immense, trained army overnight, but failed to mobolize simultaneously her industrial forces. America, with an army to find and equip, and with the handicaps which her inexperience and unpreparedness entailed, was able, at the same time, the *Review* states, to keep her steel furnaces in operation and to surpass her 1916 mark, itself a record. The decline in pig-iron output from 1916 is comparatively slight and is due to the difficulties met in assembling raw materials. The *Review* concludes by stating that the year's record production inspires confidence in the future. Germany's steel industry, when pitted against America's, is fighting a losing battle.

Signal Corps Wants Electrical Men

The Signal Corps, U. S. Army, has announced that it can use the services of a large number of men having electrical training. They are needed especially in connection with the radio communication systems in use in the military service. All classes of electrical men—wiremen, expert electricians, storage-battery men, telegraph and wireless operators, and men with electrical-engineering training and experience are wanted. The opportunity offered is exceptional because of the great interest and importance of this branch of the service which has been most aptly characterized as the nerve system of the army. Men engaged in the radio division of the communication work in particular have an increasingly important part in the great intelligence system upon which army operations are almost totally dependent. The scope of this work requires men who will fall in general into three classes, depending on the character and amount of experience had by the individual; namely, radio operators, radio mechanics and field radio experts.

Application blanks for service in the radio work of the Signal Corps may be secured by addressing the Office of the Chief Signal Officer, Land Division, Training Section, Washington, D. C. Men of draft age may make application and if qualified will be inducted into the army, at their request, for service in this branch of the Signal Corps. After enlistment or induction, all personnel will be sent to one of several radio schools for six weeks to three months of intensive training in one of the three general branches of the radio work for which their previous experience qualifies them. Some of the personnel completing these courses will be commissioned, and the opportunity for advancement for all graduates will be dependent on the individual ability.

Comparative Costs of Heating by Electricity, Gas and Coal

The following examples will give one an opportunity to determine the comparative costs of heating a building by electricity, gas, hard coal, and soft coal, by employing the figures or costs of fuels in his own locality.

The heating value of one kilowatt-hour is approximately 3400 thermal units—therefore, at 10c. per kw.-hr., one cent will purchase 340 thermal units. At $7.50 per ton hard coal—making available about 8000 thermal units per pound—one cent will purchase 21,333 thermal units. At this rate it would cost $62\frac{7}{10}$ times as much to heat with electricity as with coal.

The available heating value of one cubic foot of gas for heating purposes is approximately 600 thermal units per cubic foot. At 50c. per 1000 cu.ft., one cent would purchase 12,000 thermal units. With coal at $7.50 per ton—it would cost $1\frac{8}{10}$ times as much to heat with gas as with hard coal.

With electricity and gas on the same basis—but with soft coal—having a heating value of 6000 thermal units per pound and selling at $3.50 per ton—it would cost one hundred times as much to heat with electricity as with soft coal—and $2\frac{9}{10}$ times as much to heat with gas as with soft coal.—*The Ideal Fitter*.

Obituary

John P. Sparrow, chief engineer New York Edison Co., died suddenly of pneumonia at his home, Sunday, Mar. 17. A full account of Mr. Sparrow's career is now being prepared and will appear in our next issue.

Personals

Harry S. Potter has resigned as general manager of the Tarentum Glass Co. to become general manager of the Wellington Glass Co., Cumberland, Md.

C. W. Watkins, of Dorranceton, Penn., inventor and patentee of the Watkins automatic air-regulating furnace door, has sold his United States patent rights on the device to the Page Boiler Co., of Chicago, Ill.

Miscellaneous News

Launch Big Concrete Ship—The world's largest concrete ship, 7900 tons, christened the "Faith," was launched at a Pacific port Mar. 15. With the successful completion of the ship the construction of 54 similar vessels will start, according to her builders. The "Faith" was launched six weeks after the concrete was poured into the forms.

Fifty-eight Electric Companies operating in Pennsylvania have filed notices with the Public Service Commission that they propose to advance rates since Jan. 1. In every instance the advances are declared to be necessary because of increased cost of fuel, labor and materials. In a number of cases objections have been filed and hearings held. In the same period there have been notices of increases filed by 24 gas companies, while 20 telephone companies, most of them rural lines doing a purely local business, have given notice of advances in rates.

Stevens Institute Commencement—As many members of the senior class have been pursuing an accelerated schedule since Nov. 21, 1917, the graduating exercises this year will be advanced from June 11 to Apr. 2, as follows: Saturday, Mar. 30, 8 p.m., alumni smoker; Sunday, Mar. 31, 7:45 p.m., baccalaureate sermon. Tuesday, Apr. 2, 10:30 a.m., forty-sixth annual commencement in the auditorium; 1 p.m., President and Mrs. Humphreys' reception to the graduating class, trustees, faculty, alumni, undergraduates and friends at Castle Stevens; 3:30 p.m., review of Stevens Battalion under command of Francis G. Hubbard, First Lieutenant, 71st Infantry, N. Y. G., drillmaster, by President Humphreys and graduating class.

Business Items

The Wilson-Snyder Manufacturing Co., of Pittsburgh, Penn., has opened an office in Cleveland, Ohio, at 511 Citizens Bldg., with H. W. Van Cleve, of the Pittsburgh office, in charge as district manager.

The D. Connelly Boiler Co., of Cleveland, has awarded contracts for an addition to its main boiler shop. The addition will be 140 x 80 ft. of steel construction and glass. This company is installing a set of plate-bending rolls which are said to exceed in length and capacity any similar machine in any boiler-manufacturing plant in America.

The Dingle-Clark Co. has been organized with offices at 536 Engineers Bldg., Cleveland, Ohio. This corporation will handle a complete line of motors, transformers, controllers, turbo-gears and is in a position to install electrical equipment for any size plant. Howard Dingle and W. W. Clark were, up to Feb. 1, respectively district manager and assistant manager of the Crocker-Wheeler Co. in Cleveland. Both are well known in Ohio electrical circles by reason of their ten-year connection in this territory.

William T. Price resigned as manager and chief engineer of the De La Vergne Machine Co.'s oil-engine department recently to become president of the P-R Engine Co., of New York, and second vice president of the Rathbun-Jones Engineering Co., of Toledo, which will undertake the sale and manufacture respectively of Price-Rathbun stationary and marine oil engines built in accordance with a new principle of fuel injection developed by Mr. Price during the past several years. The P-R Engine Co. has its main office at 110 West 40th St., New York, 'and branch offices in Philadelphia, Baltimore and Toledo.

NEW CONSTRUCTION

Proposed Work

N. J., Jersey City—The Hudson County Boulevard Commissioners will receive bids until April 3 for equipment for the lighting system of the Hudson County Boulevard. E. Cahill, Pres.

N. J., Pitman—The Electric Co. of New Jersey has been granted permission by the Board of Public Utilities, to issue $197,000 bonds; the proceeds will be used to build additions and make improvements to its plant. W. P. Mercer, Mgr.

Penn., Clifton Heights—The Kent Manufacturing Co. has had plans prepared for the erection of a power plant and boiler house. Estimated cost, $50,000. F. E. Hahn, Arch., 1112 Chestnut St., Philadelphia, is receiving bids for the construction. Noted Jan. 29.

Penn., Waynesboro—The Greencastle and Waynesboro Ry. Co., Bank Bldg., is having plans prepared for the erection of a 2 story, 40 x 50 ft. substation. Estimated cost, $10,000. H. D. Sefton, Gen. Mgr.

Md., Linthicum—The Consolidated Gas Electric Light and Power Co., Lexington St. Bldg., Baltimore, will soon award the contract for the erection of a 26 x 40 ft. addition to its power station. Estimated cost, $7000. E. D. Edmonton, Baltimore, Gen. Supt.

N. C., Dunn—The General Utility Co. recently incorporated with $100,000 capital stock, plans to build an electric lighting plant. Estimated cost, $25,000.

N. C., Warrenton—The Warrenton Electric Light Co. plans to build a 3 phase, 2200 volt transmission system. J. M. King, Mgr.

Ga., Elberton—City plans to extend its electric lighting system. S. W. Allen, Gen. Supt.

Fla., Daytona—The Daytona Public Service Co. plans to increase its capital stock from $300,000 to $500,000; the proceeds will be used for additions and improvements to its system. R. W. Messmore, Ch. Engr.

La., Shreveport—The Elliott Electric Co. is considering the installation of additional equipment.

Ky., Graham—The W. G. Duncan Coal Co., Greenville, will build a 75 x 100 ft., brick and concrete power house. The work will be done by day labor. C. M. Means, Oliver Bldg., Pittsburgh, Pa., Consult Engr

Ky., Newport—The Newport Rolling Mill Co. has acquired a site here and plans to build 11 additional sheet mills and install new machinery including a 6000 kw. generator set to operate proposed mills. Estimated cost, $500,000. W. A. Andrews, Pres.

Ohio, Middleport—The Staltee-Essex Coal Co. plans to install electrical equipment in its mine. F. Essex, Supt.

Ohio, New Petersburg—Fred Essex plans to install electrical equipment in his mine.

Ill., Charleston—City plans to issue $20,000 bonds to improve its electric lighting and water works systems. Address T. T. Shoemaker.

Ill., Rockford—City election in April to vote on $500,000 bonds for the erection of an electric lighting plant. E. A. Wittergren, City Clerk.

Wis., Reedsburg—City plans to improve its electric lighting plant and install new machinery including electrical generating unit of 250 or 300 kw. directly connected to either uniflow engine or steam turbine. O. W. Burkett, Gen. Supt.

Wis., Thorp—The Thorp Electric Light and Power Co., recently incorporated plans to take over the City electric lighting plant and improve and enlarge same. P. D. Kline, interested.

Iowa, Dysart—The Iowa Ry. and Light Co. plans to install a high tension line from here to Traer. W. G. Dows, Cedar Rapids, Gen. Mgr.

Kan., Colby—City plans to build a transmission line from here to Oakley. C. V. Parrott, City Clerk.

Kan., Gardner—City plans to build an electric lighting plant. Estimated cost, $20,000.

Neb., Carroll—Village voted $9500 bonds to install a lighting system.

Neb., Schuyler—City election April 2 to vote on $40,000 bonds to build an electric lighting plant. E. A. Schmid, Mgr.

Okla., Stillwater—City voted $175,000 bonds for improvements and additions to its electric lighting plant. G. M. Smith, Supt. Noted Mar. 5.

N. M., Gallup—The Town Board plans an election to vote on propostion to build an electric lighting plant. K. H. Myers, Secy.

Wash., Walville—The Central Light and Manufacturing Co. has filed a petition with the Lewis County Commissioners, for authorization to build an electric light and power line from here to Meskill. R. P. Brush, Pe Ell, Supt.

Calif., Bakersfield—The Mt. Whitney Power Co. of Bakersfield, plans to spend $108,562 to improve and enlarge its hydroelectric generating plants and $216,937 to extend distributing lines in Tulare, Kern and Kings Counties. E. R. Davis, 624 Pacific Electric Bldg., Los Angeles, Mgr.

Ont., Armagh—The Armagh Electric Co. receives bids in April for electrical equipment for power development. Estimated cost, $40,000.

Ont., Cornwall—The Cedar Rapids Transmission Co. has had plans prepared for the erection of a 110,000 volt station.

Ont., London—The City will appropriate $25,000 for extensions to its electric lighting plant.

Ont., Rideau—The Hudro Electric Commission plans to purchase High Falls on the Mississippi River and build a generating station on same.

B. C., South Wellington—The Canadian Collieries are in the market for boilers and air compressors to install in the mines.

CONTRACTS AWARDED

N. J., Hoboken—The Board of Education has awarded the contract for installing electrical fixtures and lighting system in Public School No. 3, to W. Coleman, 29 Willow Court, Jersey City. Estimated cost, $15,000.

N. J., Jersey City—The Board of Education has awarded the contract for installing electrical fixtures and lighting system in Lincoln High School on Harrison Ave., to W. Coleman, 29 Willow Court. Estimated cost, $21,000.

N. J., Perth Amboy—The American Smelting and Refining Co. has awarded the contract for a 1 story, 60 x 70 ft. addition to its power house to be erected on Maurer St., to I. Crouse, 495 State St. Noted Oct 23.

Penn., Philadelphia (Kensington)—L. S. Leberman has awarded the contract for a 1 story, 30 x 40 ft. power house addition and a new boiler house, to Conneen Constr. Co., 1737 Filbert St. Noted Feb. 26.

D. C., Wash.—The U. S. Government has awarded the contract for electric lighting system in Anacostia, to the G. E. Engineering Co., 417 Canal St., New York City. Estimated cost, $10,535.

Tenn., Hadleys Bend—The U. S. Government has awarded the contract for furnishing electrical equipment for the proposed power plant, to the West Electric Co. Estimated cost, $5,000,000.

Ohio, Cleveland—City has awarded the contract for an addition to its electric lighting plant on East 53rd St., to Kelley Demarest Constr. Co., 418 American Trust Bldg. Estimated cost, $25,000. City is constantly purchasing machinery and equipment and will soon be in the market for all kinds of boilers, generators, switchboards and equipment. W. E. Davis, Ch. Engr.

Mich., River Rouge—The Ford Motor Co. has awarded the contract for a 1 story, 10 x 60 ft. transformer house to be erected on Dix Rd. and River Rouge, to H. G. Christman Co., Stevens Bldg., Detroit.

Ill., Great Lakes—The U. S. Government has awarded the contract for an addition to the overhead distribution and lighting system at the Naval Training Station, to Paxchen Bros., 111 West Washington St., Chicago. Estimated cost, $7830.

Mo., Carthage—The Polak Steel Co., Cincinnati, Ohio, has awarded the contract for an addition to its power plant here, to M. Marcus Building Co., 2023 Reading St., Cincinnati, Ohio.

Wash., Puget Sound (Bremerton P. O.)—The U. S. Government has awarded the contract for a telephone and transmission line, to Nepage & McKenny, Armour Bldg., Seattle Estimated cost, $8950.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1] Mar. 21, 1918	Individual[1] Mar. 21, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1] Mar. 21, 1918	Individual[1] Mar. 21, 1918
Pea	$5.05	$5.80
Buckwheat	4.30—5.00	5.50—5.80
Barley	3.25—3.50	4.00—4.25
Rice	3.75—3.95	4.50—4.80
Boiler	3.50—3.75	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Mar. 21, 1918	One Yr. Ago	Mar. 21, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines a year ago as compared with today are as follows:

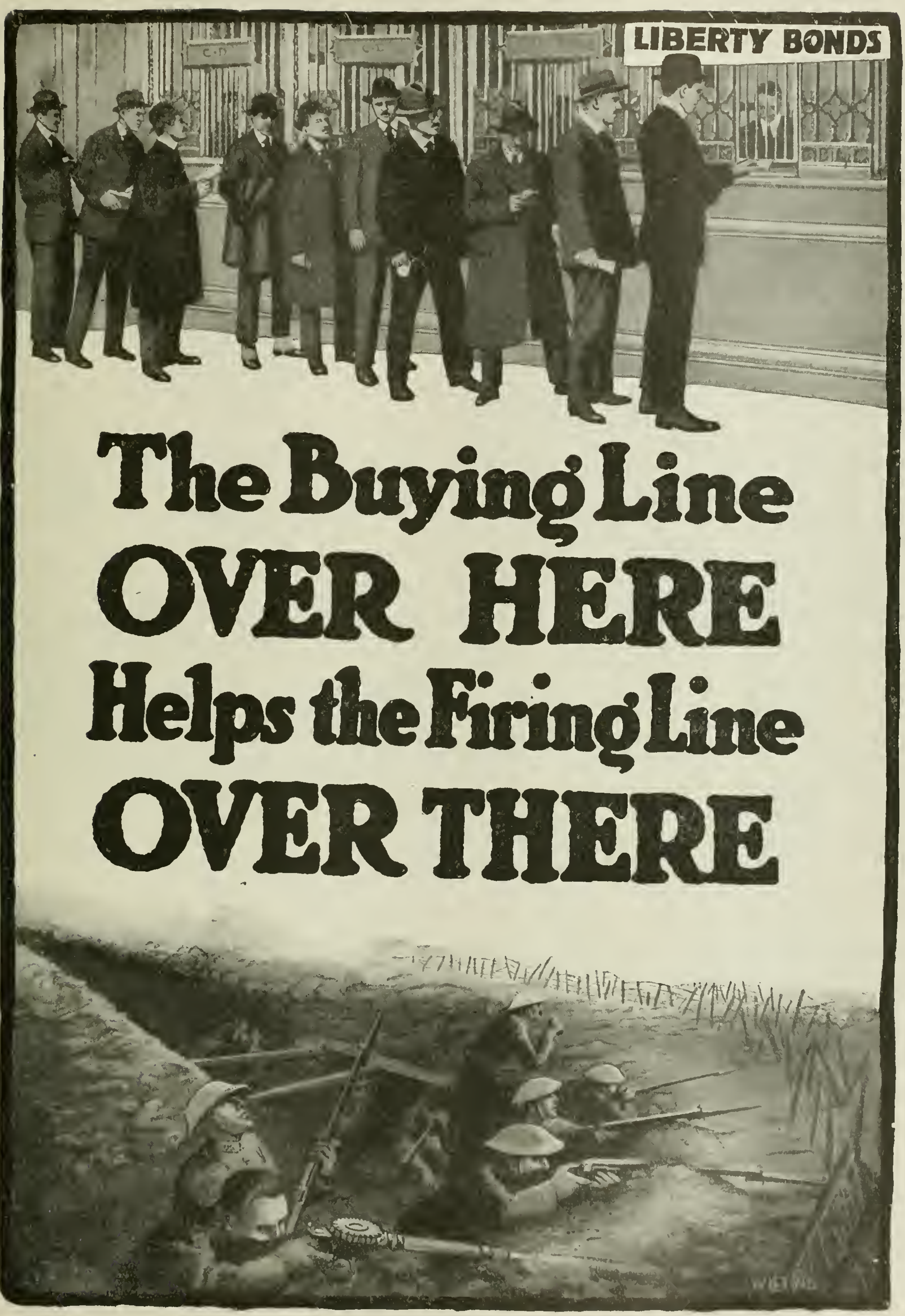
	Williamson and Franklin Counties Mar. 21, 1918	Mt. Olive & Staunton Mar. 21, 1918	Standard Mar. 21, 1918
6-in. lump	$2.65-2.80	$2.65-2.80	$2.65-2.80
2-in.-lump	2.65-2.80	2.65-2.80	2.65-2.80
Steam egg	2.65-2.80	2.65-2.80	2.65-2.80
Mine-run	2.40-2.55	2.40-2.55	2.40-2.55
No. 1 nut	2.65-2.80	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.30	2.15-2.30	2.50-2.65
No. 5 washed	2.15-2.30	2.15-2.30	2.50-2.65

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

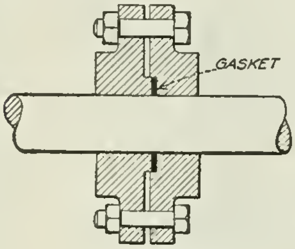

LIBERTY BONDS
The Buying Line
OVER HERE
Helps the Firing Line
OVER THERE

Underground Steam Mains

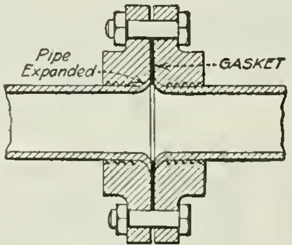
By CHARLES L. HUBBARD

While the construction details of underground mains are much the same as for any other piping of large size, the fact that they are less accessible in case of repairs makes it necessary to use extra care in their installation. Furthermore, the greater length of run as compared with ordinary power-plant or heating work makes the matter of expansion one of much importance, which calls for special provision and anchors.

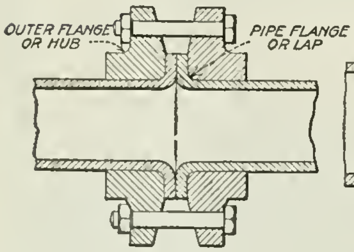
THE method of making the joints will depend upon the pressure and temperature carried on the system. For heating, both by steam and water, the lengths of pipe are commonly put together with screwed couplings, placing flanges at sufficiently frequent intervals to facilitate the removal of sections should occasion require, but, so far as possible, advantage should be taken of the flanged joints which must be put in for other purposes and in this way reduce the cost of installation. These flanged joints will occur at bends, take-offs to buildings, expansion joints and anchors. For the low pressures carried on heating work, the plain flange with a good form of flexible packing gives satisfactory results and allows of a section of pipe being easily removed, which is a more difficult matter with a recessed flange on heavy piping. A gasket of "soft" packing will make up for any small inaccuracies in the alignment of the pipe and is not so likely to permit a leak should the line settle slightly. Corrugated copper gaskets have been used with satisfactory results. If a recessed joint is to be used, the male-and-female type, shown in Fig. 1, is preferable to the tongue-and-groove flange, being easier to pack when in place. The depth of recess is made just sufficient to hold the packing in place, varying from $\frac{1}{16}$ to $\frac{1}{8}$ in., according to the size of pipe. There is danger of leaks developing where the flanges are joined to the ends of the pipe—that is, when the pipe does not extend through the flange—because there may be sand holes in the casting, imperfect threads, etc.; but this is guarded against in various ways, one of the simplest and most satisfactory being by threading the pipe with a full taper, then screwing the flange on by power until the end of the pipe projects through about $\frac{1}{16}$ in., then facing off in a lathe. Another method is to round off the inner edge of the flange and expand or peen the end of pipe into it, as in Fig. 2.



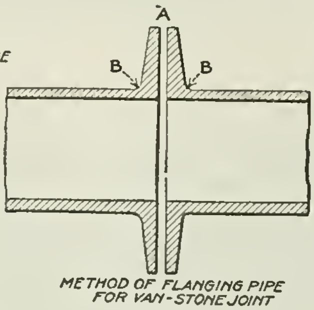
RECESSED FLANGE
FIG. 1



PIPE EXPANDED IN FLANGE
FIG. 2

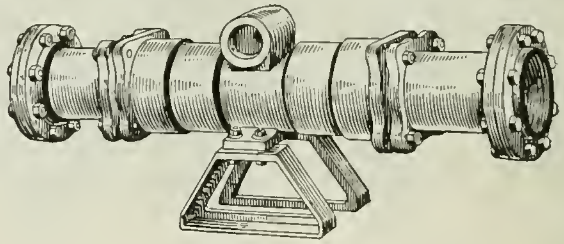


VAN-STONE JOINT
FIG. 3

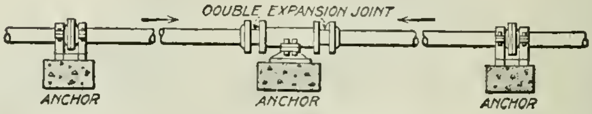


METHOD OF FLANGING PIPE FOR VAN-STONE JOINT
FIG. 4

FIGS. 1 TO 4. TYPICAL FLANGED PIPE CONNECTIONS



DOUBLE SLIP-JOINT
FIG. 5



DOUBLE SLIP-JOINT WITH ANCHORS
FIG. 6

FIGS 5 AND 6. DOUBLE SLIP-JOINT AND ITS LOCATION IN A LINE

For lines carrying high pressure, and especially highly superheated steam, more care must be taken in the construction of the joints. While there are many types of higher-pressure flanges in use, some form of the Vanstone joint is probably employed more frequently than any other. The principle of this joint is illustrated in Fig. 3 and consists essentially of flanging the ends of the pipe and drawing them together by means of a pair of loose flanges or hubs slipped over the pipe, which act as a clamp. In order to give sufficient strength, the flanged ends of the pipe must be thickened either by upsetting or turning over a flap to get the extra thickness. As it is difficult to get a perfect weld in the latter case, it seems best to first upset the end of the pipe to obtain the necessary thickness, which should be at least equal to the normal pipe walls after machining on both sides.

The form shown in Fig. 4, in which the stock is somewhat thinner at *A* than the pipe wall and slightly thicker at *B*, has given satisfactory results. Finishing the flange or lap is of much importance, and in general it should be machined on both sides to get a tight and durable joint, although in some cases only the face is finished when the back is accurately formed and the scale carefully removed. Tests made on joints of this construction show that the laps will hold considerably more pressure than the bolts, and with specially designed flanges and bolts it has been shown that the pipe will burst before the joint will give way. To make a lasting joint, the pipe flange should fit snugly in the hub of the outer flange in order to give it the proper support.

For pressures above 150 lb. the outer flanges should be of the "high-hub" type, made of rolled, forged or cast steel. While a joint of this type may be made tight without a gasket, by grinding, it is not usually advisable in case of inaccessible mains, because a ground joint is expensive and, even if properly made, may become loosened by the tremendous forces of expansion and contraction. It is therefore recommended that the bearing faces be given a fine tool finish and be provided with a gasket suitable to the pressure and temperature carried. The ordinary corrugated copper gasket has given satisfactory service for saturated steam, but does not seem to be good for superheated steam, owing to a tendency to pit out in some part of the flange from some undetermined cause. In place of copper soft Swedish steel coated with "Smooth-on" cement has been satisfactorily used. Gaskets made up of copper on bronze surrounded with asbestos have also been made use of.

The life of the gasket depends largely upon the method of pulling up the bolts. If the joint is first drawn up on one side and then on the other, there is almost certain to be trouble with the gasket, but instead of this procedure the bolts should be taken up gradually and evenly all around the flange.

The welded joint is made use of in two ways—either by welding heavy flanges to the ends of the pipe and bolting them together or by uniting the ends of the pipe without flanges. Welded flanges are used where the piping is to be removable or where it is to be joined to a fitting, but joints of this kind are more expensive than the Vanstone type because all finishing must be done on heavy sections of piping, instead of a portion of it being on small individual flanges that are easily handled. Welding the ends of the lengths of pipe, without the use of flanges, is accomplished by means of the oxyacetylene torch or the thermit welder and is successfully employed in laying lines of underground piping for water, steam and high-pressure gas. While the work may be done with the oxyacetylene torch in any position, the best results are obtained when the pipe is rotated so as to do all the welding from the top.

A committee of the National District Heating Association, in 1915, investigated the matter of pipe welding and reported the cost to be from 25 to 50 per cent. less than for screw couplings, depending upon whether the work was done on the bank or in the trench. The cost per joint at that time, for labor and materials for work done on the bank, was estimated as follows: 4-in., \$0.44; 6-in., \$0.57; 8-in., \$1.06; 12-in., \$1.57; 16-in., \$2.21. The cost for welding in the trench was estimated at twice the foregoing. If it is necessary to remove a section at any subsequent time, it is easily cut out by means of the oxyacetylene flame and a new piece of piping welded in by the same means.

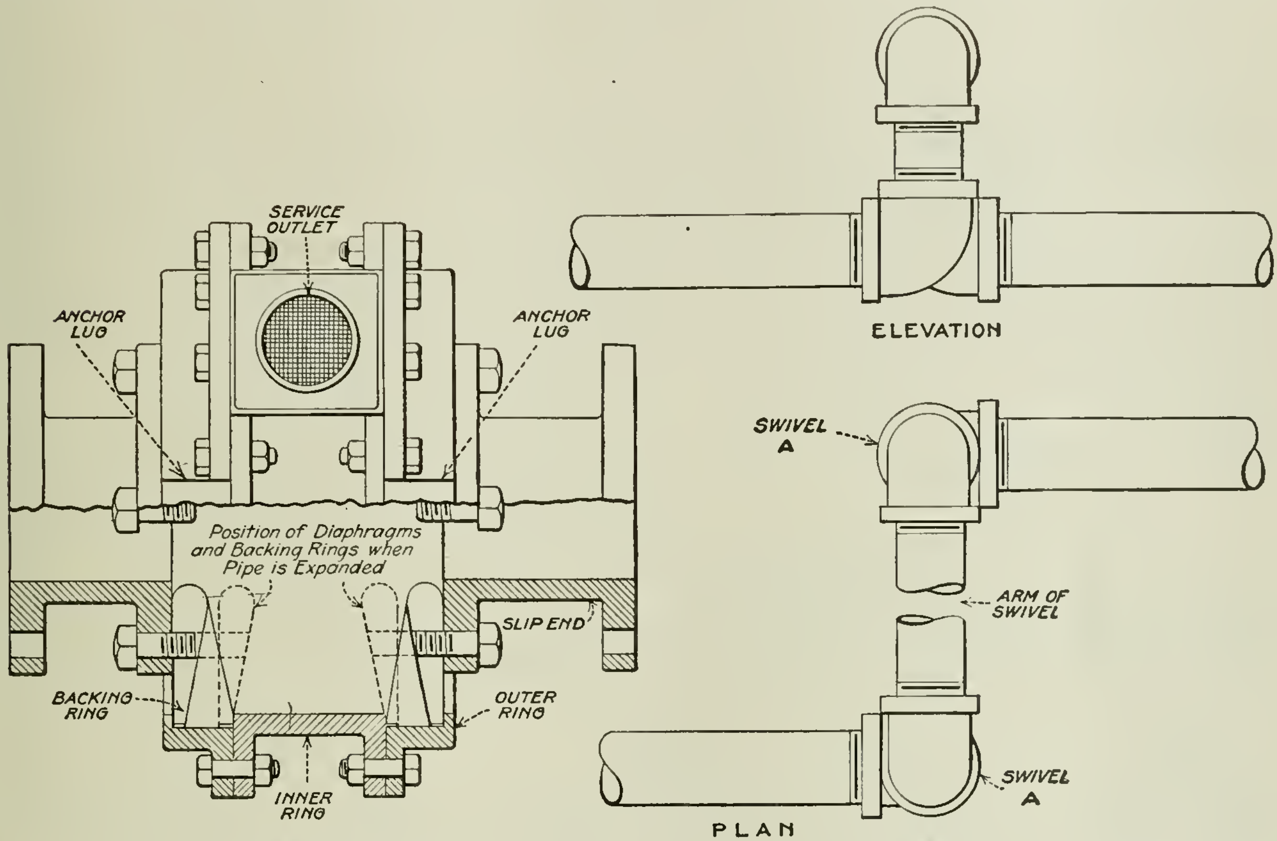
The expansion of wrought-iron and steel pipe under different conditions may be determined by the formula,

$$l = 0.00009(T_1 - T_2)L$$

in which

l = Increase of length, in inches;
T_1 = Temperature of steam in pipe;
T_2 = The lowest temperature to which the pipe is to be subjected;
L = Original length of pipe in feet.

The factor 0.00009 is obtained by multiplying the

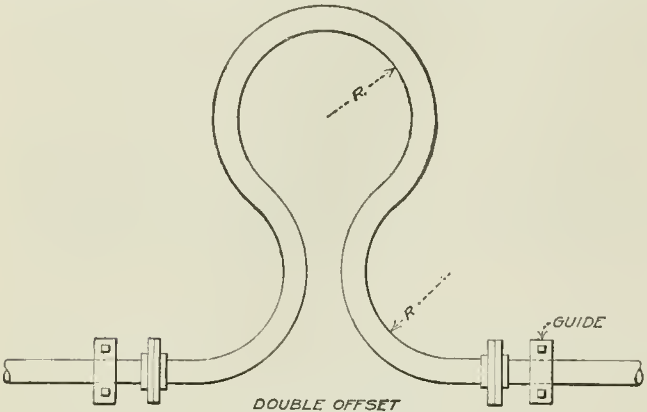


VARIATOR OR DIAPHRAGM EXPANSION JOINT
FIG. 7

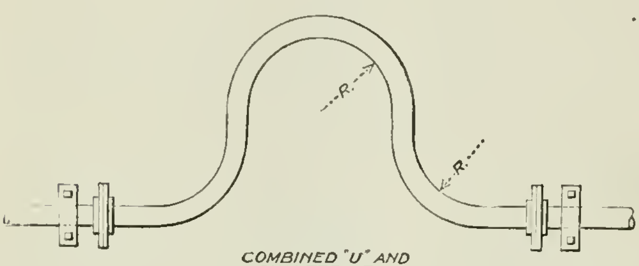
DETAIL OF SWIVEL JOINT
FIG. 8

FIGS. 7 AND 8. TWO FORMS OF EXPANSION JOINTS IN GENERAL USE coefficient of expansion, 0.0000075, by 12, in order to reduce the length L to feet, which puts the formula in more convenient form for general use.

Example: A main 1000 ft. long was fitted at a temperature of 60 deg., the lowest considered, and carries steam at 150 lb. pressure and 100 deg. superheat. What will be the increase in length due to expansion?



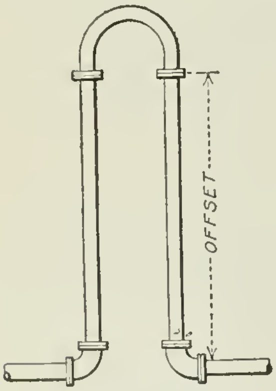
DOUBLE OFFSET EXPANSION BEND
FIG. 9



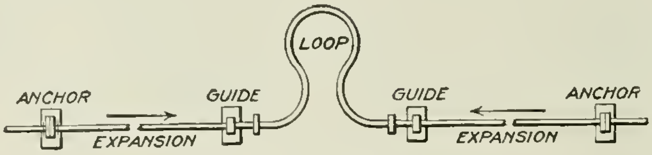
COMBINED "U" AND QUARTER BEND
FIG. 10

FIGS. 9 AND 10. STANDARD FORMS OF EXPANSION BENDS

Here, $T_1 = 366 + 100 = 466$, $T_2 = 60$ and L 1000. Substituting in the formula gives $l = 0.00009(466 - 60)1000 = 36.5$ in., or practically 3 ft. This shows the importance of providing means for taking care of the variation in length so as to avoid throwing undue strain on pipe and fittings. In low-pressure steam and water heating the expansion is much less, owing to lower working temperature. In work of this kind the increase in length will not usually exceed 1.5 in. per 100 ft. of run.

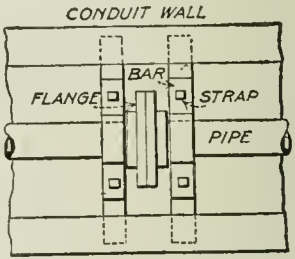


OFFSET EXPANSION LOOP
FIG. 11

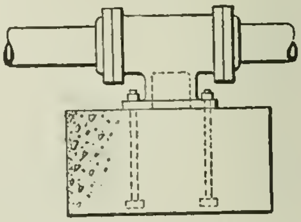


Expansion in Opposite Directions
FIG. 12

Expansion in Same Direction
FIG. 13



BAR AND STRAP ANCHOR
PLAN
FIG. 14



TEE ANCHOR
FIG. 15

FIGS. 11 TO 15. LINE CONSTRUCTION WITH EXPANSION LOOPS AND ANCHORS

There are three methods commonly employed for taking care of the expansion in long runs of piping—expansion joints, which include slip joints and variators; swivel joints; and loops. The objection to slip joints is the difficulty in keeping them in working adjustment, for if the gland is drawn up too tightly the joint will not slip, and on the other hand, if too loosely adjusted leakage will take place. In order to get the best results, the pipe line must be securely anchored at suitable points and also properly supported upon either side of the joint to prevent sagging and binding.

A simple way of combining all of these requirements in a single fitting is shown in Fig. 5, which illustrates double-slip joint, outlet and anchor. The method of installing this in the line and its relation to other anchors is shown in Fig. 6. Joints of this type should be so spaced that the maximum slippage will not exceed five or six inches, which in the case of low-pressure steam or hot-water heating will mean every 300 or 400 ft. A typical expansion joint of the "variator," or diaphragm, type is shown in Fig. 7. In this case the expansion and contraction are taken care of by a pair of flexible copper diaphragms of a special form. Joints of this design avoid the use of stuffing-boxes and all adjustments, thus making them especially adapted to underground work. It is, however, a patented device and must therefore be obtained from the manufacturers.

The swivel joint, or expansion loop, is also made use of in places where suitable. The first of these is usually adopted where long-radius bends are not practicable on account of lack of space and where screwed fittings or joints of the Vanstone type are used. A diagram of this arrangement is shown in plan and elevation in Fig. 8, which illustrates how any lengthening or shortening of the line is taken up by a slight turning or swivel movement at the flanges at points A. When there is ample space, long-radius bends are preferable to any other method, especially for high-pressure work. In this case all movement of the pipe is taken up by the elasticity of the metal, thereby doing away with any movement at joints. A typical expansion loop is shown in Fig. 9, and as the pipe itself is under an enormous strain, it is evident that the loop must be carefully proportioned in order not to overtax any part of it.

Table I, made up from curves published some time ago in the *Electrical World*, gives the maximum allowable expansion for different sizes of pipe with varying radii of bend of the general form shown in Fig. 9.

For example, a loop of the form shown in Fig. 9, made of 8-in. pipe and having bends with a radius of 70 in., will safely care for 8 in. of expansion. When the loop is of the form shown in Fig. 10, take 80 per cent. of the expansion given in Table I for the same pipe size and radius of bend.

TABLE I ALLOWABLE EXPANSION, IN INCHES

Diameter of Pipe, Inches	Mean Radius of Bend (R Fig 9) 30	40	50	60	70	80	100
3	3	6	9	13	18		
4	2.5	4	7	10	14	18	
5		3	6	8	11	15	23
6			5	7	10	12	20
8				6	8	10	15
10				4	6	8	12
12				3	4.5	6	10
14					4	5.5	8

These figures are based on the strain in the pipe, and any strain at the flange joints other than that parallel with the axis of the line should be guarded against by guides, as indicated.

Sometimes the expansion loop is made up of a pipe bend and fittings, as in Fig. 11, in which case Table II may be used to give the required length of offset for different amounts of expansion and different sizes of pipe. These figures take into account the strain on the fitting as well as on the pipe and are therefore somewhat higher than would be required if the fiber strain of the pipe alone were considered.

The inner radius of the bend at the end of the loop should never be less than five diameters of the pipe, and a length of straight pipe equal to two or three diameters should be provided at each end for handling in the process of bending. In order to distribute the expansion evenly between the different joints or loops, it is necessary to anchor the pipe at regular intervals. The method of placing the anchors for a double-slip expansion joint is shown in Fig. 6, in which case the expansion is toward the joint from either side, as indicated by the arrows. This arrangement is also applicable to an expansion loop, as in Fig. 12. When it is desired to use shorter loops, they may be placed close together and the expansion made to take place continuously in one direction, as in Fig. 13, which shows the arrangement of guides and anchors with reference to the loop. The layouts shown are for long lines of pipe. It frequently happens in practice that sufficient offsets and changes in direction are necessary to reach the different buildings to furnish a considerable part of the flexibility required without the use of special joints. Conditions of this kind should be fully taken advantage of in order to simplify the construction and reduce the cost of installation.

TABLE II. LENGTH OF STRAIGHT PIPE IN OFFSET, IN FEET (Fig. 11)

Expansion in Inches	Diameter of Pipe, Inches 3	4	5	6	8	10	12	14
1	7	8	9	10	11	12	13	14
2	9	11	12	13	15	16	18	19
3	11	13	15	16	18	20	22	24
4	13	15	17	19	21	24	25	28
5	15	17	19	21	24	27	29	32
6	17	19	20	23	26	29	32	35
7	18	20	22	24	28	31	34	37
8	20	22	24	26	30	33	36	40

Various methods are employed for anchoring a pipe line, depending upon local conditions. A simple form that may be applied at any flanged joint or offtake fitting is shown in Fig. 14, and is self-explanatory. Another, formed of a tee fitting with the side outlet closed, is illustrated in Fig. 15. This requires a special foundation built into the conduit to which the flange of the tee is bolted. All expansion joints of the slip or "variator" type which have moving parts should be placed in manhole chambers where they are readily accessible. Expansion loops should have ample room to expand in the conduits or chambers without coming in contact with the side walls or other piping. The method of support will depend largely upon whether the pipes are carried through tunnels or conduits of comparatively small size and is best taken up in connection with tunnel and conduit construction.

Boiler Explosion at Providence, R. I.

By H. S. Knowlton

A sixty-inch horizontal return-tubular boiler at the Mt. Pleasant Wet Wash Laundry, Providence, R. I., exploded at 6:40 a.m. Monday, Mar. 4, killing three persons, seriously injuring four others and completely wrecking the establishment. The boiler was being fired by one of the proprietors, who was killed. It was inspected July 15, 1917, by E. W. Farmer, city boiler inspector of Providence, and was reported then in first-class condition. Business growth at the laundry led to the recent purchase of two large washers, which were being placed in service for the first time on the morning of the explosion.

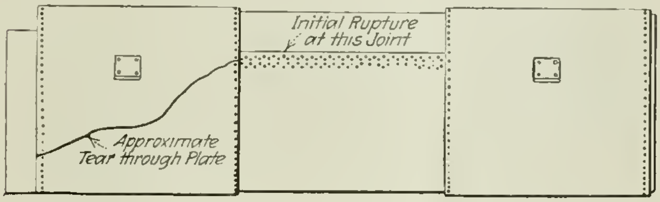


FIG. 1. WHERE INITIAL RUPTURE OCCURRED AND APPROXIMATE PATH OF TEAR THROUGH FIRST SHEET

The boiler contained sixty 3-in. tubes 16 ft. long and was hand-fired. It supplied steam to a small single-cylinder engine and to the various steam-heated machinery housed in the laundry, a 50 x 60-ft. one-story wooden structure. As the fireman was instantly killed, it is impossible to determine with exactness the condition immediately preceding the explosion, but one of the partners of the concern, who passed through the boiler room at 4:30 a.m., states that at that time the steam gage showed a pressure of 55 lb. and that about four inches of water was showing in the gage-glass.

Examination of the boiler after the disaster disclosed no apparent structural defects. The boiler sheets had no indication of having been burned or of crystallization where the fracture occurred. The explosion tore the boiler in two. The rear sheet and tube head, Fig. 2, were thrown backward to a point just behind the original location of the boiler. The other section, comprising the center and front sheet, Fig. 3, opened up, the shell being torn away from the tube sheet and flattened out in an irregular plate. Many of the tubes were blown out and scattered about the neighborhood for distances up to 600 ft., but the damage was slight excepting in the laundry itself.

From the appearance of the wreckage it is deduced that the initial failure occurred in the longitudinal seam of the center sheet and extended to the girth seam between the first and second sheets. From this point the first sheet was torn diagonally through the solid metal to the front head about as shown in Fig. 1. The opening up of the center sheet tore through the rivet holes on the girth seam, as shown in Fig. 2. A portion of the sheet of the rear section was torn instead of the rupture following the rivet holes of the girth seam.

FIG. 2. REAR SHEET OF THE EXPLODED BOILER

The boiler was of the single butt-strap double-riveted design, the rivets being $\frac{3}{4}$ in. in diameter, spaced 3 in. apart on centers and staggered in rows 2 in. apart. The shell plate was $\frac{5}{16}$ in. thick. In the rear section six of the tubes remained attached to the tube sheet, and although some of these were flattened out and bent, no signs of fracture could be seen. There was a slight pitting on the front tube sheet, and a little pitting was noticed on the side of the larger sheet fragment.

Most of the braces, which were $1\frac{1}{4}$ in. diameter, remained in place in the rear section of the boiler, the rivets of which held with the exception of three at the girth seam, which were in a longitudinal joint, these three being sheared off.

The boiler had not been operated for about 48 hours prior to opening the laundry on the morning of the explosion, but there had been a pressure of about 20 lb. throughout the night. The boiler was operated at 75 lb. pressure; it was about six years old and was allowed a maximum pressure of 100 lb. The safety valve was of the ball-and-lever type and was connected to the boiler by a cast-iron nozzle of light construction. The safety valve had not lifted from one year's end to the other, and on the night before the explosion the partner who was killed moved the ball out to the end of the lever, which put the blowing-off point to 120 lb. instead of 100, allowed on the inspection certificate, and 75 lb., the normal operating pressure.

Summing up, the evidence is that the boiler operator was not experienced; the single butt-strap joint on the longitudinal seam was of poor construction; the violence of the explosion indicates that there was plenty of water and a high steam pressure. A sticking safety valve, together with the weight moved to the extreme end of the lever and a hot fire in the furnace, left to take care of itself (as was done while the engine and other machinery was being got ready for starting up) are the probable causes for the explosion.

FIG. 3. FRONT TUBE SHEET AND FIRST TWO SHELL SHEETS

Hydro-Electric Power Development in Australia and New Zealand

BY LUDWIG SCHMIDT

An account of the present state of hydro-electric development in Australia and New Zealand, the proposed extensions and new enterprises, and a brief outline of the legal conditions under which the water-power resources are made available.

THE utilization of the water-power resources of the Australian continent, if not exactly a monopoly of the government, is at least a prerogative secured to the nation by a series of laws passed during the last twenty or thirty years. As these laws are similar, it will be sufficient to give the principles of the law of the State of Victoria, which was passed in 1896. According to this law, the state reserves to itself the right to generate electrical power including that drawn from natural sources. This right can be delegated to others under a special license, which, however, in the case of a person or a private corporation, cannot run longer than thirty years. At the expiration of the term the license may be renewed at the option of the state, under modified conditions which apply mostly to the optional powers of the municipalities or the state to acquire, when desired, the property of the licensee for the purpose of municipal or state operation. No electrical enterprise can be undertaken without the issuance of a special order or permit. This stipulation, however, does not apply to private undertakings, such as installations made in factories and for similar purposes. The carrying of overhead lines requires special permission by the local or government authorities, as the case may be. High-pressure transmission lines are subject to special control. The government retains the right to review the rates charged, and no enterprise may discriminate against any consumer as to distribution or charges.

DISTRIBUTION OF OPERATING LICENSES IN VICTORIA

Under this law 107 licenses were issued in Victoria from 1896 to 1914, of which 57 allowed the operation of municipal enterprises, 49 applied to private and corporate enterprises and one was given to the government. As to the influence of the laws governing transmission of power, the result has been a preponderance in favor of overhead transmission, which extended during 1914 over 3233 miles, while there were in existence only 80 miles of underground cables.

Electrical enterprise and power development had been extremely active in Australia before the war, but since that time progress has been slower, apparently because of the general contraction of capital. Lack of suitable shipping facilities made it difficult for Australia to dispose of its foodstuffs and raw materials in the world's market. The result was a general desire to save on the part of municipalities and the government, both of which are responsible for the extension of electric enterprise. On the other hand, the causes that led to a decline in expansion have added to a general activity in the industry itself. With Australia receiving less goods from abroad, the home industry was compelled to make up the loss. New machinery was introduced, and with the machinery new manufacturing methods, which resulted in a greater consumption of electric power. Also, the electrochemical industry, which was much benefited by the war, increased the demand on the power resources of the country.

The yearly report of the Melbourne Electrical Supply Co. is generally regarded as an index of the state of the electrical industry of the Dominion. The following figures, therefore, are of interest: During the year 1915 to 1916 this company had an increase of 20 per cent. in the number of consumers. The power supply rose 15 per cent., the total connections 22 per cent., and the number of units sold 36 per cent. above that of the year before. The gross revenue was 24 per cent. higher than that of the preceding year.

Similar indications of great prosperity in the electrical industry of Australia may be found in the reports of many other undertakings; but the character of the electrical materials imported shows clearly the direction the electrical business has taken during recent years. During the years 1915 and 1916, for instance, the State of New South Wales received from the United States the following electrical machines and supplies:

	1915	1916
Dynamos	$317,252	$324,031
Switches	92,648	50,110
Heating and cooking apparatus	9,378	9,678
Electroliers	18,361	27,115
Regulating, starting, and controlling apparatus	150,715	96,000
Telephones	180,303	305,319
Accumulators	47,269	13,880
Arc lamps	21,544	15,041
Cables	15,612	28,934
Miscellaneous	1,976	26,969

It will be noticed that the demand has run rather in favor of material for extension purposes than materials for new installations.

In the meantime, however, interest in future electrical development in Australia is far from waning. Good progress has been made in charting and developing the existing natural power resources. In this respect Tasmania has been especially active. Theoretically the Island of Tasmania seems to offer great possibilities for hydro-electric development, but in practice the situation is not quite so favorable. The many small and large rivers which form important falls are not water carriers during the whole year. They lose much of their force during the dry season, and successful hydro-electric development becomes possible only where the flow of the river can be supplemented by the use of artificial or natural reservoirs. Such locations are few on the island, and where they exist they are not situated within easy access of the centers that would be most benefited by them. Even the big natural reservoir which is now used for hydro-electric power generation on a large scale is far removed from its principal consumer, the City of Hobart and the surrounding district.

The so-called Great Lake of Tasmania lies in the center of the island at an altitude of 3350 ft. above sea level. It has an area of 42 square miles and draws its water from a watershed covering 200 square miles or more. During at least six months of the year this region has a comparatively heavy fall of rain, which, if retained, guarantees to the rivers flowing out of the lake a sufficient surplus of water to eliminate the danger of their becoming useless for power generation during the dry months. Here, with the help of a dam conserving the waters of the lake, is in operation the government hydro-electric plant, which serves Hobart and other cities of Tasmania with electric light and power. The dam is run across the southern end of the Great Lake, and the waters are led by the existing river bed to a second reservoir from which pipe lines feed the turbines.

Government Assists Development in Tasmania

The Great Lake region is not easily accessible, and much time, labor and money were lost in transporting materials and machinery to the building grounds. So it happened that the capital provided by the promoters proved to be insufficient, and the work was in danger of being discontinued, as it was impossible at the time to get additional capital. So the government of Tasmania, unwilling to let lapse a project which, when completed, would benefit the whole country materially, stepped in and undertook to finish the scheme under an agreement with the former owners.

After the government took hold, the work progressed very rapidly. The station finally was opened during 1916 with an initial development of 10,000 hp. of the 100,000 hp. which is expected to be available. The result of the opening has been that most of the cities in proximity to the station either have given up their own power enterprises or have connected their stations with the government scheme.

The City of Hobart has entered into an agreement which secures to the city at least 1,500,000 units per annum, to be used for municipal and private purposes. The city pays a minimum price for the power consumed and undertakes to do everything in its power to increase the sale and use of electrical power within its limits. The government reserves the right to deal directly with consumers that buy more than 500 hp. The government also bought the existing generating plant of the city, to be used in an emergency, and it is stipulated that the city shall have the first call on the power generated in this station, should the occasion arise.

Electric Power for Mining Companies

The government also has made power-supply agreements with several of the large mining and electrometallurgical enterprises that operate in the island, such as Amalgamated Zinc, Ltd., and the Mount Lyell Co. Beginning with the first of January of the present year, the government agrees to supply Amalgamated Zinc with 4000 hp., and within two years that company agrees to take 26,000 additional horsepower at a price of $300,000 per year for the 30,000 hp. It also has a call for 20,000 hp., which need not be taken from the Great Lake development. Under a similar agreement the Mount Lyell Co. will receive 50,000 hp. The extension of the plant for the purpose of supplying these additional demands is already under way, and during the spring of last year $855,000 was voted by the Tasmanian government for the further development of the site.

There has been some dissatisfaction among Tasmanian manufacturers over the government's action in distributing the vast power resources of the Great Lake to big industrial enterprises, and so there has been an extension of surveys made in the island for other sites likely to be used for power development. As a result the following new developments have been proposed: A development of 10,000 hp. can be obtained on Lake Rolleston, near Zeehan. There are several prospective sites on the Franklin River. The Great Lake region contains, apart from the big development described, a possible development of at least 40,000 hp. on the Derwent River, which would have to be worked in conjunction with the lake. From 40,000 to 50,000 hp. may be obtained on the Arthur Lakes.

In the meantime work has begun on the Mount Lyell development on King River. Here a dam 120 ft. high across a narrow gorge forms a reservoir of 3½ square miles, sufficient to generate 30,000 hp. The water is carried in pipe lines to the power station, which will be operated by the government and will be used principally to furnish current for the electrical treatment of zinc ores.

Hydro-Electric Tendencies in New Zealand

The present tendency of hydro-electric development in New Zealand probably is best characterized by quoting from the report of U. S. Consul Alfred A. Winslow, of Auckland. This report says: "Much preliminary work is being done on proposed public works, such as extensive harbor improvements at several ports, hydro-electric plants and new railway developments on North Island, many new public buildings and extensive road building to open up new sections of the country. The government hydro-electric plant at Lake Coleridge, about 70 miles west of Christchurch, was opened during the year with splendid results for Christchurch and vicinity. The city is now lighted by electricity, the tramcars are operated with power from this source, and many of the industries in and about the city secure their power from this plant, at very low rates in all cases. There is a demand for more current than can be supplied by the present installation of 6000 hp., and it is proposed to put in another unit of equal power. The Minister of Public Works has announced that progress was made on the preliminary work for government hydro-electric development in the North Island and that the work will progress until completed. with a view to developing the scheme as soon as conditions warrant."

These preparations in the meantime have developed rapidly, and they show that a great number of sites will be available for hydro-electric purposes in the island. The most promising are the following: A large development able to produce 120,000 hp. on a 50 per cent. load-factor basis at the Arapuni Gorge, eight miles from Hira Hira. Of this total, 30,000 hp. could be developed at a cost of $6,000,000. This would be sufficient to cover the present demand for power from Auckland and surrounding districts. The most suitable source of power supply for the City of Wellington is the Mangahao River, where approximately 50,000 hp. would be available. If this should not be sufficient, there is another site in the Taranaki district offering good facilities. The Hawkes Bay district, finally, could draw its power supply from Lake Waikaramoana.

The scheme of power development proposed by Evan Parry, the chief electrical engineer of the Public Works Department, is very far-reaching. It not only provides for an early development of the principal sites available, but it contemplates also to link up these sites. This would add materially to the security of the output and would guarantee to the whole North Island a continuous source of cheap power probably not to be found in any other territory of the same extent in the whole world.

The Wellington scheme utilizing the waters of the Mangahao River provides for an interesting engineering feat, as it will be necessary to cut a tunnel through the mountain range separating that river from the Tokomaru River With the help of this tunnel the waters of the latter river will be fed to the Mangahao. The power station will be situated on the Mangahao, within easy reach of the railroad, so that material can be transported to the site without much difficulty. To develop 25,000 hp. in this locality will cost approximately $2,100,000. To this will have to be added the cost of providing the trunk lines and other installation necessary for power distribution to the district, which is estimated at approximately $2,900,000, bringing the cost of the scheme to $5,000,000 in all. Trunk lines will be run from the central generating station to Wellington, Palmerston North, Wanganui, and Masterton as chief distributing centers. The power will be sold to the municipalities in bulk for distribution to small consumers, and the larger consumers will be supplied by the government.

The enterprise shown by the New Zealand government doubtless has been stimulated very much by the great success of the Lake Coleridge development, the opening of which took place during 1916. The Christchurch municipality says in its yearly report that the development has proved an unqualified success, and a governmental report dealing with the same subject points out that the effect of the new power source was evidenced immediately by a great activity in all industries.

The original development of the Lake Coleridge scheme provided for 6000 hp., but during the erection of the plant it became apparent that this would not be sufficient to meet the large demand, and it was finally decided to add another unit of 2000 hp. to the three already existing. During the first year of operation a fifth unit of 4000 hp. was added. The plant earned enough during the first year of operation to pay for its running expenses, and satisfactory progress has been made since then. R. A. Lundquist, the United States Commercial Agent, who recently visited New Zealand, says that the Lake Coleridge power plant ultimately will supply a territory 75 to 100 miles north and south of Christchurch.

The future of the electrical-power situation in New Zealand will depend largely upon the success of the present undertakings. As in Australia, hydro-electric development in New Zealand is a prerogative of the government under a law passed in 1887 and extended in 1908. Under this law there are in operation at present 111 electrical undertakings, 10 of which refer to tramway systems.

The present tendency all over Australia and New Zealand is to make use as much as possible of the hydro-electric powers available in preference to all other kinds of power. The demand, however, has not grown to such an extent that hydro-electric generation can be used to advantage in all locations. The result is that there is still a very extensive demand for steam turbines and engines. The fact that coal can be obtained at a fairly low rate gives steam generation a decided advantage over gas and the internal-combustion oil motor. According to R. A. Lundquist, there will be a demand, as far as New Zealand is concerned, for steam turbines in units of about 500 to 600 hp. for central stations. Below that horsepower steam engines will be favored for the present.

Bonus Plan for Boiler-Plant Operatives

BY HAYLETT O'NEILL

The author proposes a bonus plan whereby the firemen, boiler cleaners and fire cleaners may share in the saving effected by close attention to operation and maintenance of the boiler-room equipment. Numerous charts are given to readily check up performance of the boilers, efficiency being rapidly estimated on CO_2 content of flue gases and temperature of uptake gases.

THE principal argument for a boiler-room bonus plan is that such a system, in stimulating efficiency and thereby resulting in the workman getting part of the money that otherwise would go to the coal dealer, makes employer and employee partners for each other's benefit.

The extraction of heat from fuel to generate steam is a complicated process. Some of the factors of waste and efficiency are inherent by nature in the fuel, atmospheric conditions, etc., while others are dependent upon the design, operation and upkeep of the furnace and boiler. Ordinarily, a plant using modern stoking equipment should get better results than a hand-fired plant. But unfortunately, the elimination of old equipment comes slowly and the object of a bonus must be to obtain the best results with existing apparatus.

Practically every bonus is estimated from one or both of two measurements: (1) Over-all plant efficiency or money cost of steam production; (2) percentage of CO_2 in the flue gas, an index to the efficiency of firing and maintenance of the boiler settings.

To be of value the first system requires regular and accurate analyses of coal fired, weights of coal fired and water evaporated, etc., and while the over-all efficiency obtained is the final test of plant operation, the system by itself is faulty in that there is no fixation of responsibility for savings or losses upon the individuals concerned in the various operations. Such a system is proper when its benefits are applied to the chief engineer or chief executive.

The CO_2 system, where the flue gas is accurately sampled for an entire period and analyzed, gets surprising results in many places; but such a system is faulty in that CO_2 percentage by itself has no relation to the demands on the coal pile. The CO_2 merely measures the degree of air supplied in excess to that theoretically required as a minimum for perfect combustion of a given fuel. Thus, as in Fig. 1, with coal containing about 5 lb. of hydrogen per 100 lb. of combustible, 10 per cent. CO_2 indicates that 23.2 lb. air was supplied per pound of combustible, or 80 per cent. in excess of theoretical requirements.

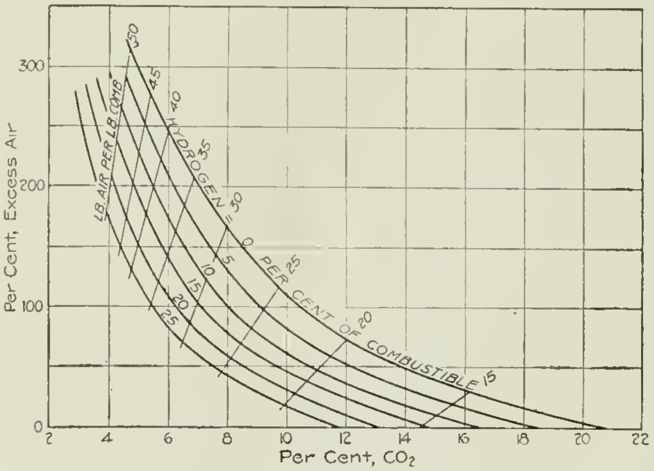


FIG. 1. VARIATION IN EXCESS AIR WITH CO_2 WHEN FUEL IS COMPOSED OF CARBON AND HYDROGEN

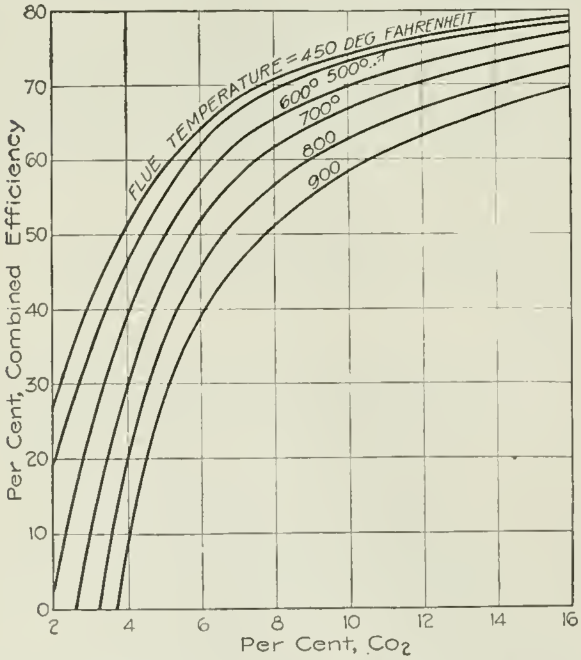


FIG. 2. BOILER EFFICIENCIES ESTIMATED FROM CO_2 AND FLUE TEMPERATURES—EASTERN COALS

By far the greatest operating loss in a boiler and furnace is that loss of heat which escapes in the flue gas, and this heat is measured by the weight of gas and its temperature. Consequently, a knowledge of flue temperature is essential to the measurement of boiler-room losses. These two measurements can be made to accurately indicate the total losses.

Fig. 2 shows the calculated combined boiler and furnace efficiency in terms of CO_2 and flue temperature.

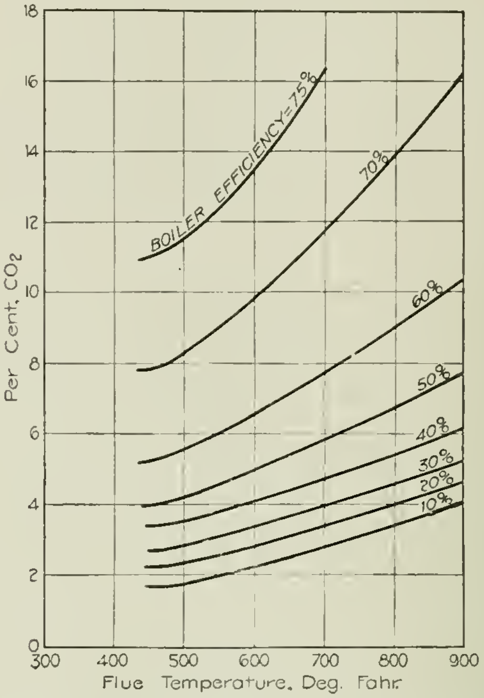


FIG. 3. RELATION BETWEEN CO_2 AND FLUE TEMPERATURES FOR CONSTANT BOILER EFFICIENCY

The values are calculated with certain operating conditions, actually variable, assumed as constant, when the samples of gas and temperatures are accurately taken and averaged over a given period. There will be found a remarkable agreement with actual efficiencies as determined in the usual approved manner. That is to say, if the average CO_2 and flue temperature were respectively 10 per cent. and 600 deg. F., the average combined boiler and furnace efficiency would be 70 per cent. within 1 or 2 per cent. above or below.

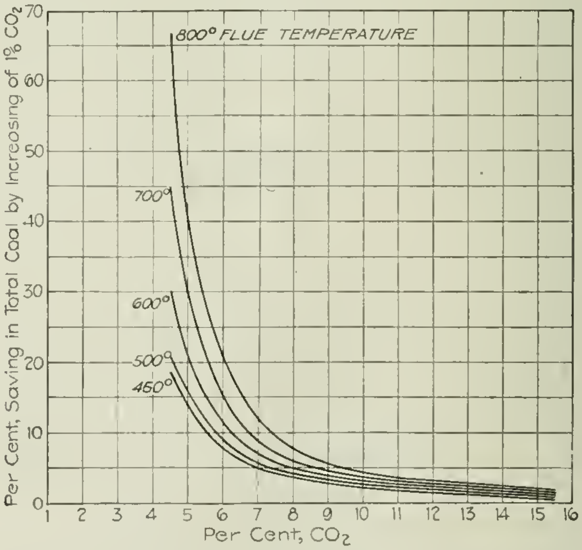


FIG. 4. SAVING IN COAL FOR CONSTANT EVAPORATION BY INCREASING CO_2

Fig. 3 shows more clearly the same values, but with CO_2 and flue temperature plotted against each other for fixed combined boiler and furnace efficiencies: That is, with 8 per cent. CO_2 there would be the same boiler efficiencies as with 14 per cent. CO_2; or 70 per cent., if the flue temperatures were respectively 480 deg. F. and 810 deg. F. If a fireman by careful firing produced 14 per cent. CO_2, and the boiler-cleaning and repair crew allowed the boiler to become dirty, the baffles to deteriorate, etc., the net benefit to the plant would be nil. In fact it is evident from the chart that it is possible to increase the CO_2 percentage and still have a net plant loss. In Fig. 2 a flue temperature of 600 deg. and a CO_2 percentage of 10 per cent. indicate a combined boiler and furnace efficiency of 70 per cent. By increasing the CO_2 to 12 per cent., but permitting the condition of the boiler to become so bad as to result in an 800-deg. flue temperature, the efficiency will fall to about 67 per cent., with a net fuel loss of over 4 per cent.

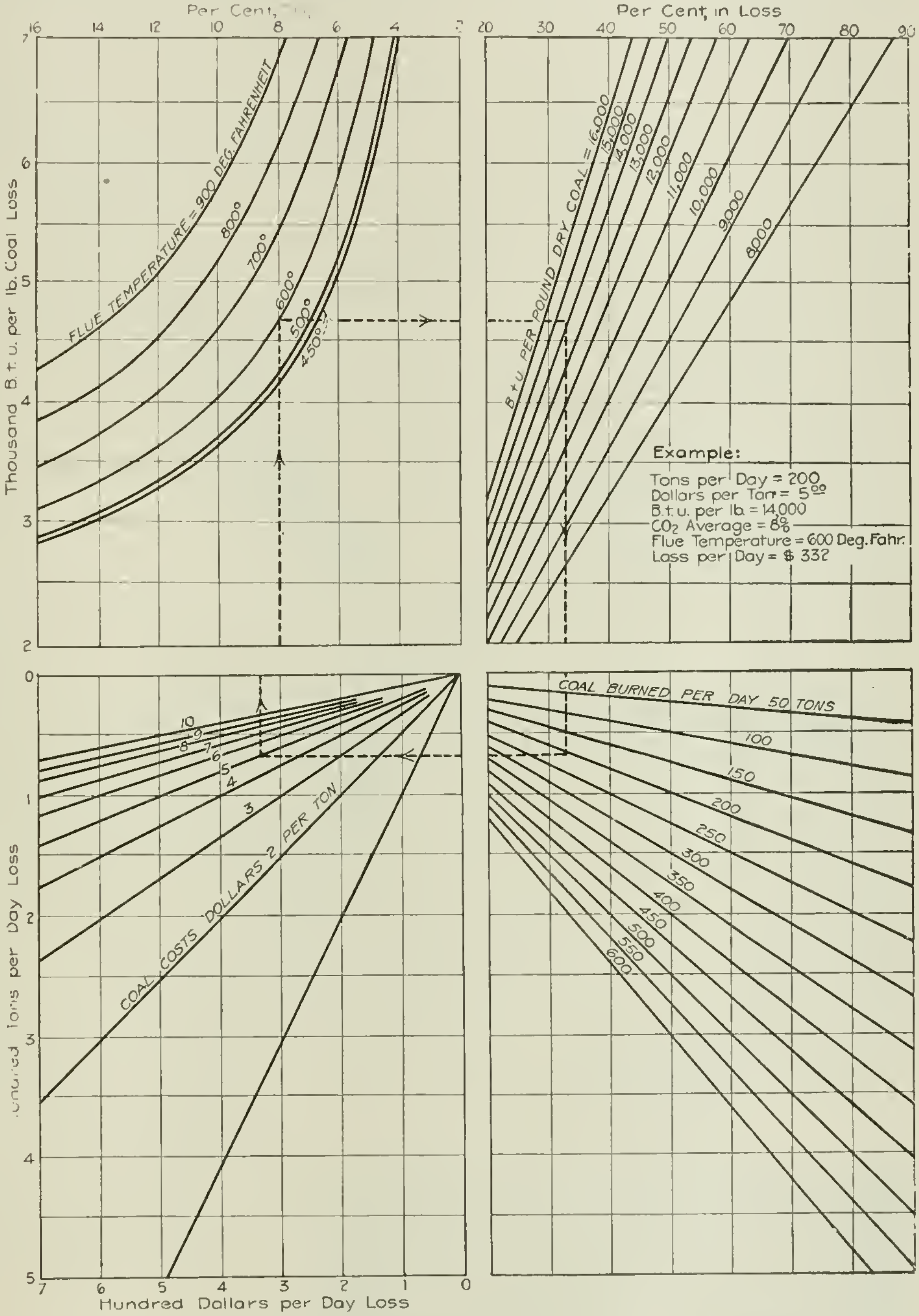


FIG. 5. FUEL LOSSES MEASURED BY CO_2 AND FLUE TEMPERATURES

Nearly all CO_2 bonus systems allow a fixed sum of money for each increase in CO_2 above a standard. The operating results may work out all right in the end, but there is a danger in the workman's not sharing in true proportion to his saving. That is, the percentage of fuel saving per CO_2 percentage increase is variable, depending upon the percentage of CO_2 and flue temperature. A fixed bonus rate results in the workman's receiving less than he is entitled to under certain conditions, and more under other conditions. For a plant run at high rating or with poor heating surface, the importance of high CO_2 percentage is greatest. There is a greater gain from boosting low CO_2 than from boosting high CO_2. That is, in Fig. 4, with 600 deg. flue temperature, a gain in CO_2 from 9 per cent. to 10 per cent. will save 3 per cent. coal, while a gain from 4 per cent. to 5 per cent. will save 20.5 per cent. coal. This explains the almost incredible savings that can be made in a poorly fired plant, with only a slightly increased effort by the management and the workmen. It is easy to make big savings in a poorly operated plant; but the savings become increasingly hard as perfection is approached.

Although there is theoretically a gain in increasing CO_2 up to a point of zero excess air, 18 per cent. to 19 per cent. for soft coal, there is probably no practical gain in going beyond 16 per cent. Engineers are not agreed upon this point because of the difficulty of getting sufficient accurate data, but it may be said that the gain would be next to nothing.

Thus a bonus system based on a fixed payment per percentage increase of CO_2 and planned to give to the workman a reasonable percentage of the savings made by improving poor operation may bring as large bonuses to the workman as the total saving to the plant, when top-notch results are obtained, in which case further improvement results in a loss to the owner.

The proposed bonus scheme is to pay a bonus to each of three classes—firemen, boiler cleaners and fire cleaners—who are respectively responsible for performances measured by CO_2, flue temperature and percentage of combustible in refuse, each of which values determines the bonus. Actually, the three classes may be vested in one man or several, in which case the bonuses are to be calculated in the same way, but payment is to be made according to responsibility. In a one-man plant one man would get three bonuses, etc. Each bonus is to be a fixed percentage of the fuel saving measured by CO_2, flue temperature and percentage combustible in refuse, for results better than those measured by standard CO_2, flue temperature and percentage combustible in refuse. Thus there will always be a fixed ratio between profits of workmen and owner, which is desirable.

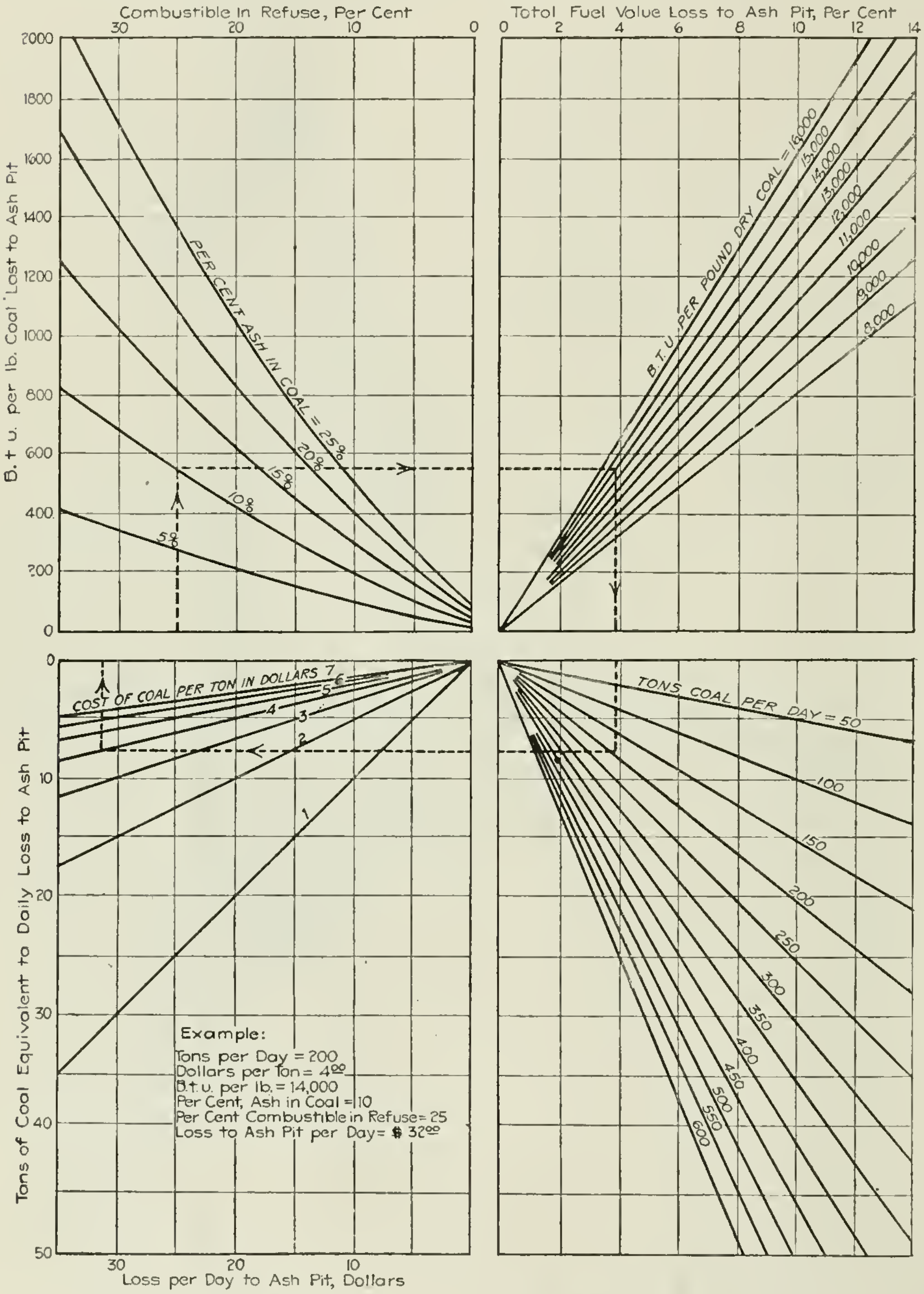


FIG. 6. BOILER-ROOM LOSS CHART, SHOWING FUEL LOSSES TO THE ASHPIT

Ordinarily, CO_2 depends upon the quality of firing, but it also is dependent upon the condition of the boiler setting and of the grates over which the fireman, as such, has no direct control. On the other hand, a good fireman would not allow himself to be deprived of the fruit of his efforts because of a poor setting or of poor grate. Knowing that such defects in the apparatus lead to unnecessary excess air, if the maintenance man fails to do his duty, the fireman naturally will report defects of apparatus to the chief for proper action.

The maintenance man or boiler cleaner can save money by keeping the boiler clean and the baffles in such shape that the boiler will readily absorb heat, so that the flue temperature will be low. An unscrupulous repairman may wilfully neglect the setting and grates in order to admit excess air to cool flue gas so as to increase his bonus. But such a condition would naturally be opposed by an active fireman.

It is true that the flue temperature is dependent not only upon the condition of the apparatus, but also upon the rate at which the fuel is fired. Even in the most efficiently designed installation the percentage of total heat absorbable falls off as the boiler rating increases and the flue temperature rises with increase of load. Therefore it is necessary to base the standard flue temperature for an average load by test. This is comparatively simple for industrial plants where the load is rather steady.

Fig. 5 shows the daily losses in dollars and cents based on the efficiency charts, for any condition measured by CO_2 and flue temperature. That is, under the conditions for the plant illustrated, the daily loss would be \$332. Loss from combustible in ashpit refuse is primarily up to the fire cleaner, who may be a special man or the regular fireman. In case the loss is great owing to poor condition of grates, the fire cleaner, whose interest is thereby prejudiced, should report conditions to the chief for proper action.

The losses on account of combustible in the refuse are measured not only by the percentage of combustible in the refuse, but also by the percentage of gas in the coal. Twenty per cent. combustible in refuse of coal containing 5 per cent. ash means a loss of 205 B.t.u. per pound of coal, while the same percentage of combustible in refuse of coal containing 25 per cent. ash means a 1023-B.t.u. loss per pound of coal.

Fig. 6 shows the daily losses in dollars and cents for any condition measured by percentage of combustible in the refuse and percentage of ash in the coal. That is, under the conditions of the plant illustrated, the daily loss is $32.

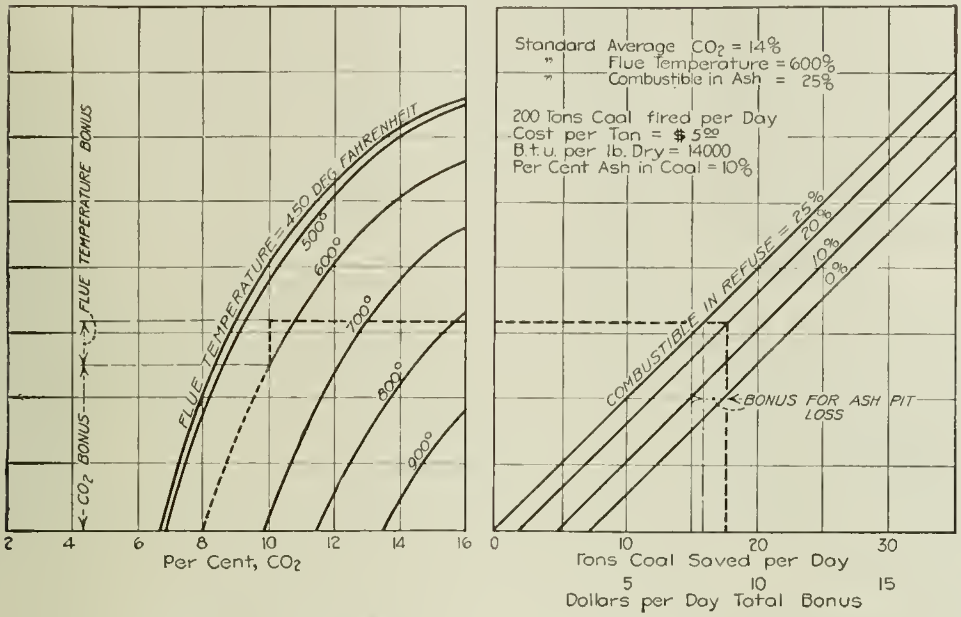


FIG. 7. CHART TO DETERMINE BONUS FOR BOILER PLANT OPERATIVES

Fig. 7 shows a bonus chart with assumed conditions as to quality, quantity and price of coal, with bonus equal to 10 per cent. of the savings calculated from the efficiency chart, to be made by obtaining results better than those measured by the standards of 8 per cent CO_2, 600 deg. flue temperature, 25 per cent. combustible in ash.

Assuming the following average attained:

CO_2, per cent	10
Flue temperature, deg. F.	550
Combustible in refuse, per cent	20

the daily bonus per day equals:

To firemen	$6 10
To boiler cleaners and maintenance men	1 80
To fire cleaners	1 00
	$8 90

The division of the bonuses to individual men is left to the judgment of the management. In the example given, it may be advisable to increase the bonus to boiler cleaners to $3.60 per day, in which case the bonus would be equal to 20 per cent. of this saving to the plant.

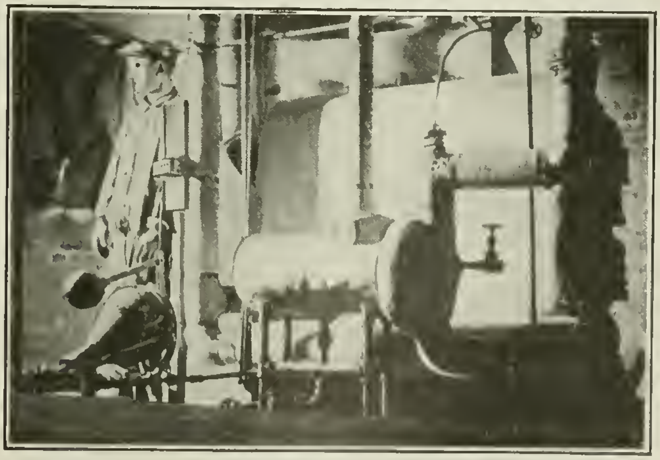
Steam To Heat Water for House Heating

By P. J. Bryant

The use of steam to heat water is not uncommon, but as to the economy of the transfer of the heat from steam to water there seems to be a scarcity of data at hand. We have such an installation at the institution where I am employed, and our operating experiences may be of interest to others. The large buildings are all heated by steam furnished from a central power plant through tunnels, but residences have individual heating systems in their basements. The chaplain's cottage is heated by hot water heated by steam from the tunnel steam main, and the illustration shows a tilting trap to which a tally is attached to meter the condensation during a test of the steam required to heat the cottage.

The heater, also shown, is 32 in. long and 14 in. in diameter, having 16 sq.ft. of heating surface, and the water circulates through the tubes by the thermo-siphon principle. High-pressure steam is delivered through a reducing valve at 2 lb. pressure, controlled by a temperature-regulating valve, so that the water in the system may be maintained at any predetermined temperature. Ordinarily, the condensation from the heater returns to the tunnel system through a seal, but in order to obtain operating data, the calibrated tilting trap with a counter attached, was installed temporarily and all the condensate during the month of February passed through this improvised meter. Daily readings of the counter were taken, and the daily consumption of steam, in pounds of condensation, was plotted for the month against the daily outside temperatures and, although the consumption varied inversely as the temperature change, there was no definite ratio. This is accounted for by variable winds as well as bright or cloudy days, snow, etc. Following is the result: February, 1917, average outside temperature, 25.2 deg.; pounds condensate for the month, 58,270; per day, 2081; cost per month at 20c. per thousand pounds, $11.65; day, $0.416. The cost of steam, 20c. per thousand pounds, was figured from the cost of evaporation at the power plant.

The convenience and flexibility of such a system are at once apparent.



TALLY COUNTER ATTACHED TO STEAM TRAP

Burning Slack Containing Excessive Moisture

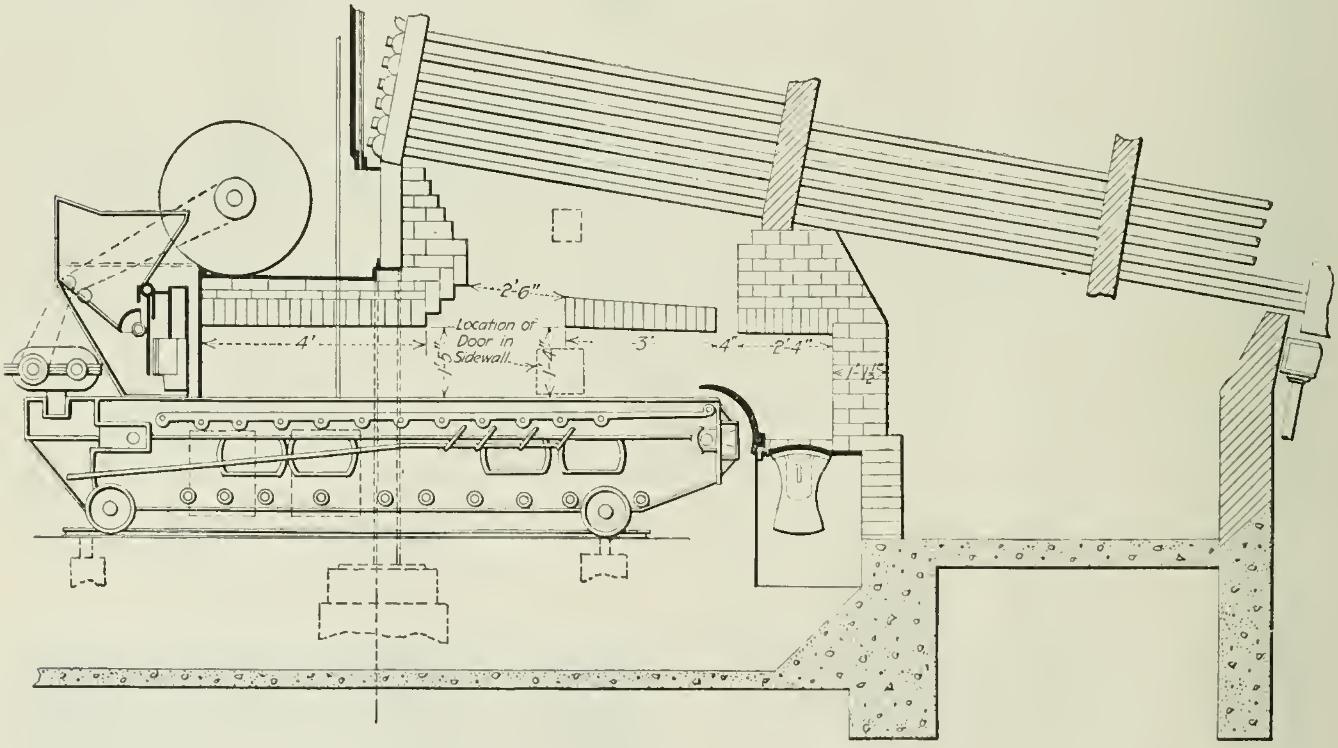
By J. F. McCALL

Superintendent and Chief Engineer, Municipal Power Plant, Calgary, Alberta, Canada

The author burns Drumheller (Alberta, Can.) slack coal, averaging 15 per cent. moisture and 12 per cent. ash on a chain-grate stoker with an arch over the entire grate except for a space 2 ft. 6 in. deep, and the width of the grate long. The long deflection arch extending forward 3 ft. from the brige-wall rolls the flame of the 30 per cent. volatile coal forward far enough to evaporate the moisture as the coal comes on the grate from the feed hopper, avoiding caking of the coal at the rear of the grate.

THERE is sufficient coal in the province of Alberta to supply the whole of the North American Continent for several centuries. The quality varies considerably from surface lignite to the excellent coking coal at Fernie and the valuable semi-anthracite in the Banff district. The known deposits extend over an enormous area, from the Peace River district in the north to the international boundary, and from Medicine Hat to the Rockies. Supplies are sent as far east as Regina, Saskatoon and Winnipeg; the hard coal at Banff finds its way to the coast, and the coke product of the south is extensively used in the smelters across the border. Freight rates, however, govern the extent of the market, the local requirements do not begin to absorb the possible output, and the greater part of the field lies undeveloped. A few years ago a new district, known as the Drumheller field, was opened, and immediately became a factor in the market. This coal was found to average around 11,500 B.t.u. on analysis, but contains excessive moisture, frequently over 15 per cent. I tried the Drumheller slack coal several times on our 335-hp. water-tube boilers with chain-grate stokers, invariably with very unsatisfactory results. It was impossible, owing to the excessive moisture, to ignite the coal sufficiently until it had passed about three feet into the furnace. This was the more disappointing as the freight rate from the Drumheller district was from 20 to 40c. per ton cheaper than the rate on the supply we were using, and in the class of coal we burn the freight is usually the larger item. This, however, did not affect us as much as it did the power plants at Saskatoon and some other towns and cities north of Calgary, all of which have the Drumheller field between them and the field south of Calgary, their freight rates in that case being more than double ours and their cost of production correspondingly higher. Their difficulty in burning the Drumheller coal was the same as we experienced.

Early in 1917 I learned that experiments were being made in Edmonton and Saskatoon with a view to burning the Drumheller coal, the idea being to dissolve the moisture immediately the coal reached the furnace grate. To find out what they were doing and to get some ideas for myself, I went to both places, and found that taking into consideration their higher costs for fuel as compared with ours, the Saskatoon and Edmonton plants had been fairly successful in burning the Drumheller coal. I was satisfied, however, that the arrangement made there of the furnace grate could be improved upon, and we made alterations to eight of our 335-hp. boilers, and eventually evolved the idea represented in the drawing. The chief feature is the center deflecting



SETTING FOR BURNING SLACK HIGH IN MOISTURE AND ASH arch, which deflects the flame from the burning coal to the front of the furnace and thereby ignites the fresh coal as it enters the grate. This flame evaporates all moisture, and the result is an intense heat evenly distributed. We have no trouble in getting 110 per cent. overload out of these boilers, and can burn anything which has anything in it to burn. We have been successfully burning coal with 22½ per cent. of moisture, so that we are able to use freely the slack from the Drumheller field.

We found it necessary to remove an 18-in. sector of the stoker (Babcock & Wilcox chain-grate) casing, to move the bridge-wall back to correspond, so that we could put the stoker back. We considered that it would be desirable to allow an ignition space of 18 in. below the hopper. Ignition takes place at from 8 to 12 in. The reason for the opening at the rear arch is that we found that the fuel on the grate showed a tendency to bank at the end of the grate and that this bank was rich in combustibles. By arranging the opening, a strong draft was created at this point and we were able to burn the carbon out of this bank. In our earlier alterations we allowed only a 4-in. space, but later we found a 6-in. space gave better results. A trial of an 8-in. space proved unsatisfactory. Much depends on the available draft. We used a 0.3-in. draft.

It will be understood that these boilers are equipped with chain-grate stokers of the close-link type. To find out how the arrangement of arches would work with other kinds of stokers or in hand-fired boilers must be a matter of experiment.

In September last we made several tests on the Drumheller coal. In each case the boiler was fired for 24 hours. The test lasted for 10 hours, the object being to test the coal and to obtain working results from the boilers under the new arch arrangement. The following is an average result:

Average pressure, gage, lb. per sq.in	149
Average draft (at furnace), water, in	0.31
Average temperature, steam (saturated), deg. F	364.6
Average temperature, steam (superheated), deg. F	512
Average temperature, flue gas, second pass, deg. F	690
Average temperature, flue gas at damper, deg. F	487
Average temperature water (at heater), deg. F	116
Average CO_2, per cent	11.33
Builder's rating, hp	335
Horsepower developed	458
Percentage of builder's rating	136.7
Water evaporated per pound of coal as fired, lb	6.65
Equivalent evaporation per pound of coal as fired, lb	8.02
Stoker speed, average, ft. per min	2
Thickness of fire, in	4

On analysis these coals from the Drumheller mines are quite uniform. The following is an analysis of an average sample:

Moisture, per cent	15.04
Ash, per cent	12.18
Volatile combustible, per cent	29.95
Fixed carbon, per cent	42.47
B.t.u	11,450

In view of the present shortage of coal these successful experiments will probably prove of interest. It is possible, under the conditions enumerated, to burn any fuel that has anything in it to burn, and it would be quite possible to utilize dumps of wet slack coal which lie at the mouth of coal mines all over the continent, rejected as being useless on account of the moisture content, the accumulation of long periods of exposure to the weather. It is quite reasonable to suppose that there are large quantities of fuels of this class which owners of boiler plants are at present unable to use, in some cases hauling their coal from a distance when they have a suitable fuel close at hand.

Sarco Metallic Gaskets

Lead would make a good gasket with high-pressure steam if it were not so liable to blow out. A lead gasket, being soft, fits into any depression in the flange and gives way for any protruding surface. A copper ring gasket makes a good joint, but being harder than lead, does not conform to the surface of the joint so readily.

A combination of a lead and a copper gasket has been devised by the Sarco Co., Woolworth Building, New York City. It is made for various purposes and in different forms. For flange work, Fig. 1, the lead ring *A* forms the inner member, and just fitting over the outer edge is a copper ring *B* of smaller cross-section. This is to permit the lead ring to come under considerable pressure in tightening up the joints before the flange begins to compress the outer copper ring.

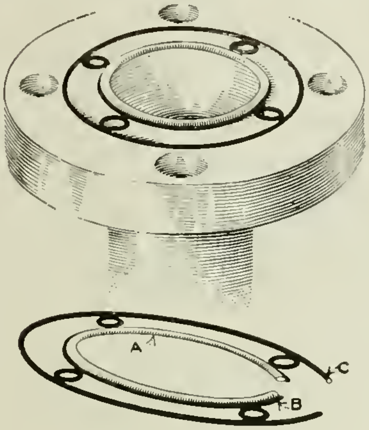


FIG. 1. GASKET FOR WIDE-FACED PIPE FLANGE

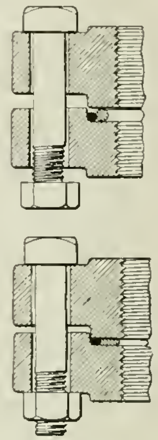


FIG. 2. BEFORE AND AFTER COMPRESSION

With this type of gasket the copper and lead elements, *A* and *B*, are surrounded by a centering ring *C*, the outer diameter of which is a trifle less than the diameter of the circle on which the inner edge of the bolt holes line; thus the bolts, when fitted into place, center the gasket. The centering ring *C* is held concentric with the gasket rings by small copper circles, all members of the gasket being lightly soldered to form a complete unit.

For union connections, where the coupling surfaces to be sealed are relatively narrow, the gasket is composed of a lead and a copper ring lightly soldered together at intervals. The application of the gasket is shown in Fig. 2, which also shows the gasket before and after the joint is tightened. The inner lead ring is of greater cross-section than the copper one and squeezes out into a ribbon form under pressure. The slightly compressed copper ring backs it solidly and prevents the lead ring from blowing out when it is under pressure.

A gasket for superheated steam above the safe working point for lead is made of a number of soft concentric copper rings. For joints the gaskets of which are subject to corrosive fluids from the outside the copper ring is surrounded by a lead one, which, as the gasket is compressed, forms an effective shield against the access of foreign matter. These gaskets are made in various sizes.

The Central-Station and Isolated-Plant Controversy

THE continuation of the hearing before the Public Service Commission for the First District of New York on Mar. 11 was taken up principally with an investigation of the relations between the New York Service Co. and the New York Edison Co. According to the testimony of several witnesses, the New York Service Co. is a company that undertakes the management and operation of isolated plants. In a number of instances the salesmen of the Edison company had suggested to prospective customers the advisability of discontinuing the private-plant generation of electricity and the purchase of current from the Edison company, at the same time allowing the New York Service Co. to operate the steam plant. The case of the Hotel Majestic, mentioned at the hearing of Mar. 4, was an instance of this sort of arrangement.

The purpose of the hearing at the outset was to investigate the service, facilities and rates of electrical corporations with regard to furnishing current for breakdown or auxiliary use, and for buildings having private electric plants. The interest of the Fuel Administration and the controversy between the private plant and the central station are matters that developed naturally from statements made at the first hearing in the case.

It had been suggested that if isolated plants could be supplied with current from the central station during those periods in which the isolated plants had no use for the exhaust steam from their engines, it would be possible to shut down those plants and save a considerable amount of fuel. It was pointed out that the additional burden thus thrown upon the central station would be in the nature of an off-peak load.

At the hearing on Mar. 11, John W. Lieb, of the New York Edison Co., made the emphatic statement that on Manhattan Island, and under Manhattan Island conditions, there was no such thing as off-peak service. To substantiate this assertion, he produced two load curves, one for Dec. 12, 1917, and the other for June 5, 1917. The former represented the maximum load for the year 1917, which was 234,736 kw. The latter showed a maximum load of 200,000 kw., due to a very sudden thunderstorm. The point Mr. Lieb sought to bring out was that during the summer—when the isolated plants would wish to use the suggested off-peak service—the Edison company was likely to be subjected to a demand for current equal to the capacity of the plant, and that at very short notice. From this he argued that an off-peak condition did not exist.

At the same hearing, Charles E. Stuart, representing the Conservation Division of the Fuel Administration at Washington, asked permission to read into the record a statement defining the position of the Fuel Administration in the matter of coal conservation by manufacturers of electric current. In part, his statement was as follows:

> The individualistic way in which fuel is now consumed in cities is not efficient. A ton of coal burned in a large central station will produce at least four times as much electric power as if burned in the average small plant, and if centralized burning could be introduced to a greater extent, the amount of fuel required could be largely reduced without reducing in any way the ultimate production of light and power.
>
> It may be generally stated that in buildings where electric plants are located and where exhaust steam from engines is utilized in the heating of the building, furnishing hot-water requirements, and possibly providing a very small amount of steam for industrial and other processes, such buildings can readily adopt central-station service without a loss of money and at a large percentage of saving in fuel.
>
> In many other cases it might be more economical from the viewpoint of fuel saving to utilize isolated electric plants in conjunction with central-station service. The ideal arrangement would then be to use the combination of services in such a way that no exhaust steam is sent to the atmosphere to be lost.
>
> It is the duty of the Fuel Administration to devise means for securing a curtailment in the use of fuel in ways which will impose a minimum of hardship. It is believed that there are many plants not only in New York, but throughout the entire country, which could, at least temporarily, shut down their own electrical machinery and purchase power from others at a financial advantage to both parties and with a considerable saving in fuel.
>
> The Fuel Administration believes that if even a comparatively small proportion of the plants throughout the country which could save fuel in this way at a profit to themselves would do so, it would prove a tremendous help in meeting the fuel situation with which the country is confronted, and in winning the war.
>
> While it may appear that the interests of the central station are being benefited to a large degree, such is not of necessity the case. In some cases, central stations may be shut down. In any event any connection between a central station and a building or a manufacturing plant that is affected, will, of necessity, be for the period of the war only or through the period where the coal situation is critical. The machinery of the isolated plant can be readily preserved through this period of necessity. Under these circumstances the heavy expense attendant upon the making of the connection by the central station may completely or even more than offset any profit which could be expected of such a load through a short period.
>
> At this point another very important question, that of the release of the operatives of the plants, presents itself. In those cases where small electric plants are closed down entirely, there will be a larger number of men available than in cases where a partial closing down is brought about. In any event these skilled men are vitally needed in many of the war industries of this country, and provision is now being made whereby men of such training will be assisted in obtaining profitable work suitable to their ability.
>
> Again, the conservation efforts of the Fuel Administration are being directed in order to conserve the interests of all with the least inconvenience and cost and with the object of making the coal supply that is available go just as far as possible and to prevent the necessity of further drastic measures such as were necessary in January. In this spirit the Fuel Administration invites the coöperation of the isolated plant owner, whether the question be of connecting in on the lines of a central station or whether it be that of operating his plant to maximum efficiency. The alternative will be at least the one if not the other.
>
> The administration at this time has no idea of attempting to bring about any such result by means of orders, or of even suggestions that fuel be saved by the closing of isolated plants where this would cause hardship to the owners, not commensurate with the benefit derived by the public. It is interested in the present hearings, however, in the hope that they will set forth the facts and also the savings which are possible in certain cases in so convincing a way that each plant owner will consider himself a volunteer member of the administration, charged with the duty of investigating his own condition in a nonpartisan way and, where circumstances warrant it, of taking the necessary steps to secure the saving.

The second paragraph of the foregoing statement is of especial interest to the owners of isolated plants in which a small part of the steam generated is used in producing electric current while the greater part is used for heating, drying, cooking, etc. Its conclusions are diametrically opposed to the results of experience in many instances in which isolated plants discontinued the generation of electric power and adopted central-station service, at the same time continuing to produce steam for heating and other purposes. The testimony of Copeland Townsend, of the Hotel Majestic, at the hearing of Mar. 4, showed that the adoption of such a plan not only failed to save coal, but placed the plant under additional heavy expense.

Mr. Stuart, who issued this statement on behalf of the Fuel Administration, is an electrical engineer and a member of the firm of Stuart, James & Cooke, whose business it was, previous to the war, to investigate power plants with a view to determining whether they could not be supplanted economically by electric power from large central stations. In an interview with the editor of *Power* Mr. Stuart said that his firm had investigated perhaps 800 plants, most of which were connected with mining operations, and that the majority of these eventually changed from individual service to central-station service.

When he was asked whether the statement he had read into the record was an expression of his own individual views, he replied that it represented the consensus of opinion of a number of the Fuel Administration's engineers, himself included; however, he finally admitted that there were numerous small plants, such as those carrying combined heating, power and lighting loads, in which the substitution of central-station service would undoubtedly fail to show a saving of coal.

This is the opinion held by many engineers who have carefully considered the problem. At the January meeting of the American Institute of Electrical Engineers, a paper was presented by Lynn S. Goodman and William B. Jackson on "The Effects of War Conditions on Cost and Quality of Electric Service," in which the authors made the following assertions: "When viewed from every standpoint, it will be seen that the economical central power generating station is the proper medium for the supply of the large power requirements arising on account of the war"; and "these advantages of the central-station power are so large that it is advisable for the Government to use every reasonable means to encourage the central-station companies and discourage individual power plants during the war period."

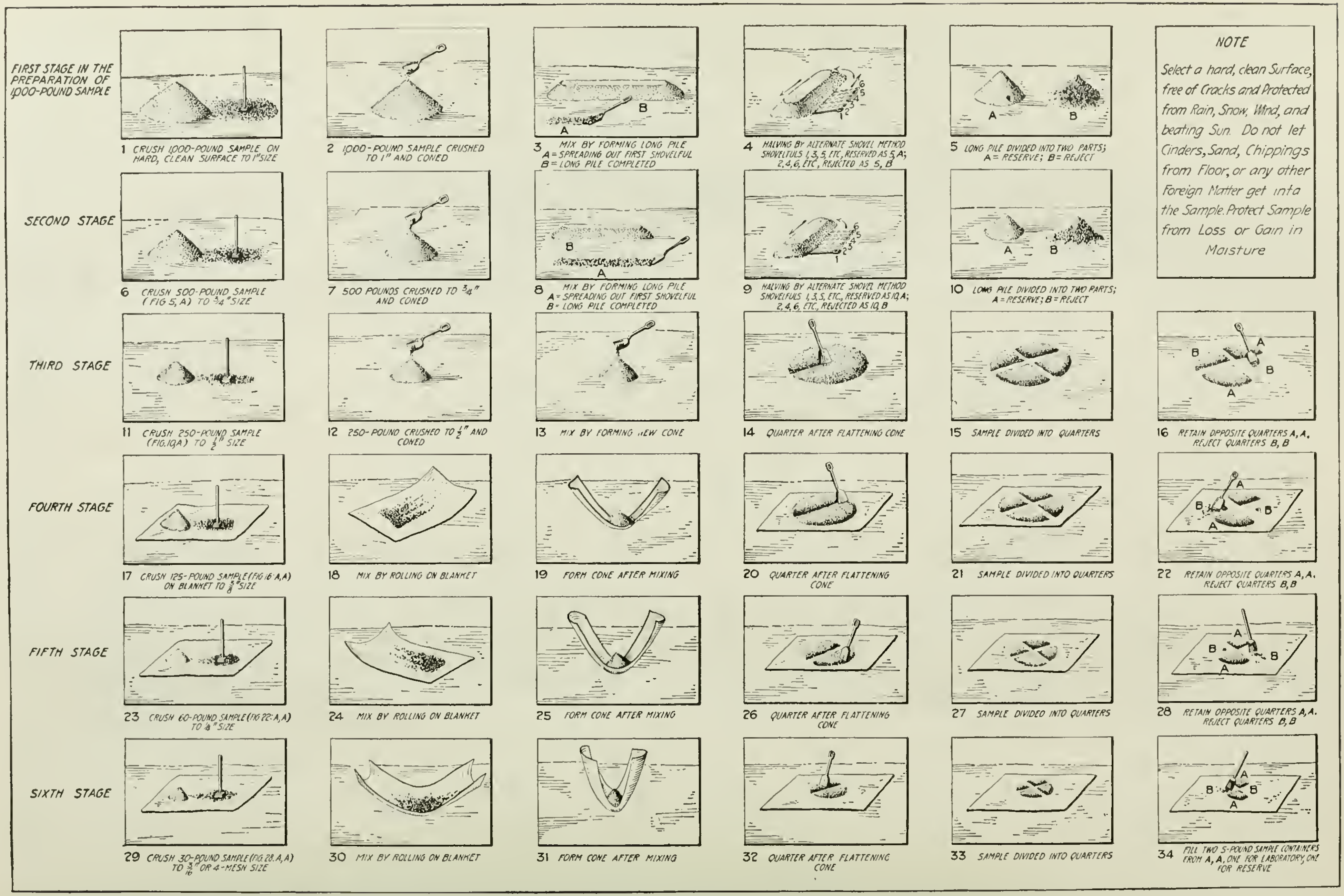
As might have been expected, such sweeping claims as these were not allowed to stand unchallenged. Bion J. Arnold, in discussing the paper, said:

> There is no question in my mind that where you can utilize steam for heating and have some use for that heat aside from merely heating in winter time, there is an advantage in having an isolated plant. For instance, in a hotel, where you need steam for cooking, under such conditions as that the isolated plant, in my judgment, will be superior to the central-station power; that is, it can produce its own heat and electrical energy cheaper than it can buy it from the central station. That is the only instance, in my experience, where I have found that it would work out in that way; otherwise, it is generally cheaper to buy energy from the central station.

The same topic was referred to in the discussion by Mortimer Freund, who said:

> I do not believe it proper to allow to pass unquestioned the authors' statement that "the economical central-power-generating station is the proper medium for the supply of large power requirements arising on account of the war," and further that "it is advisable for the Government to use every reasonable means to encourage the central-station companies and discourage individual power plants during the period of the war." Both of these statements are too sweeping in character and, as a matter of fact, only justifiable for such cases, where a careful and disinterested consideration of all the circumstances will warrant such a conclusion.
>
> It seems to me that the second statement might better be substituted by the following: It is advisable for the Government to encourage all consumers of fuel to use every effort to fulfill their heat, light and power requirements by such means as will utilize fuel most economically and do away with all existing wastes which are preventable.
>
> There are industrial plants, for example, where a great part, if not all, of the electricity used is virtually a by-product due to the utilization of exhaust steam from the electrical generating unit. I have in mind a large industrial plant which up to 1915 operated two separate boiler plants, the output of one of which was utilized almost exclusively for drying. The exhaust steam from the electric generating plant was wasted in the nonheating season and only partly used during the heating season. Substitution of purchased electricity had been suggested. Since 1915 the exhaust steam has been utilized in place of live steam, the use of one of the boiler plants has been discontinued and the actual cost of electricity, in view of the use of the exhaust steam, is far less than the best price which outside service can offer. The action on the part of the management of this mill in undertaking the change necessary to permit of this has not only paid them well on the investments made, but has benefited the country to the extent of reducing their fuel consumption. Surely, the authors do not recommend that the Government discourage such an individual generating plant, although such a conclusion might be drawn from their statements.
>
> I hold no brief for the private power plant. There are unquestionably many private plants now in operation which should be supplanted by central-station service. It has been my own practice to recommend central-station service in all cases excepting those where the installation of a new private power plant or the continuance of an existing plant would show a substantial saving in the cost of operation or other advantages of substantial worth. The private power plant is not an obsolete idea, as some have been trying to tell us. There are cases where it results in the most highly efficient production of heat, light and power. Each case should be decided upon its own merits and not on the basis of sentiment. Sweeping generalities are, in my opinion, unwarranted and misleading.
>
> The central-station service and the private power plant should not be in conflict, especially at the present time. Each has its proper sphere, and conditions may have arisen or will arise in particular instances to cause one service to supplant the other. It has been and will be to the mutual advantage of many central stations and private plants to coöperate by exchanging of service at different times of the day or during different seasons of the year. Friendly consideration and coöperation should exist between central-station management and the management of private power plants, so that maximum efficiency in operation may be maintained and the greatest benefit assured to the general public. This is a policy in keeping with the spirit of the times and necessary for the conservation of our natural resources.

If we help Uncle Sam by buying Liberty Bonds, we help ourselves. The buying of Liberty Bonds resolves itself into an expression of the highest form of intelligent self-interest. A British sergeant told a cocky young American, just off a troopship, "You aren't fightin' to save France, an' you aren't fightin' to save Belgium; you're jolly well fightin' to save your children and your grandchildren." The same line of reasoning applies to the buying of Liberty Bonds, for in the last analysis you aren't buying them to help a mythical old gentleman in a bestarred swallow-tailed coat and striped trousers who is having a lot of trouble purchasing ships and shoes and sealing wax; you're jolly well buying them to help yourself.



1 CRUSH 1000-POUND SAMPLE ON HARD, CLEAN SURFACE TO 1" SIZE

2 1000-POUND SAMPLE CRUSHED TO 1" AND CONED

3 MIX BY FORMING LONG PILE
A = SPREADING OUT FIRST SHOVELFUL
B = LONG PILE COMPLETED

4 HALVING BY ALTERNATE SHOVEL METHOD SHOVELFULS 1, 3, 5, ETC., RESERVED AS 5, A; 2, 4, 6, ETC., REJECTED AS 5, B

5 LONG PILE DIVIDED INTO TWO PARTS; A = RESERVE; B = REJECT

6 CRUSH 500-POUND SAMPLE (FIG 5, A) TO 3/4" SIZE

7 500 POUNDS CRUSHED TO 3/4" AND CONED

8 MIX BY FORMING LONG PILE
A = SPREADING OUT FIRST SHOVELFUL
B = LONG PILE COMPLETED

9 HALVING BY ALTERNATE SHOVEL METHOD SHOVELFULS 1, 3, 5, ETC., RESERVED AS 10, A; 2, 4, 6, ETC., REJECTED AS 10, B

10 LONG PILE DIVIDED INTO TWO PARTS; A = RESERVE; B = REJECT

11 CRUSH 250-POUND SAMPLE (FIG. 10, A) TO 1/2" SIZE

12 250-POUND CRUSHED TO 1/2" AND CONED

13 MIX BY FORMING NEW CONE

14 QUARTER AFTER FLATTENING CONE

15 SAMPLE DIVIDED INTO QUARTERS

16 RETAIN OPPOSITE QUARTERS A, A, REJECT QUARTERS B, B

17 CRUSH 125-POUND SAMPLE (FIG 16: A, A) ON BLANKET TO 3/8" SIZE

18 MIX BY ROLLING ON BLANKET

19 FORM CONE AFTER MIXING

20 QUARTER AFTER FLATTENING CONE

21 SAMPLE DIVIDED INTO QUARTERS

22 RETAIN OPPOSITE QUARTERS A, A, REJECT QUARTERS B, B

23 CRUSH 60-POUND SAMPLE (FIG 22: A, A) TO 1/4" SIZE

24 MIX BY ROLLING ON BLANKET

25 FORM CONE AFTER MIXING

26 QUARTER AFTER FLATTENING CONE

27 SAMPLE DIVIDED INTO QUARTERS

28 RETAIN OPPOSITE QUARTERS A, A, REJECT QUARTERS B, B

29 CRUSH 30-POUND SAMPLE (FIG. 28, A, A) TO 3/16" OR 4-MESH SIZE

30 MIX BY ROLLING ON BLANKET

31 FORM CONE AFTER MIXING

32 QUARTER AFTER FLATTENING CONE

33 SAMPLE DIVIDED INTO QUARTERS

34 FILL TWO 5-POUND SAMPLE CONTAINERS FROM A, A, ONE FOR LABORATORY, ONE FOR RESERVE

NOTE

Select a hard, clean Surface, free of Cracks and Protected from Rain, Snow, Wind, and beating Sun. Do not let Cinders, Sand, Chippings from Floor, or any other Foreign Matter get into the Sample. Protect Sample from Loss or Gain in Moisture

How To Sample Coal With a Shovel, Tamper and Blanket. From Technical Paper 133, Bureau of Mines

Editorials

The Buying Line and the Firing Line

THE Buying Line Over Here and the Firing Line Over There, which our cartoonist has depicted in the foreword of this issue, makes us ask the question, Can there be any comparison? Although the buying of Government securities by those at home is absolutely necessary in order that supplies in a never-ending stream be kept flowing to the boys at the firing line, a comparison between the two is difficult of comprehension.

How many of us at home have made any real sacrifice? True, we have our wheatless days and our meatless days, but so far no eatless days, and whatever restrictions we have made, those of us who have made them, regarding our stomachs, have found it to have a beneficial effect. Therefore, in this respect our sacrifice has not been a hardship at all, but something that we should have done for our own physical well being, war or no war.

Most of us are employed in as congenial or even more congenial vocations than ever before, at better wages than received in pre-war periods and to a very large extent indulging in the same luxuries we always have.

As to buying Liberty Bonds, is this a sacrifice—to invest money in your Government's bonds, a security that is the safest investment in the world at a rate of interest that is as good and in some cases better than can be obtained in a savings bank? This act, even leaving all patriotic motives out of it, is nothing more nor less than a sound common-sense business transaction, in which you are absolutely sure of benefiting yourself financially.

How about the boys on the firing line over there—those who have given up their home and its comforts and all that most of us hold dear, for the life of the trench and the dugout? This is best expressed by the following letter received from Citizen Soldier No. 258, ——th District, National Draft Army. This letter should make every American do more than think. It should make him act.

> They say, who have come back from Over There, that at night the troubled earth between the lines is carpeted with pain. They say that Death rides whistling in every wind, and that the very mists are charged with awful torment. They say that of all things spent and squandered there young human life is held least dear. It is not the pleasantest prospect for those of us who yet can feel upon our lips the pressure of our mothers' good-bye kiss. . . . But, please God, our love of life is not so prized as love of right. In this renaissance of our country's valor, we who will edge the wedge of her assault make calm acceptance of its hazards. For us the steel-swept trench, the stiffening cold—weariness, hardship, worse. For you, for whom we go, you millions safe at home—what for you? . . . We shall need food. We shall need care. We shall need clothes for our bodies and weapons for our hands. We shall need terribly and without failure supplies and equipment in a stream that is constant and never-ending. From you, who are our resource and reliance, who are the heart and hope of that humanity for which we smite and strive, must come these things.

For us at home to do our bit isn't enough. Our utmost is mighty little compared to the supreme sacrifice our men are willingly making. We can't all fight, but we can all support the Government. We can all economize and we can invest our savings in Government securities. Remember this war won't be won if we depend on the other fellow to win it. It's up to you. Your bit isn't enough; we must see to it that the Buying Line Over Here is maintained in a way that will make it possible for the boys at the front to make the firing line Over There impregnable. One way of doing this is to buy all the bonds you can of the Third Liberty Loan, to be offered on Apr. 6.

Bandar-Log or Bee?

FROM the time a monkey opens his eyes in the morning until drowsiness overpowers him at night, he is pretty much a law unto himself. He does anything he wants to, when he wants to, and as long as he wants to. A whimsical individualism sums up his philosophy of life. The day's end finds him just where he was in the morning. The tribe—bandar-log, Kipling calls them—respond to any leader of the moment and as quickly quit him to follow another or to fetch up individually with a brand-new, suddenly caught and all-absorbing idea.

Like any other philosophy, it is a charming one if you like the net results of it. The monkey does. On the contrary, the bee doesn't. The bee insists on organization by functions. His philosophy is self-sacrificing, vigorous and stern—a Spartan philosophy applied to production. "Beeficiency" is the Taylor System raised to the nth power; and the bee doesn't get the honey.

If the bee had sense, he'd maintain his present organization a few hours a day—which would easily supply his wants—and be a bit bander-logish the balance of the time. But he cannot. The reason is because he doesn't think. He's a machine that is a part of a bigger machine. On the other hand, if he did think, he'd immediately tend to become individualistic, and the moment that happened the organization would begin to wabble. There would be argument about how the comb should be built, who should build it, who should boss it, how much honey should go to each; societies for the prevention of this and that would be formed. Social workers must eat; so must bosses; so must societies for the prevention of things.

Nature did not see fit to devise a species having the merits of both bandar-log and bee—a sort of bandar-bee.

A bandar-bee would help us a lot just now. It would be the real super-thing. It would be highly coöperative for a few working hours and highly individualistic the rest of the day. It would accept the notion that working together bee-fashion is the answer to the question of maximum production in minimum time; but being a super-thing, it would reject the notion that the honey gathered should all get into the hands of a few crafty speculators to be sold back at the speculators' price. It would control distribution with the same bee-like coöperative efficiency that it used in production.

It would accept the axiom that self-expression is necessary to a thinking super-thing—that monkey play in a monkey way is after all the best fun in life. It would approve the bandar-log system, in which the individual in his idle hours may sit on a limb and philosophize, or try a new way of weaving twigs, or join the bunch in a frolic, or play with the kids.

Obviously, the bandar-bee would be a clear and direct thinker. He would be an intense individualist—so intense an individualist that in order to have the maximum number of hours a day for individualism, he would sink his individualism when he came to his production and distribution hours, and be an intense coöperator. He would treat as wasters those superbees who would work themselves and others without any thought of the monkey play, merely to amass a personal pile of honey. There would be piles of honey, adequate personal piles, but not huge ones.

Individualism and self-interest are about the same thing. The date when the bandar-bee will appear on the earth depends upon the amount of hammering which mankind must undergo, to pound into it a realization of the fact that in the long run self-interest can be most permanently promoted by intense and unselfish coöperation in production and distribution.

The Water-Power Bill

A SPECIAL committee of eighteen members of the House has devoted a week to hearings upon the Administration's Water Power Bill. This bill, which is a proposed House substitute for the Shields Bill as passed by the Senate, creates a commission consisting of the Secretaries of War, Interior and Agriculture and having an executive officer to be appointed by the President. This commission may grant licenses for the development of power projects upon navigable streams or streams located upon public lands for terms not to exceed fifty years, at the end of which time the Government may renew the license, transfer it or take the project over itself.

The tentative draft of the bill, commented upon in *Power* of February 19, provided that the Government on recapture should pay for the project "the fair value not to exceed actual cost of the property taken." Inasmuch as a large proportion of the original investment might have been retired through depreciation and amortization during the fifty years' tenure, it would be possible, as was pointed out in the editorial referred to, for the promoter, in addition to a fair profit during that time, to receive back much more than he put into the project. This has been taken care of in the draft of the bill now before the committee by providing that the Government shall have the right, on the termination of the license, to take over the project upon the payment of the "net investment" of the licensee. This net investment is defined as the actual legitimate cost as defined and interpreted in the "Classification of Investment in Road and Equipment of Steam Roads, issue of 1914, of the Interstate Commerce Commission" plus similar costs of additions thereto and betterments thereof minus the sum of the following items properly allocated thereto, if and to the extent that such items have been accumulated during the period of the license from earnings in excess of a fair return on such investment: (a) Unappropriated surplus, (b) aggregate credit balances of current depreciation accounts, and (c) aggregate appropriations of surplus or income held in amortization sinking fund or similar reserves or expended for extensions or betterments.

Dependence for the regulation of rates, service, issue of securities, etc., is placed upon the public-service commissions or other authorities of states where such regulation is provided. Where no such local regulation exists, the Federal commission has authority. A rental, not less than ten cents per horsepower per annum, is to be charged, except to states and municipalities. Whether this is based upon the potential, installed or developed capacity, or the amount of power sold is not clear. This, if kept to the minimum, represents not much more than an administrative charge, but is applied in part to the improvement of the lands and rivers upon which the project is located. There was no objection to the rental, as the operator will simply pass it on to the consumer. One of those who took part in the discussion suggested making the maximum fifty cents per horsepower annually so that it would not become a burden in meeting competition.

The presentation was arranged to show the benefits that would accrue from the development of the powers; then that the privileges that the Government is offering are not so valuable as is popularly supposed because water powers can compete with steam power only under favorable conditions, and that projects must not be burdened with too many restrictions and handicaps; then to seek the modification of the bill in those respects in which these handicaps might be supposed to lie. These were chiefly in the tenure and recapture provisions.

Our preference has been for a license revocable at any time on repayment of the net investment. There is an argument for the term license, however—not that which is usually advanced, that the project cannot be financed without a franchise valid over the lifetime of a long-term bond, for the recapture provisions of an indeterminate license could protect the investment however soon it was taken over, but that the chance of making a profit is the incentive for the promoter. If the Government can take it by restoring what has been put into it as soon as it begins to pay a profit, his chance for remuneration is jeopardized.

The bill provides that the commission may in its discretion give preference to applications for licenses by states and municipalities for developing power for state and municipal purposes. Municipal purposes are defined as "all purposes within municipal powers as defined by the constitution or laws of the state or by the charter of the municipality where any such purpose is directly pursued by the municipality itself with the primary object of promoting the security, health, good government or general convenience of its inhabitants," and licenses may be issued without charge for the development, transmission or distribution of power solely for state or municipal purposes.

As the Federal Government would be unlikely to recapture a project and operate it by selling the power, the opinion seemed to be that unless it acquired it for a governmental purpose, as for making nitrate, ammunition, etc., or operating Government-owned railways, projects would, on the expiration of the licenses, pass into the possession of the municipalities that they served unless satisfactory terms could be made for renewal. Municipality, as used in the bill, means a city, county, irrigation district or other political division of a state competent under the laws thereof to carry on the business of developing, transmitting or distributing power.

At the present rate of development it is difficult to predict what social and industrial conditions may be fifty or more years from now, but the bill appears to safeguard as well as possible the interests of the public while offering security to capital and incentive to enterprise.

America Calls to Americans

ON APRIL 6, one year from the day the United States entered the war, the Third Liberty Loan will be offered for subscription. It is imperative that it should be oversubscribed. It is frequently asserted that the moral effect of a magnificent response will be felt among our Allies and by the enemy. While this is undoubtedly true, there is another reason why the money should pour in, which must not be overlooked—*It is needed!*

Each day sees some new demand for extraordinary expenditure. The shipbuilding program alone will entail an outlay that must be stupendous. The building of aircraft calls for immense appropriations. And these are only two items in the cost of the war. The maintenance of troops at home and abroad and a hundred other expenses are mounting every day.

There can be no question that this Third Loan will be made at a time when the war has reached a critical stage. Money and more money must be expended. The Allies can no longer contribute in amounts that are necessary at this crucial time. America must furnish the sinews of war. And America calls to Americans. That is all that need be said. To think that she should appeal in vain is impossible.

The school children of New York City alone are preparing to raise $50,000,000. Surely, American men and women would be ashamed to look these children in the face if they failed to grasp the privilege which is offered of aiding America at this critical time in the history of the nation.

Conservation of Natural-Power Resources in Australia

THE article on hydro-electric power development in Australia and New Zealand, published on page 465 of this issue touches a question which is just now of great interest to the American reader. It appears that the Australians have decided to make as wide a use as possible of their natural-power resources in the future, and also that they are not willing that these resources shall be exploited by private capital, but shall be developed by the nation in the interest of the nation.

The realization of the great importance which hydro-electric development will play in the economic life of Australia and New Zealand so far has found expression in the carrying out of vast schemes of hydro-electric power generation. Of these, the great development contemplated in the North Island of New Zealand deserves special attention. When completed, this enterprise will not only tap most of the best power sources known at present, but will also be interconnected in such a way as to make the resources of each development available for all the other developments.

The whole of the work is carried out by the government, and the government will be the owner of the generating stations and the means of distribution. The cities and large consumers of electrical power will buy from the government. By this scheme a guarantee is offered that the resources of the country will be developed so as to give the best results.

Australia and New Zealand have been very farsighted and fortunate in taking early steps to prevent the unhealthy exploitation of their natural-power resources. Laws passed years ago have made the undertaking of electrical enterprises dependent upon government license, and when the time came to tap the great dormant power resources of the country the government's position was strengthened by additional laws giving to the nation virtual control of all the existing resources.

Does Rhode Island Need a License Law?

DURING the last few weeks we have published accounts of an unusually large number of boiler explosions. On page 463 of this issue is a report of another one in which three persons were killed and four were seriously injured.

Nothing is definitely known as to the pressure carried at the time. One hour and forty minutes before the explosion the gage registered fifty-five pounds pressure and sufficient water was showing in the gage-glass. Two factors stand out prominently, one being that the safety valve was found frozen solid the day after the explosion, although the weather was not sufficiently cold to produce this result. The other is that the man who was operating the boiler was performing this duty without a license, and, furthermore, the State of Rhode Island does not make it necessary for a boiler attendant to have one.

Some good may result from this explosion in that it may lead to the adoption of a city, if not a state, law governing the supervision of steam plants and the licenses of those engaged in their operation.

Suggested Caution Warranted

In spite of the coal shortage this winter, the showing made in the annual statement of the Rhode Island Coal Co., just issued, is the worst on record, with a deficit of more than half a millions dollars. The December deficit alone was $102,347.76. And yet coal mining is generally a profitable business, and Rhode Island coal has lasting qualities.—*Boston Globe*, Feb. 27, 1918.

Before purchasing any of the 400,000 shares of stock offered in the pamphlet previously mentioned, investigators would do well to make a thorough investigation, visit the mine and form their own conclusions.—*Power, Oct. 5, 1909.*

Correspondence

Does a Bonus System for Firemen Pay?

Many articles have been written advocating bonus systems for firemen on a CO_2 or high-evaporation basis, but my experience is that competition among firemen has not always produced the desired results when the actual conditions are known, for, however dense and ignorant of the laws of combustion a fireman may be, it does not usually take long for him to learn how to beat a CO_2 recorder or to find means whereby he can juggle evaporation.

Almost every fireman, whether he is working under a bonus system or not, likes to receive credit for a good day's work, and there are always a few unscrupulous ones who will adopt underhand tricks in order to increase their own prestige. The percentage of these unscrupulous ones may be small, but they are usually present in sufficient number to defeat the object of any system or friendly competition ever devised or inaugurated.

In a small hand-fired installation where a CO_2 recorder is used, the fireman on each watch tries to make a good showing on the chart. One fireman in cleaning the fire under the boiler to which the recorder happens to be attached does a "half job"; merely pulling out the loose dirt and clinkers, leaving the heavy clinker formation on the bridge and side walls, cleaning the fire just sufficiently to enable him to "get by" for the remainder of his own watch. As a result of such a cleaning, the CO_2 on the chart is down for but a short time. When it is the next man's turn to clean that particular fire it is in an awful condition—the clinker formation on the walls is hard as cement and has covered a large part of the great area. This fireman is perhaps conscientious in the discharge of his duties, and by hard labor and loss of considerable time he manages to remove the clinker and regain the lost grate area. But the record he has made on the chart is anything but "pretty," the CO_2 has been down for a long interval.

The chances are that the unscrupulous fireman is credited with being a speedy and skillful man, while the conscientious fellow is criticized for his poor showing. The usual result is that the fireman so censured, rather than start a controversy, either seeks another position or else resorts to the other fireman's underhanded methods. The efficiency of the plant suffers in either case. When there is considerable difference in the results obtained by the different firemen, the engineer should ascertain the true reasons for such before bestowing praise or censure.

Some time ago I read an article about a certain plant where a competition was fostered between the boiler-room crews on the different shifts to see which crew could obtain the best evaporation. The results so obtained and published were misleading, the actual conditions were not made known—some of the tricks resorted to by the night crew to bolster up the evaporation on that shift. The coal passer who was responsible for the weighing of the coal, after having got well caught up on his work was in the habit of going to a quiet corner best known to himself, for a little nap. The fireman would seize this opportunity to sneak in an extra car or two of coal, which of course was never recorded. "Cracking" the blowoff and other means they had of getting rid of the water were resorted to. Whether any such methods were practiced by the crews on the other shifts or as to how long these practices went undetected, I do not know, but certainly the competition so fostered came far from attaining the desired results.

In my estimation intelligent and appreciative supervision, good working conditions, fair wages and reasonable hours will pay the plant owner greater dividends than all the bonus systems or competitions ever devised or inaugurated. By reasonable hours I do not mean seven days a week for, however interested an engineer or fireman may be in his work, he needs one day of rest and relaxation if he is to maintain his maximum efficiency. I am glad to note that there seems to be a growing tendency among the more reasonable employers to recognize this fact. L. L. SPRAGUE.

Andover, Mass.

There Should Be an Ash Inspector

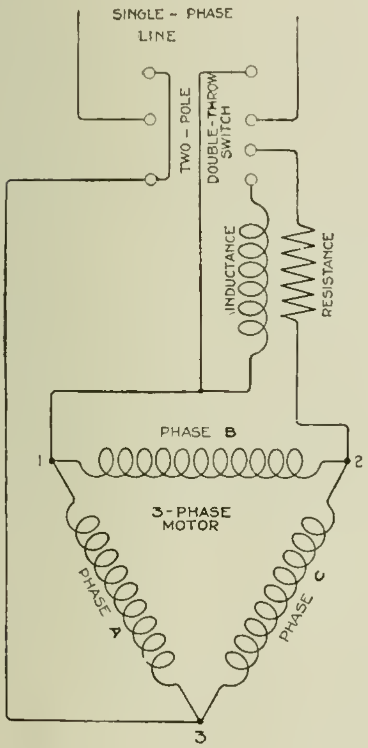
Reading the editorial, "Why Not Have an Ash Inspector?" in the issue of Feb. 19, page 267, reminds me of a suggestion that I made the local fuel administrator some time ago—to appoint a capable man clothed with authority to visit plants, commercial and domestic, and to say to the owners or operators: "Your fuel is not suited to the conditions," or "Your grates are not right," or "Your draft is not handled rightly," "Your settings are leaking," or any of the many things that go to prevent getting good results. He should show the operator how to handle the furnace, then see that instructions are followed or cut the fuel off, whether it be the fault of the installation or of the men handling it. In homes there are many heaters that are wasting a lot of fuel where an expert could help out, and the owners would be glad to save if they knew what steps to take to do so.

My suggestion to the fuel administrator was not acted on for the reason, as stated, that there was no provision for such a man nor funds with which to pay one. Why should a power plant, where the men and the company are trying in every way to save and run economically, be compelled to stop to save coal for those who are wantonly wasting it? It is not fair and is very discouraging to the ones that are trying and "working their heads" off to save. There certainly should be an ash inspector and one who knows something besides what he has learned from some textbook.

Binghamton, N. Y. ASA P. HYDE.

Operating Polyphase Motors Single-Phase

The letter in the issue of Jan. 29, by F. W. Plumb, on operating two-phase motors single-phase recalls two incidents in my experience along a similar line. A power company in a Southern city made it a practice to run long single-phase primary extensions out into the country in order to furnish lighting and single-phase power to the farmers. One such customer had ordered a corn shredder and a single-phase motor to drive it. The machine was delivered, but the motor was delayed in transit and it became necessary to get the machine running. No other single-phase motor of sufficient size was available, so it was decided to attempt the work with a large three-phase machine. The motor was installed and a phase-splitting device built, as shown in the figure, to assist in starting. After some adjustment of the phase-splitting coils and a little assistance on the belt, the motor came up to speed with the switch in the down position; then the switch was thrown up, which connected the motor directly to the single-phase current. The motor continued to operate in this manner until the single-phase machine was delivered and installed.



PHASE-SPLITTING CONNECTION

In another case a small central station had two generators, one single-phase and the other a three-phase. The single-phase machine was used only in emergencies and to furnish light when there was no power load on the plant. One of the manufacturing plants in the town used several small three-phase motors and one larger machine of the same type, which, however, was only partly loaded. The three-phase generator broke down and required several days for repairs to be made; in the meantime, the power consumers desired to continue operations.

A temporary single-phase connection was made to the large motor and a split-phase device constructed for the purpose of starting the large machine. After the large motor was started on the single-phase circuit, it was thrown over on the three-phase line, one phase of which was connected to the single-phase generator. In this way the three-phase motor was made to operate as a single-phase to three-phase converter in addition to pulling its own load on single-phase power, so that the small motors could be started and operated on three-phase power as formerly. The large motor now operated at nearly full load, but the small motors took about the same power from the circuit as when supplied from the three-phase generator.
D. R. SHEARER.

Johnson City, Tenn.

Single-Phase Operation Caused Low Power Factor

With frequency changers operating in parallel, both the motors and the generators must be in phase. With the motors locked in phase with the main generators and the motors having a different number of poles than the generators of the frequency changers, there is evidently only a certain relative position in which the generators of the sets will be in phase. If this position is not obtained when the motors are switched in, it becomes necessary to do what the operators term slipping poles on the motor. This is accomplished by opening the motor switch long enough for the synchronizing indicator on the motor to make a complete revolution, indicating that the rotor of the motor has dropped back one pair of poles, with regard to the main generator, and then closing the switch when the motor is again in synchronism.

This may have to be repeated a number of times on some occasions, to bring the generator of the frequency changer sets to be paralleled in phase with the one that is running. It is a job that requires careful handling even for an experienced operator, because the machine drops out of phase at an increasing speed when the switch is opened, and by the time it comes into phase again, the hand on the synchronoscope may be moving quite rapidly. If the change is not made properly, the whole starting operation must be done over again.

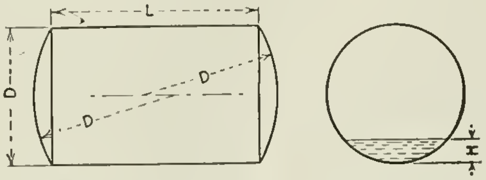
When two alternating-current generators are paralleled, the indicator of the synchronoscope always swings to the zero point and remains rigidly in this position. One morning, however, after cutting in the motor of a 2000-kw. frequency-changer set, the indicator made several swings back and forth across the zero point before it finally decided to stay there. Nothing else happened and the machine kept on running, so I went ahead and cut in the generator. As luck would have it, the generator happened to be in phase, and it was not necessary to slip poles on the motor to get the latter in phase. When the exciting current of the motor was adjusted so as to maintain unity power factors, it required something like twice normal value.

I had always made it a practice to go up on the switch gallery and examine the high-tension switches as soon as possible after each operation. This is what probably saved trouble this time, as there was only a small fraction of a load on the machine and no doubt, under the conditions afterward found, as soon as load came on the machine would have pulled out of step. When I came to examine the switch, the cause of the trouble was at once evident. One of the wooden rods which closed the switch, there being one on each phase, had been broken; consequently, the motor was operating single-phase. As a temporary measure I took a stick and pushed the broken section into place, thus closing the third phase of the circuit. This made it necessary to reduce the exciting current for the motor to its normal value, to maintain unity power factor.

Minneapolis, Minn. E. W. MILLER.

Calculating the Contents of Oil Tanks

There is a timely article in the Jan. 22 issue of *Power*, on the calculation of the contents of horizontal cylindrical tanks with dished heads, when the liquid is at different levels. The writer has no criticism whatever to offer concerning Mr. Strohm's method, which is the most logical way; but the time involved in getting up a table of capacities by that process is a nerve-trying ordeal—as the writer knows! It is evident that for the tank mentioned in Mr. Strohm's article it would be necessary to use the circular-segment formula forty-eight times, to obtain the volume at every inch of depth of the liquid for one-half of the tank.



DIMENSIONS USED IN FINDING CONTENTS OF TANK

The writer is employed by a large byproduct coke company, and the average plant of this nature has many storage tanks which must be calibrated and for which gages must be provided, so that the contents may be read at any time. He calibrated our tanks for a long time by the method given by Mr. Strohm, using a planimeter to obtain the areas of the segments, thus decreasing the labor somewhat. But our troubles came to an end when the writer discovered, in an old paper on chemistry, the formula,

$$V = 7.48D^2Lf_1 + 14.96D^3f_2$$

in which

V = Contents of tank in U. S. gallons at the depth considered;
D = Diameter of tank in feet;
L = Length of tank in feet;
H = Depth of liquid in tank;
f_1, f_2 = Factors whose values depend on the value of H, as shown in the table.

The meanings of the several letters may be more readily understood from the accompanying illustration.

VALUES OF f_1 AND f_2 FOR DIFFERENT DEPTHS

H	f_1	f_2	H	f_1	f_2
0.05	0.014681	0.00017	0.30	0.198168	0.01048
0.10	0.040875	0.00085	0.35	0.244980	0.01386
0.15	0.073875	0.00221	0.40	0.293370	0.01805
0.20	0.111824	0.00420	0.45	0.342783	0.02234
0.25	0.153546	0.00687	0.50	0.392699	0.02697

It should be noticed that the table gives the values of the factors only for every 0.05 of the diameter of the tank, whereas it is usual to calibrate tanks for each inch of depth. This difficulty can be overcome by calculating the capacities at all depths from 0.05D to 0.50 D, and then plotting the results in the form of a curve on cross-section paper, to a sufficiently large scale. The vertical scale can be used to represent depths and the horizontal scale to represent capacities in gallons. After the curve is carefully plotted, the capacity at any inch of depth may be read from the horizontal scale. By this means the formula need be used only ten times, instead of once for each inch of depth.

Pittsburgh, Penn. William C. Strott.

[From the sketch shown by Mr. Strott, it appears that his formula is strictly applicable only in case the radius of the dished head is equal to the diameter of the tank, although it will probably give results accurate enough for all practical purposes when applied to any horizontal cylindrical tank with dished heads.—Editor.]

Sucking from a Condenser

In the issue of Jan. 29, 1918, there is another letter [Others on pages 807, Dec. 11, and 740, Nov. 27—Editor.] on "Sucking from a Condenser," and I have read all the previous articles, but the matter was brought home by the same thing happening in the plant of which I have charge, breaking both steam valves of a Corliss engine. The circumstances as reported to me were as follows: The engineer had just shut off the steam to stop the engine, and was going around to the other side of the cylinder to shut the valve in the exhaust line between the engine and air pump or jet condenser, when there was a sound of water in the cylinder and a discharge of water from the relief valves. On examination I found both steam valves in eight or ten pieces each and the floor wet from the water, although it must have been twenty minutes after the accident before I got to the engine room.

The question is, Where did the water come from if not from the condenser? My conclusion, after studying the matter, is this: When this plant was built, the exhaust from the engine was dropped about 2 ft., then carried horizontally for about 15 ft.; there is a tee and two 45-deg. bends in this length; the condenser is connected to the tee, then it turns up with an elbow to the relief valve to the atmosphere. Now this pipe past the tee makes a dead end in which a certain amount of water is held by the exhaust from the engine; and when the steam was shut off, a few strokes of the pump cleared the engine of steam pressure, so that there was a partial vacuum as far back as the throttle valve, as the action of the piston would raise the exhaust valves off their seats and give the water in the dead end a surge or wave toward the engine—in fact, enough to carry it past the tee and into the engine so that the action of the piston would be as much of a vacuum pump as the pump itself.

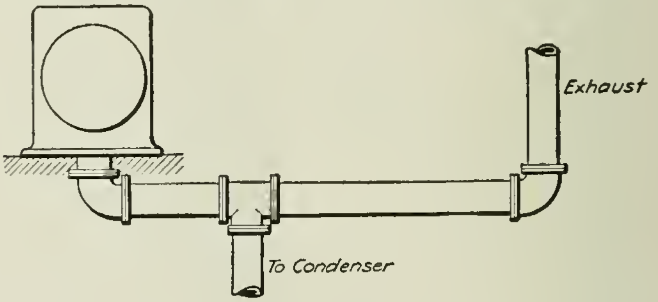


DIAGRAM OF EXHAUST PIPING

This is the second condenser that I have found connected in this way (off a tee). In the other case the condenser was condemned as "no good" until I changed it from the tee to the end of the pipe and put the relief valve on the tee; since then it has been working satisfactorily. The same change is required in this latter case, but the engine is used only in case of emergency and it is difficult to make the change, so it has not been done yet.

J. Drummond.

Granby, Que., Canada.

Telescopic-Oiler Discussion*

The discussion of telescopic oilers recently appearing in *Power* has brought out useful points. As H. Hamkens pointed out at the beginning of the discussion, the main disadvantages of most telescopics, especially the older ones, are too many parts, leakage of oil, tendency to irregular feeding and too rapid wear.

It is true that the older telescopics were somewhat complicated and that, with numerous springs, locknuts, washers, etc., they were hard to keep in repair and in good working order. But the design has gradually been simplified and improved until today oilers can be procured which are apparently as simple as it is possible to make them.

As Mr. Fenno pointed out in his article in the July 17, 1917, issue, the tendency to pumping and irregular feeding can be overcome simply by providing suitable clearance between the inner and outer telescopic tubes.

The rapid wear of the tubes noticed by Mr. Hamkens in some instances, is the result of their binding upon each other due to imperfect alignment either when installed or after reassembling. This can be avoided by due care when installing and, with some telescopics, extreme care when reassembling. It all depends upon the type of joint employed.

By employing the special design of true male and female joint shown in the illustration, all wear due to imperfect alignment, except that due to poor installation, is completely avoided, because no threading is even disturbed. Also, because this joint permits of gravity feed, the pumping tendency is practically, and leakage completely, eliminated.

With the arrangement shown by Mr. Fenno and illustrated in Fig. 1, the oil accumulated at the bottom of the outer element as at *A*. In other words, the flow of oil is against the direction of the joint instead of with it. Hence, the fiber packing *B* is always in contact with the oil and subject to deterioration and leakage.

In most of the older designs the joint could not be taken apart without first unscrewing the telescopic pipe. This meant that with any irregular alignment whatsoever in the initial assembling, the pipe would have to be screwed up to exactly its original position when reassembled, or extreme wear was sure to ensue.

With the type of joint shown in Fig. 2, both wear and leakage are practically overcome. The overhanging lip *D* drops the oil from the movable element *E* directly into the hollow of the fixed element *F*, and hence, unless the oil is fed in a flood greater than the latter can conduct it to the pin, the joint *G* remains leakless.

The joint is taken apart by sliding off the spring clip *H*, which is attached to the loose collar *I*. The movable element *E* then slides out of the fixed element *F*. As the construction at the top of the telescopic is similar, the telescoping pipes may both be removed without detaching them from their parts of the joints. Hence, they can always be replaced in alignment. As no nuts or screws are used in putting the joints together, they may be taken apart for cleaning or inspection while the engine is running unless the speed is uncomfortably high.

WILLIAM W. NUGENT.

Chicago, Ill.

Lime As a Protection for Steel

In the issue of Feb. 26, on page 301, there is an interesting letter by N. Bowland, on "Why Hot Water Pipes Pit," which gives as the reason for the rusting of steel and iron the unlike polarity of different parts of the material, setting up galvanic currents. To have a galvanic current requires, as is well known, an electrolyte, usually an acid, however weak, such as comes from vegetation sometimes and through the pollution of streams by sewage and the liquids from factories of different sorts.

In this connection I was led to the belief that if the solution was made alkaline there would be no electrolysis. To test this out, two pieces of commercial angle iron were cut from the same bar and placed in separate jars filled with river water, but to the water in one jar a handful of spent lime was added, while that in the other jar was left natural. Before immersing the two specimens in the water thus prepared, they were sandblasted to remove all mill scale and rust except one face that was left as it came from the mill and one face of each specimen, in addition to sandblasting, was polished to a fine surface. Both specimens were immersed in the jars on the same date, Oct. 2, 1915. The one in the natural river water began to rust immediately and is now covered with a thick coating, and much oxide has fallen off and covers the bottom of the jar. The other remains exactly as when put in. The polish on this specimen, immersed in lime water, is as perfect as on the day it went into the jar. The sandblasted side shows no rust whatever, but on the natural side there is one small speck about ⅛ in. in diameter which is brown in appearance, but there seems to be no appreciable increase in area or thickness of this brown spot from month to month.

This protective action of lime water is made use of by English hostlers, who are accustomed to take the highly polished steel bits from the horses' bridles when they come in from a trip and throw them into a bucket of lime water to prevent them rusting before they get time to give them their daily polishing. I find that lime water is effective in preventing rust in the bottoms of steel hulls, which nearly always have more or less bilge water in them, often from condensation of atmospheric moisture when there is no leakage. Whitewash is also an excellent preservative of steel in inclosed places like the air tanks in steel gates, where it effectually banishes rust and at a fraction of the cost of paint. It needs occasional touching up where condensation water drips from the top of the tank. It is a cheap remedy where applicable, but of course it will not stand abrasion or where the steel is under running water. It has been used for coating the tanks of the 50-ft. gates of the Mississippi River lock with the best of results. It seems to show that where the acid of the water is killed with lime, no electrolysis can take place.

The experiment is easy to make, but it seems not generally known what a good and cheap preventive of rust lime is when mixed with water. Readers of *Power* may find many uses for this simple protective and possibly someone may find a way to combine lime with a paint that will stick to the metal under water, making an ideal coating for steel.

Keokuk, Iowa. MONTGOMERY MEIGS.

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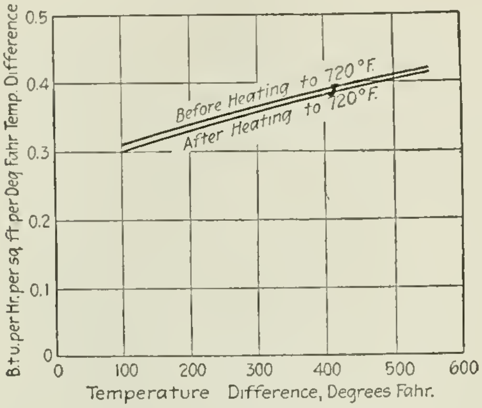
*See "Power" 1917, Jan. 30, p. 142; Mar. 6, p. 325; Apr. 3, p. 463; May 22, p. 707; May 29, p. 748; July 17, p. 96; Sept. 18, p. 399; Dec. 11, p. 806.

A Correction Regarding the Use of 85 Per Cent. Magnesia

In the May 1, 1917, issue of *Power* there appeared, on pages 593-6, a reprint of a report made by the Mellon Institute on heat-insulating materials. In both this report and in the editorial commenting thereon (page 604 of the same issue) statements regarding magnesia were made, which should be clarified and corrected, particularly as, in view of the present urgent necessity for conserving our coal supply, the true value of steam-pipe and boiler coverings for saving coal should be recognized and the proper use of such coverings encouraged. The editorial was partly rectified in the July 17, 1917, issue (page 90), but in view of the fact that reprints of the original article and editorial are being freely circulated, we desire to emphasize the true meaning of the original report.



CONDUCTIVITY OF MAGNESIA HEATED TO 720 DEG.

It was stated in the original that "even when subjected to low temperatures, it is only a matter of time before disintegration (of magnesia) takes place, as is well known from the behavior of magnesia coverings for steam pipes." And in the editorial this assertion was regarded as proved by the report, since the comment made was: "It is brought out that when subjected to low temperatures it is only a matter of time before disintegration of this material (magnesia) takes place."

The tests reported upon in the article cited were made for the purpose of determining the relative values of various refractory materials for furnace insulation, involving a set of conditions totally different from those for which magnesia is intended for use, conditions for which magnesia is admittedly unfitted. The high temperatures necessary in furnace practice are far in excess of those demanded by the highest steam pressures, even with a considerable degree of superheat in addition. It is well known that at a high temperature carbonate of magnesia loses combined-water and carbon dioxide, but this takes place at temperatures above 700 deg. F.

On page 594, in the article referred to, the statement was made: "It is well known that magnesia is equal in insulating value to many times its thickness in ordinary firebrick, so long as disintegration does not take place." We should like to restate this as follows: "It is well known that magnesia is equal in insulating value to many times its thickness in ordinary firebrick, when applied to temperatures suited to its use."

Magnesia is not a refractory; and the statement that disintegration of magnesia takes place at *low temperatures* refers to the temperatures of *furnace linings*, where 700 deg. F. might reasonably be called a low temperature. Such a temperature is much higher than magnesia, as a heat-insulating material, encounters in its regular day-in and day-out service. Even this temperature, however, can safely be used in steam pipes covered with 85 per cent. magnesia. In the accompanying diagram the upper curve shows the conductivity of a 2-in. thick magnesia covering before being subjected to a temperature of 720 deg. F. The lower curve was taken just after this test and shows that no damage was done to the covering but, on the contrary, that the thermal efficiency was slightly improved by the high temperature to which it had been subjected.

E. R. Weidlein,
Acting Director,
Mellon Institute of Industrial Research, University of Pittsburgh,
Pittsburgh, Penn.

Repairing Worn Valve Stems

I have had experience with worn valve stems on Corliss engines as referred to by Mr. Oakley in the issue of Feb. 12, page 230, and find that it is best to build them up by the oxyacetylene process and turn them to the original size in a lathe, making a mechanical job of it.

Sleeves may be all right when one knows just what the conditions are, but the next man that takes charge does not know what has been done. So, if the bracket is cut away, it means that if he orders new ones from the manufacturer they will not be of much use without a ring in the bottom of the stuffing-box to keep the packing in place; and it will also be necessary to have special packing for the stems with sleeves on, whereas one size should fit all four stems. J. B. Freeman.

La Grande, Ore.

Measuring High Pressures with Dead Weight

In my article, "Measuring High Pressures with Dead Weight," appearing in *Power*, Feb. 26 issue, at the bottom of Table II, on page 288, is a note which reads: "Fifteen pounds per sq. in. equals 30.35 in. of mercury; 1 in. of mercury equals 13.6 in. of water." This note should read: "Fifteen pounds per sq.in. equals 30.53 in. of mercury at 32 deg. F.; 1 in. of mercury equals 13.6 in. of water." Sanford A. Moss.

Lynn, Mass.

A Liberty Bond will soon become a badge of loyalty.

A Liberty Bond is a profit-sharing certificate on the prosperity of America.

A Liberty Bond is an old-age insurance policy, fully paid and nonassessable.

A Liberty Bond gives you a look into the future, but defeat in the war will tie you to an unfortunate past.

A Liberty Bond will pay you interest on the future of America. Defeat will make you pay compound interest on the future of Germany.

Inquiries of General Interest

Hotter Feed Water at Expense of Heating Capacity—We have use for all the exhaust steam from an engine that develops about 50 hp., but the exhaust-steam feed-water will not raise the temperature of the feed water higher than 200 deg. F. Would it pay to increase the size of the heater? K. R. R.

Where there is use for all the exhaust steam that is available, an increase of feed-water temperature would be of no benefit, for to accomplish the same heating by the exhaust as at present, the heat going to increase the feed-water temperature would need to be made up by live steam or some other source of heat.

Two Induction Motors on the Same Load—Is it practical to connect two induction motors on the same lineshaft where the load is varying? One motor is 300-hp. and the other 100-hp. capacity. G. C. T.

It would not be advisable to attempt to operate two motors of any type on the same load. If the machines are the same size and constructed to have the same characteristics, they probably would operate fairly satisfactorily. But when they are of different sizes or types, the probabilities are that one motor will take over more than its share of the load. This is readily understood when it is considered that one machine may take its full load at 5 per cent. and another at 10 per cent. decrease of speed.

Heating Surface and Grate Area for Steam-Heating Boiler—What number of square feet of heating surface and grate area should a boiler have for a low pressure steam heating apparatus to supply 1500 sq.ft. of direct radiating surface? W. B. C.

In estimating the required size of boiler, the number of square feet of direct radiating surface must be understood to include the surface of uncovered piping. Using good anthracite, or the better grades of bituminous coal, and with a good draft and usual frequency of firing, the boiler-heating surface should be equal to the total number of square feet of radiating surface divided by about 7.5 and the grate area should be equal to the total radiating surface divided by about 160. Hence for 1500 sq.ft. of radiation and pipe surface, the boiler should have about 200 sq.ft. of heating surface and 9⅓ sq.ft. of grate area.

Testing Out Correctness of Indicator Reducing Motion—How may it be determined whether an indicator-reducing motion is correct? E. T.

For determining the truthfulness of a reducing motion as used with a given indicator on a given engine, place the engine on a center, make a mark on the crosshead corresponding with one made on one of the guides and then turn the engine over to the other center and make another mark on the guide to correspond with the mark on the crosshead previously referred to. The distance between the marks made on the guide will be the length of stroke. Subdivide this distance corresponding to eighths of the stroke and, for greater accuracy, lay off sixteenths at the ends of the stroke, having all divisions so located that they may be matched with the mark on the crosshead for properly placing the crosshead and piston at the different positions they would occupy for the selected fractional parts of the stroke. With a spring in the indicator and a blank card on the paper drum, trace a long atmospheric line by drawing out the cord by hand. Then hitch the cord to the reducing motion and with the engine placed so the crosshead mark registers with one mark after another on the guide, raise the pencil arm of the indicator a short distance above the atmospheric line and obtain a trace for each position of the crosshead. If the reducing motion is correct, the distances between the tracings of the pencil will be in proportion to the corresponding fractions of stroke laid off on the guide.

Allowable Boiler Pressure for Stay-Bolted Water Leg—What would be the safe working pressure for the water legs of a locomotive type of boiler having plates ⅜ in. thick, with screwed and riveted stay-bolts ⅞ in. outside diameter, pitched 6 in. centers? F. R. B.

According to the A.S.M.E. Boiler Code, the maximum allowable working pressure for stayed flat plates should be calculated by the formula

$$P = C \times \frac{t^2}{p^2}$$

in which

P = Maximum allowable working pressure, pounds per square inch;
t = Thickness of plate in sixteenths of an inch;
p = Maximum pitch of stay-bolts;
C = 112, for stays screwed through plates not over $\frac{7}{16}$ in. thick.

By substituting,

$$P = 112 \times \frac{6 \times 6}{6 \times 6} = 112 \textit{ lb. per sq.in.}$$

Screwed stay-bolts ⅞ in. diameter, 12 threads per inch, would be 0.7307 sq.in. diameter at the bottom of the screw thread and have a net cross-sectional area of 0.419 sq.in. With an allowable load of 7500 lb. per sq.in., each stay-bolt would be capable of sustaining a load of 0.419 × 7500 = 3142.5 lb. The plate area occupied by each stay would be $(7/8)^2 \times 0.7854 = 0.6013$ sq.in. and the net plate area supported per stay would be $(6 \times 6) - 0.6013 = 35.3987$ sq.in. Hence the safe working pressure would be limited to the allowable working pressure for the stay-bolts, namely, $3142.5 \div 35.3987 = 88.7$ lb. per square inch.

Temperature of Steam After Passing Through Reducing Valve—If steam at 90 lb. gage pressure and 97 per cent. dry is passed through a reducing valve and the pressure is reduced to 5 lb. gage, what will be the temperature and quality? C. A. C.

According to the steam tables, the heat of a pound of dry saturated steam at a pressure of 90 lb. gage, or 105 absolute, consists of 302 B.t.u. in the water and 885.2 B.t.u. latent heat, so that if 97 per cent. dry, each pound of the initial steam contained $302 + (885.2 \times 0.97) = 1160.6$ B.t.u. In passing through the reducing valve, some heat is lost by radiation from the surface of the valve to the surrounding medium, depending on the character of insulation, but as loss of heat from friction is small, as the temperature within the valve is rather less than the temperature of the initial steam, loss of heat from radiation may be neglected; and as any work done on the steam in moving itself through the valve is restored when the steam is brought to rest, it may be considered that each pound of the steam after passing through the reducing valve, although reduced to the pressure of 5 lb. gage, contains as much heat as it contained in the initial condition, namely, 1160.6 B.t.u. Reference to the steam tables shows that a pound of dry saturated steam at 5 lb. gage, or 20 lb. absolute, contains 1156.2 B.t.u., hence each pound would contain $1160.6 - 1156.2 = 4.4$ B.t.u. in excess of the heat required for a dry saturated condition. Allowing the specific heat of superheated steam at the reduced pressure to be 0.48, the steam would be superheated $4.4 \div 0.48 = 9$ deg. F. As the temperature of dry saturated steam at 5 lb. gage is 228 deg. F., the actual temperature would be $228 + 9 = 237$ deg. Fahrenheit.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

The Water-Power Bill

THE Administration's bill for the development and control of the water powers was referred to a special committee of 18, consisting of Titus W. Sims, Tennessee, chairman; Scott Ferris, Oklahoma; Asbury F. Lever, South Carolina; Frank E. Doremus, Michigan; Edward T. Taylor, Colorado; Gordon Lee, Georgia; Dan V. Stephens, Nebraska; John E. Raker, California; Ezekiel S. Candler, Mississippi; Carl Hayden, Arizona; John J. Esch, Wisconsin; Irvine L. Lenroot, Wisconsin; Gilbert N. Haugen, Iowa; Edward L. Hamilton, Michigan; William L. LaFollette, Washington; James C. McLaughlin, Michigan; Richard Wayne Parker, New Jersey; Sydney Anderson, Minnesota.

The week commencing Mar. 17 was set apart for hearings upon the measure. The bill, which has been considered in recent issues of *Power*, creates a commission consisting of the Secretaries of War, Interior and Agriculture and provides for the issue of licenses to those who wish to undertake the development of water powers upon navigable rivers or public lands for terms not to exceed fifty years. Rates and service will be regulated by the commission where there is no state regulation. The provision that the Government could take the property at the expiration of the license upon the payment of a "fair value not to exceed the original investment," which *Power* criticized in the original draft of the bill, has been changed so that the Government shall pay the "net investment of the licensee" as defined and interpreted in the Classification of Investment in Road and Equipment of Steam Roads, issue of 1914 of the Interstate Commerce Commission, plus similar costs of additions thereto and betterments thereof, minus the unappropriated surplus aggregate credit balances of current depreciation accounts, aggregate appropriations of surplus or income held in amortization, sinking fund or similar reserves or expended for extensions or betterments.

MR. MERRILL'S STATEMENT

On Monday O. C. Merrill, of the Forestry Division, one of the authors of the bill, presented a statement on behalf of its projectors. He showed that although there was a very considerable drop in the prices of material after the fixing of prices by the Government in 1917, prices still remained at the close of the year far above the pre-war level. Hydraulic machinery has advanced from 100 to 150 per cent. over 1914 prices; electrical apparatus, from 125 to 150 per cent.; steam-turbine generators, 150 per cent., and water-tube boilers, 170 per cent., with uncertain deliveries. The union scale of wages in classes of work found in power-plant construction has advanced in many cases from 25 to 40 per cent. since 1913. Operating costs have increased, owing to the higher prices of labor, maintenance, materials and fuel. Increased fuel costs have made the development of power by water increasingly desirable.

The demand for power has increased at an accelerated rate, until during the last two years the annual increment in power generated by commercial central stations alone has been from three to four billion kilowatt-hours, requiring an annual increase in installation of from one and one-half to two million horsepower. In the United States the kilowatt-hour output by central electric stations was 61 per cent. greater in 1917 than in 1914. During the four years from 1913 to 1917 the ratio of the operating expenses to gross revenue had increased from 62 to more than 68 per cent. The greater costs of construction and operation in connection with other demands upon capital make financing difficult. These conditions make water-power legislation that will offer capital a fair return and a certainty of tenure desirable.

Although new developments and extensions will be necessary to meet the demands of the immediate future, a considerable increase in the output of electrical energy could be secured by the combination of existing isolated plants into a single system through the medium of high-tension transmission lines. In 1912 the capacity load factor averaged only 26 per cent. for the United States and probably is not above 30 per cent. today. Eighty per cent. of the electric power development of Montana is in one system, and it has a capacity load factor of 58 per cent. Studies made in 1912 for New York City and Chicago showed that the consolidation of the operating stations in the latter city would have saved from $10,000,000 to $12,000,000 in investment. In New York it would have saved from $18,000,000 to $20,000,000 and would have reduced operating expenses by $1,000,000 a year.

EXTENT OF WATER-POWER RESOURCES UNKNOWN

Nobody knows whether our water-power resources are 30 million or 300 million horsepower, or what is the relation of the powers to any particular market. An intensive study should be made of the conditions and possibilities. The bill coördinates the activities of the three departments that have to do with water power. Our industrial efficiency both during the war and thereafter will be increased or diminished according to whether we do or do not make adequate provision for the development of our water-power resources. Water-power legislation should be considered a war emergency measure and as such should be taken up by Congress and passed at an early date.

Following the presentation of his formal statement Mr. Merrill was questioned by members of the committee, remaining upon the stand all day Monday and Tuesday forenoon. He was interrogated principally on the following phases of the bill: Licenses, rentals, rates and rate regulation, and recapture of project. His replies brought out the following points:

The terms of the license should be absolutely definite and unchangeable for the entire period of issue. This is quite necessary in order to prevent any uncertainty in the mind of the licensee as to the conditions under which he can operate. It would be inadvisable to introduce any factor that would make the terms of the license subject to change. One member of the committee suggested that the term of the license should be for an original period of 50 years "unless the applicant should request and the commission agree upon a shorter term."

It was suggested that the application by the licensee for a new license should antedate the expiration of his original license by a definite stated period of time, which should be long enough to permit the delivery of a new license on the expiration of the old one. There was considerable discussion on the tenure of the license, but it was Mr. Merrill's opinion that the original term should be for 50 years and that any unusual conditions should be met by an adjustment in the rental charge.

RENTAL CHARGES NOT FOR REVENUE PURPOSES

Mr. Merrill felt that the rental charge should apply to the total capacity of the project and not to production only. While the rental would not have much to do with encouraging or discouraging the development of a project, yet any effect which it might have should be in the direction of securing maximum development. The idea of the rental charge is not to secure revenue for the Government, but it is made in return for the issuance of a license. The money thus received is to be used (1) to defray the cost of administration and (2) the possible necessity of recovering excess earnings which it is impossible to reach in any other way.

While the rentals should be nominal, they should be greater in those cases where the Government contributes land or some other tangible property to a project, and less where the Government has nothing to offer but the license. Whatever provision is made should be clearly stated in the license before it is accepted by the licensee. It was Mr. Merrill's opinion that it would be a better fiscal policy to charge a rental that would be nominal and that would not reduce earnings below a fair return or increase rates to the consumer. As between getting revenue for the Government and reducing rates to the consumer, rental charges should operate in favor of the latter.

Rate regulation on interstate business should be left to the several state authorities and handled locally as long as local authorities show the ability to act and as long as there is no disagreement between states. Federal jurisdiction should come in when other authority is insufficient.

The recapture clause is considered to be the most important in the bill, and it was Mr. Merrill's opinion that the basis for recapture should be an actual legitimate original cost of the property plus additions, less any funds accumulated in unappropriated surplus, depreciation and amortization. The price should allow nothing, however, for any unearned increment in value of the property, good will, going value or expected profit.

Judge Raker, of California, was solicitous regarding the effects of the measure upon the use of water for irrigation purposes.

Chairman Sims said that the Government was concerned with projects upon navigable rivers simply as means for improving navigation. A 10-ft. dam might effect this purpose, but a licensee might put up a 50-ft. dam in order to get the power byproduct. In case the Government recaptured such a project, could it operate it as a power plant and enjoy the returns from the greater investment? In other words, can the Government, under the Constitution, go into the power business? Mr. Merrill could not say. We do not know what the powers of the Federal Government may be fifty years from now.

Henry J. Pierce, of Seattle, told of a $25,000,000 project in which he was interested at the Priest Rapids on the Columbia River. It would make the river navigable from its mouth to 200 miles above the rapids, nearly to the Canadian border, develop 250,000 horsepower at the lowest flow of the river and as much again or more during the season of high water. This season of surplus power synchronized with the irrigation demand, and the extra power could be used to pump water to arid lands above the watered level. He thought that in the granting of licenses preference should be given to those who were already in the business and best qualified to carry out the development.

Calvert Townley, assistant to the president of the Westinghouse Electric and Manufacturing Co., although anxious in the interest of his company, which furnishes machinery for hydro-electric installations, to see the water powers developed, was a bear on the value of such projects, claiming that there were few water projects that offered much of an advantage over steam-operated plants. For this reason the Government should not encumber the privilege with onerous restrictions.

Public Interest Should Be Protected

E. K. Hall, vice president of the Electric Bond and Share Co., spoke for the investor. The interest of the public, he said, is to get the water powers into use. The first thing in any bill is to protect the public interest. Rates and service should be regulated through state or some Federal commission so that it will be certain that no unreasonable profit shall be made. But in order to interest capital the interest of the investor must also be protected. A hydro-electric development calls for a tremendous investment, with a very short tenure of the title and a very slow turnover. The money to build the public utilities of the country comes from small investors. From the point of view of the investor there are two fundamental defects in the bill. The contract has been made definite, and the investor knows what he is getting and what is expected of him. He is assured of the enjoyment of the privilege for fifty years and of the return of his capital at the end of that period if the Government at that time wishes to recapture the project. But if the Government does not want to take the property, he must continue to run it under an indeterminate and uncertain tenure. He cannot issue refunding bonds, because he does not know how long he may be allowed to hold the property. For this reason Mr. Hall urged that if the Government did not wish to take or transfer the property on the expiration of the license the license should be reissued to the holder for a term of thirty years.

The other defect was the provision that the Government could acquire the property at the expiration of the license on payment of the net investment. This assured the investor the return of what he had put into the project and had not already taken out besides his fair profit, but did not allow him to profit by the enhanced value of the property. In all other businesses the investor was allowed, besides what fair current profit he could make, to benefit by an increase in the value of the property while in his hands. In response to an inquiry by a member of the committee, he said that he considered this the best bill offered to date.

On Wednesday morning John A. Britton, vice president and general manager of the Pacific Gas and Electric Co., told of two projects in which his company is interested—one at Lake Spaulding and one on the Pitt River—which would be affected by the pending legislation. The company owned or controlled practically all the land, but in one case the pipe line would have to pass for a short distance through a portion of the forest reserve, and in the other case about 36 acres of Government land would be subjected to occasional flooding. It did not appear just, on account of these minor concessions, that the whole great project of which they were such an inconsiderable part should be brought under the provisions of the act, and he suggested amendments whereby such minor concessions might be granted upon a lease basis. He also suggested limiting the rental to not more than 50 cents per annum per horsepower generated. The bill provides that the president may take the plant for war purposes, and upon restoring it shall pay such just and fair compensation for its use as may be fixed by the commission upon the basis of a reasonable profit in time of peace. Mr. Britton pointed out that such a settlement would not recompense the company for the loss of customers driven over to competitors or for the investment in other plant necessary to hold them, and urged that this be made to read, "shall pay to the party or parties entitled thereto just and fair compensation for the use of the property."

Indeterminate Franchise with Investment Return

In response to an inquiry of a member of the committee as to how he would regard an indeterminate franchise with a guarantee of the return of the investment in case of recapture, he answered that that was just what they wanted. With these amendments the bill is the most workable bill that he has ever seen. Asked by Representative Taylor if he knew of any water-power trust interlocking directorates or combination of interests, Mr. Britton said that he could speak only for California, but there was nothing of the kind evident there. Even if there were, with the present method of rate control and regulation it could not be made onerous upon the consumer. Every public utility ought to be a regulated monopoly.

Chairman Sims asked what would happen if at the expiration of the license there were no other applicant, and the Government must either take the plant over, involving a large appropriation, or allow the licensee to continue, the licensee would not be in a position to dictate terms to the Government. Mr. Britton's reply was that with the present tendency of public thought, at the end of fifty years it would be no shock to the public if the Government took over and operated the plant itself. To Mr. Sims' urging that the money would have to be appropriated, Mr. Britton replied that it would be paid for a going concern and immediately begin to return a revenue under which conditions public and congressional approval of the appropriation would not be difficult to obtain.

The chairman thought that it would be impossible to obtain the appropriation of such large sums and that therefore the license would be in effect perpetual. Mr. Britton thought that the Government would be glad to recapture the project and turn it over to the municipality that would have grown up around it. The most that the original grantee can make is a reasonable return. If he makes a paying concern out of it, the Government can take it when the license expires. If he does not make good, the Government can leave him in his misery.

Asked whether this bill or the Shields bill, both unamended, was the better, Mr. Britton replied that in his opinion the bill under discussion by the committee would be the most attractive to capital.

H. T. Freeman, of Hartford, of the Connecticut River Co., said that his company in the first half of the last century had put a dam in the Connecticut River by the consent of the state legislature, before the Federal Government had begun to exercise control in such matters, and urged that the provision under which the commission might grant licenses to parties operating projects upon public lands or navigable rivers "under authority heretofore lawfully granted" might be so modified as to include such a case. He also argued for "just compensation" instead of return of net investment as the condition of recapture. .The bill excludes as an element in determining cost, expenditures from funds obtained through donations by state, municipalities, individuals or others. Mr. Freeman said that in some cases customers paid for extensions of lines necessary to furnish them power, and it was explained that if the company eventually reimbursed the customer and acquired the line it became a proper element of cost, but if it involved no expenditure by the company it could not be so included.

The first excess-profit act ever passed in New England gave his company the right to make 8½ per cent. on its investment, after which the Government took 8 per cent. and any excess was divided equally between the company and the Government.

To Mr. Taylor's inquiry as to whether there was any water-power trust in New England, Mr. Freeman replied that on the contrary there is the fiercest kind of competition.

John J. Harris, of Hardin, Mont., president of the Big Horn Canyon Irrigation and Power Co., described the project in which he was interested and claimed that the Government would receive a benefit from it in flood control equivalent to what it received in improved navigation on navigable rivers and that this benefit ought to be considered in fixing the rental charge. Three years is not enough time to do the preliminary work. He was still presenting his case when the committee took a recess until Thursday morning.

THURSDAY MORNING'S SESSION

On Thursday morning Charles N. Chadwick, chairman of the Committee on Conservation of State Waters, Lands and Forests of the Chamber of Commerce of the State of New York, appeared in behalf of House Bill No. 9681. This bill seeks to create a national board of water conservation consisting of seven members appointed by the President by and with the advice and consent of the Senate, not more than four to be members of the same political party, each to be a citizen of the United States, and none to hold any other Federal, state or municipal office. They are to be appointed for seven-year terms so that the term of one commissioner will expire each year, and are removable only for incompetency or misconduct.

This board would have the control and the jurisdiction of the interstate waters of the United States. It would ascertain what are the interstate streams of the United States most available, desirable and best for development, control and jurisdiction, and study the problems relating to the conservation of the rainfall, the control of freshets, recovering desert and waste lands by irrigation and swamp lands by draining, and the pollution of interstate rivers; the utilization of the rainfall for potable purposes and for navigation and water transportation aided by storage reservoirs, regulation of stream flow and waterways, and for the development of hydro-electric and other power, and the control thereof. It would study the climatic conditions of the state and compile information and make recommendations concerning the revision and codification of the water laws and the passage of new laws coördinating Federal and state jurisdiction. It would make surveys, maps, plans, specifications, estimates and investigations with regard to interstate streams, and report to Congress with recommendations as to what action should in its opinion be taken with reference thereto.

Mr. Chadwick explained that interest has been centered upon the one problem of hydro-electric development, while the bill in favor of which he appeared dealt with the conservation and utilization of the rainfall for all purposes. The broad policy of the nation with regard to the disposition and use of its rainfall for various and conflicting purposes could not be determined by busy and transient cabinet officers but required the concentrated and continuous attention of specialists. The single executive provided for by the Administration Bill could not, single-handed, deal with the determination of the national policy in all phases of the question, and cabinet officers would become but rubber stamps for his recommendations. He doubted the constitutionality of that provision of the Administration Bill which conferred the right of eminent domain upon the licensee. Under it a licensee might condemn even municipal or state property, and the taking of private property for private use cannot be justified by a declaration of beneficent purpose. Under the Administration Bill there is likely to be a conflict of authority between state and Federal Government. There is also the question of riparian rights vs. rights of appropriation for beneficial purposes. In the East, with its congested population, the large question is the use of the water for potable purposes; in the West, with its large arid sections, that for irrigation. The commission should be composed of big men who will put in all their time, and the bill should be so drawn that they can deal with the whole, broad, general question.

Mr. Anderson, of the committee, pointed out that under such a bill each project would require an act of Congress.

Judge Raker, of California, evinced a live interest in the irrigation phase of the question and asked if the witness considered hydro-electric power as secondary to the other uses. Mr. Chadwick replied that the use for potable purposes should come first; next commercial uses, then navigation, and then hydro-electric.

CHADWICK BILL SAME IN SUBSTANCE AS ADMINISTRATION BILL

Mr. Chadwick admitted that in substance his bill was the same as the Administration Bill, with the exception of the personnel of the commission. But, under his bill, the commission would not be subject to the will of one man who could reverse the policy of the country with regard to the administration and utilization of the rainfall.

C. F. Kelley, counsel for the Montana Power Co., said that the bill, though a compromise, appeared to afford a workable measure. He said that the bonds should be amortized within the duration of the original license, and stood out for "just compensation," instead of a return of the "net investment," as the condition of recapture. He agreed that unappropriated surplus accumulated from earnings in excess of a fair return on the investment should be deducted in computing the net investment, but claimed that such portion of such funds as had been reinvested in improvements and betterments should not be so excluded. He claimed that inasmuch as the prospective applicant would be at great expense in making surveys, maps, plans, etc., a preliminary permit should be exclusive to its holder. Section 8 provides that any successor or assign of the rights of a licensee shall be subject to all the conditions of the license under which such rights are held by the licensee. Mr. Kelley suggested that such conditions may have been so onerous as to have led to the failure and foreclosure of the operation under the original license, and that there should be some arrangement whereby they might be modified with the transfer of the license. He thought that the provision that the licensee shall convey to the United States free of cost its lands and rights-of-way, and right of passage through its dams or other structures, as might be necessary to complete navigation facilities, would be likely to be burdensome. The repealing clause stipulates that "no alterations, amendment or appeal shall affect any license heretofore issued under the provisions of this act, or the rights of any licensee thereunder," which language unwittingly shuts the license off from desired modification. Mr. Kelley therefore suggested the insertion of the word "adversely" before "any license."

Chairman Sims said that upon the expiration of the license the Government had three alternatives—to continue the license in the hands of the original licensee, to transfer it to another licensee, or to take the plant over. Unless the Government had some use for it for a strictly Governmental purpose, it would not take it over. And if nobody else wanted it, there would be no alternative but to leave it in the hands of the original licensee, and that upon his own terms, so that the grant was virtually one in perpetuity.

Mr. Kelley thought that renewals and replacements were not properly taken care of in the depreciation charge, and that there was likely to be a conflict between public officials that will be zealous in protecting the public interest and the building up of a surplus. The question of what is a fair return cannot be decided at the time of granting the license, and at the end of the term a manager who thought he had a comfortable surplus for distribution to his shareholders might find it wiped out entirely upon the ground that it had been earned by charging a rate which would yield more than a fair return. No other class of property is subjected to such "discrimination." There is no limit in the bill to the reserve fund that a promoter may be required to maintain. It is not quite clear in Section 5 just what rights are conferred upon the holder of a preliminary license.

Asked if he would give a municipality a better rate than another consumer, Mr. Kelley answered that in case there were a limited amount of power available he would give a municipality the preference as to service, but at the same rate.

Mr. Ferris, of the committee, pointed out that an amortized concern could keep going very cheaply. Mr. Kelley said that the tendency in all public utilities is to increase the amount of business done by decreasing the rate, and so to make more money. Further, he thought this bill more workable than any of the others which had been offered, and he would sooner see it adopted than none.

Miss Rankin, member of Congress from Montana, asked the witness about interlocking directorates, but obtained no admission that the Montana Power Co. was so interconnected with other interests. In reply to a question by Judge Raker as to price and service to small consumers, Mr. Kelley said that there was more power developed per capita in Montana than in any other part of the United States, and that the rates were the lowest. He said that he did not know of any water-power development in the United States that was paying more than 5 per cent. dividends. He justified the common stock, usually referred to as water, as a just return to the promoter for his enterprise.

Mr. Stuart's Paper

Charles E. Stuart, of the United States Fuel Administration, read a short paper dealing with the efforts of the Administration to conserve fuel, and suggested, as possible aid by the Government in this direction, assistance which may be rendered to the power system wherever interconnections may be deemed practicable and desirable, the rendering of financial aid for the enlargement of central-station systems to produce increased power, a radical fuel saving, or where there will be obviated what practically amounts to a duplication of investment, as in the case of the construction of isolated plants at this time; the necessary help to enable the complete systemization of the power situation of the entire country, the avoidance of duplication of investment, and the establishment at some centralized point, as at Washington, of a complete perspective of the entire power situation which would prevent any of the now recognized errors or abuses, such as exist in the duplication of investment.

John J. Harris, of Hardin, Mont., President of the Big Horn Canyon Irrigation and Power Co., resumed the stand to describe some of the preliminary operations which were necessary in working up a project of this kind.

A. P. Morrison, of the Electro-Metallurgical Co., Niagara Falls, spoke from the point of view of the user of power, to whom stability of service and of rates was of the first importance. While he is apparently taken care of by the public service commissions, the fact that his investment is entitled to protection against increase of rates or diminution of service has not been given the importance that it warrants. The investment of the user of power is greater than that of the furnisher of power. No power can be developed on a franchise revokable at will, and a revokable contract is of no use to the user of power. He suggested an amendment to the bill to prevent existing projects coming in under the law to get a chance to raise rates.

Commenting upon Mr. Kelley's testimony that a project should be amortized within the life of the license, Mr. Pierce said that the Priests Rapids development could not be developed under a law that required its amortization within 50 years, and in his opinion 95 per cent. of the available water powers could not.

S. P. Weston, representing the Water Power Legislation Committee of the American Newspaper Publishers Association, also questioned Mr. Kelley's position upon the question of amortization, and said that English companies always differentiated between stock and bond capital. He showed that the available paper-pulp material outside of private ownership in the United States was in the Western States contiguous to the undeveloped water power necessary for its manufacture. He was personally interested in a project which had obtained contract for $75,000,000 worth of print paper, but was unable to finance it on account of the Supreme Court decision in the Utah case.

A discussion ensued with regard to the provisions of recapture, and Mr. Ferris, of the committee, said it appeared that the Government would either have to take the projects over, or allow them to go on. It was practically a mandatory proposition. An inquiry by Representative Lever as to whether, in the opinion of the witness, the present tendency is not in the direction of Government ownership, was followed by a speedy adjournment.

Possible Conflict with State Laws

Augustus H. Houghton, representing the Conservation Committee of the State of New York, called attention to certain possibilities of conflict with the New York State laws, and suggested amendments which would avoid these. The term of five years provided for the executive was too short. It ought to be ten or fifteen years at least. Asked by Representative Taylor why the state had not gone about developing its water powers, the witness replied that the present commission does not believe in the state going into business and competing with existing companies.

William B. Matthews, of Los Angeles, which has its own municipal plant, believed that a license to a state or municipality should be perpetual, where the United States does not wish to take it back. The commission should not have jurisdiction or regulation over the rates and service of a municipal corporation, where the power is used for state or municipal purposes. He believed that the proposed law should not only give encouragement to private capital, but to states and municipalities. It is not likely that the National Government will be disposed to recapture and operate the project itself, and that a license once granted to a private corporation will be in effect perpetually. Under this condition, which would not be compatible with the public interest, the project should be recaptured and given to the municipality, or the municipality should have a prior right to it.

A few other witnesses remain to be heard, but the bill as a whole appears to meet with general commendation, and there is every evidence that it will be reported favorably without radical changes. How it will be received by the Senate, which has already passed the Shields Bill is not so evident.

The Netherlands Government has fixed maximum prices for coal and coke, says *Commerce Reports*, which are an advance on previous prices. They are stated in florins per hectoliter, but in American terms are equivalent to about $22 a ton for anthracite and $17 for bituminous coal; coke, about $10 a ton; coal briquets, about $25 a ton. The distribution is carefully regulated by cards in specified quantities, varying with the size and nature of the residence or the place of business. The quantity allowed, especially to residences, is much smaller than the amount they consumed in peace times.

John P. Sparrow, Dead

John Porterfield Sparrow, chief engineer, New York Edison Co., and for many years a member of the American Society of Mechanical Engineers, died at his home in Flatbush, Brooklyn, on Mar. 18, 1918. He was born in Portland, Me., Mar. 17, 1860; he died therefore at the age of fifty-eight.

Mr. Sparrow was an engineer by inheritance and education, his father, John Sparrow, being well known in the engineering field. His early education was obtained in the public schools of Portland, but this was largely supplemented by his father's teachings in physics, chemistry and engineering. In 1879, being interested in sugar manufacture, he was taken to Europe by his father to study the industry, and while there visited all the larger engineering works.

JOHN P. SPARROW, FOR MANY YEARS CHIEF ENGINEER, NEW YORK EDISON COMPANY, WHO DIED OF PNEUMONIA AT HIS HOME, BROOKLYN, N. Y., MONDAY, MARCH 18. MR. SPARROW HAD CHARGE OF THE DESIGNING AND BUILDING OF THE FAMOUS WATERSIDE POWER STATIONS. BESIDES HIS MANY CONTRIBUTIONS TO ENGINEERING, HE WAS A PHYSICIST OF NO MEAN ABILITY, MADE VALUABLE INVESTIGATIONS INTO THE MICROSTRUCTURE OF THE NONFERROUS ALLOYS AND DID MUCH PIONEER WORK IN COLOR PHOTOGRAPHY.

In 1880 he entered the Portland Co.'s locomotive and marine engine works as an apprentice. He served his apprenticeship and became a toolmaker and erector for that company, leaving it in 1888 to work for the Sprague Electric Co. During the next two years he acted as superintendent for the Sprague company in charge of construction of electric railways in the various parts of the country.

In 1890 he went to New Orleans for the New Orleans Electric Co. on construction work. In 1892 he joined the construction staff of the Edison General Electric Co. and was employed in building lighting and power plants for them and the Canadian General Electric Co. until 1895. He then joined the staff of the Construction Department of the Edison Electric Illuminating Co. of New York, and in 1898 became superintendent of construction, having charge of all the construction, which included the new Waterside Station, at that time the largest and most important construction of its kind which had been attempted. In 1906 he became chief engineer of The New York Edison Co. in charge of construction and operation, the position he held at the time of his death.

Mr. Sparrow became a member of the American Society of Mechanical Engineers in 1898, and has been an active member serving on various committees. At the time of his death he was chairman of the Committee on Standardization of Flanges and Pipe Fittings and had just finished the completed report on that subject. On Feb. 1, 1918, he was appointed chairman of the Advisory Board of the Power Test Committee. His work along these lines has been particularly valuable as his long experience, trained judgment and personal influence insured the reconciliation of conflicting interests.

In the Association of Edison Illuminating Cos. he was a member of the Committee on Steam Plants from 1906 up to the time of his death, and was chairman in 1910, 1912 and 1913. In this work his most valuable contributions were those in connection with coal testing and burning. Before the Edison Association he presented a number of papers on boiler-plant problems.

In the National Electric Light Association he was a member of the Committee on Prime Movers for a number of years.

Shortly after the United States entered the war, he made a number of tests for the Naval Consulting Board in connection with smoke abatement on ships as a protection against submarines.

Mr. Sparrow's hobbies were largely of an engineering character. In photography his work as an amateur rivaled that of many professionals, and he was one of the first to take up color photography. Microscopy, as a result of his early training, was always one of his chief aids, and his work on the photomicrography of lamp filaments is well known. In later years he turned to metallography in connection with the ever-present subject of the corrosion of condenser tubes, and assisted in the settling of important questions of heat treatment in the manufacture of this material. His knowledge of physical science was fundamental, and he was an adept in the mechanical handling and manipulation which is a necessity in research work of this kind.

Mr. Sparrow had a charming personality and his optimistic temperament, uniform courtesy and entire absence of contentiousness endeared him to a host of friends. He was held in affectionate regard by the officials of The New York Edison Co. to whom his passing away comes as a personal loss.

Struggling with Poor Coal*

By George E. Wood

Mechanical Engineer, Connecticut Company

The Connecticut Co. has six generating plants ranging in capacity from 16,500 kw. to 350 kw., which supply the entire system with energy, with the exception of the New Britain, Waterbury, Norwalk and Stamford divisions, the latter sections being supplied with purchased power. The total installed capacity is 40,000 kw., of which 12,000 kw. is held in reserve. The Bridgeport, Hartford and New Haven plants supply 85 per cent. of the total output.

Since the latter part of 1916 the quality of the coal has been gradually deteriorating and at present it is a continual struggle to keep the plants operating, to say nothing of trying to improve the efficiency. If good coal could have been obtained last year a 10 per cent. increase in efficiency over 1915 would have been attained in fuel consumption, due to new and reconstructed plants. However, as the fuel was below standard, the actual tonnage consumed increased 24 per cent. over that required in 1915 and 31 per cent. over what would have been required in 1917 with standard-quality coal. It appears that with good-quality coal 7 per cent. less cars would be required on the railroads compared with the rolling stock needed to handle what one of the company's engineers terms "black asbestos."

Soon after the first lot of poor coal was received the tonnage consumed began to rise. The company engaged the services of a competent combustion engineer, who instructed the various boiler-room engineers in the vagaries of combustion under the conditions attending the constantly changing grades of coal. Without his aid the tonnage consumed would have been considerably greater.

Plants Were Designed for High-Grade Fuel

It is possible economically to consume low-grade fuels of uniform quality and corresponding low price, where the furnaces are designed to suit the fuel, with ash-removal machinery capable of meeting the heavier demands and, of course, suitable unloading facilities. When, however, a plant is designed for a high-grade coal and the fuel actually used is worse than a uniform low-grade product, there is no doubt as to what the results will be. Thus, one consignment of fuel received would pack down on the tuyeres so solidly that the combined capacity of all the blowers in the plant could not force sufficient air through to allow it to burn. To attain any semblance of combustion, it was necessary to apply slice bars through the observation doors, and even then interruptions of varying duration could not be avoided.

About the time this coal had been "run through the furnaces" and the firemen were able to attain better results, the next shipment would be received. As this new coal followed the last of the previous shipment through the bunkers, the firemen would find that with the usual plenum in the wind boxes, the coal would be blown over onto the dump plates and pile up in a red-hot mass to a depth of three to four feet. Often the entire dump plate and shaft twisted out of shape so badly that they had to be entirely renewed. Within a few days some coal was received that would burn nicely for about an hour, after which it could be seen gradually to shut off the air supply. The shaking grates could not be moved more than one-half inch, and a slice bar thrust in along the grates would lift nearly half the fire up from the grate. Steam jets in the ashpits were of little assistance in preventing this "india rubber" like clinker, and after a short time the plant was shut down for two hours. Section breakers and feeder switches were relocated to relieve the load on the plant, and the arrival of more coal made it possible to resume operation under these conditions. It also gave the operators a chance to take the boiler out of service and clean the heating surfaces, which were covered with soot and slag.

This boiler had been in service continuously for three weeks and as a result of the cleaning five barrows of stalactites were taken out, in spite of the fact that the boiler was dusted daily. If the boiler had not been taken out of line at the time, a deposit would have formed which practically would have closed the gas passage.

An investigation of the records of fuel analysis shows samples containing 24 per cent. of volatile hydrocarbons, 45 per cent. fixed carbon, 29.8 per cent. ash and 3 per cent. sulphur, with a calorific value of 10,300 B.t.u. per lb. One particular cargo "passed through the furnace" with the ash running close to 37 per cent. by weight. The average for all coal received in 1917 was but little better than the case cited.

Poor Coal Increased Maintenance

In addition to serious interruptions, great trouble has been experienced from stoker failures. These occur at some plants at the rate of two a day, and on this account it is impossible to repair them in a first-class manner. This is not to be wondered at when one stops to think of the foreign substances found in the coal, such as traprock, short bolts, coupler pins, slate, slag, brickbats and even pig iron. The smaller pieces pass through the crushers and into the furnaces, in spite of the vigilant eye of the weigh-hopper man, and then there is a cracked bearing cap, broken bracket or sprung crankshaft. Stoker repairs are tripled, and the stock of repair parts seriously depleted.

The poor quality of coal has added to the difficulties of the labor situation. It has been particularly difficult to retain the ashmen and firemen. For every carload of ashes taken out of the ash hoppers during 1915 three carloads are taken out today.

An inspection of the operating records shows that the total unit cost of production for 1917 was 1.48c., or double the cost for 1915. Of this, 82.5 per cent. is due to fuel cost. Comparing the total amounts for the fiscal years 1915, 1916 and 1917, the total cost of production for 1915 was $630,000; for 1916, $745,000 (an increase of 18 per cent. for 8 per cent. increase in production), and in 1917, $1,187,500, an increase in production of 11 per cent. and a cost increase of 90 per cent. In 1915 the total amount paid for fuel for the six plants was $425,000, or 67 per cent. of the total production cost. In 1916 it was $520,000, or 70 per cent., and in 1917 it was $976,900, or 83 per cent., which is more than twice that paid under normal conditions. Labor shows an increase of $33,000 and maintenance an increase of $70,000. It is not unreasonable to state that fully 90 per cent. in the company's increased cost of power is due solely to the fact that the road is paying for, but not getting, coal.

Company Plans Additional Equipment

Several plans are afoot to relieve conditions in the near future. The most important is the installation of additional ash-handling facilities and coal-handling equipment and storage space. In the last case it is proposed to discharge sufficient coal at each plant between the dates of Apr. 1 and Nov. 1, 1918, to take care of the needs during this period and have stored at the latter date sufficient coal to carry the plants through until the spring of 1919. To do this it will be necessary to receive in 214 days 150,000 gross tons of coal, which is equivalent to unloading 692 tons per day. To attain this result the Connecticut Co. will have to expend between $200,000 and $300,000. For the New Haven power plant it will have to furnish additional storage space. In the Hartford plant the same thing pertains, and in the Bridgeport plant another dock will have to be built, with facilities for reclaiming the coal and getting it into the bunkers. To put in this coal and get it into storage about $500,000 will have to be expended. A quotation received in this connection for an eight-wheel locomotive crane with 50-ft. boom and a 1½-cu.yd. bucket was $18,458, compared with $7,650 in 1915. This plan will relieve much anxiety as to coal shortage next year and will relieve traffic congestion.

The company has exerted every effort to reduce fuel consumption to a minimum. Strict attention has been paid to turning off all unnecessary lights and electric heaters; the skip-stop system of operation has been inaugurated; a vigorous campaign in power saving has been instituted with good results.

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*Abstract of address before New England Street Railway Club, Boston, Feb. 18, 1918.

The National Chamber of Commerce Vote on the Water Powers

1. That Federal legislation encouraging the development of water powers should at once be enacted. Adopted by the almost unanimous vote of 1324 to 6.

2. That authority to grant permits should be vested in an administrative department. Carried by a vote of 1253 to 17.

3. That the permit period should be at least fifty years, any shorter period being at the applicant's option. In favor, 1216; opposed, 42.

4. That tolls should attach only to use of public lands or benefits derived from headwater improvements. Adopted by vote of 1191½ to 40½.

5. That permittees should be entitled to acquire the right to use public lands forming only a small and incidental part of the development. Carried by a vote of 1210 to 25.

6. That recapture should be exercised only upon payment of fair and just compensation. In favor, 1234; opposed 25.

7. That if recapture is not exercised, the investment of the permittee should be adequately protected. Adopted by a vote of 1226 to 26.

8. That rates and service should be regulated by state commissions where the service is intrastate, with Federal regulation only where several states are directly concerned and do not agree or there is no state commission. Carried by a vote of 1177 to 57.

9. That if any jurisdiction to regulate the issuance of securities is exercised, it should be solely by the state. In favor, 1114; opposed, 117.

10. That no preference should be granted as between applicants amounting to a subsidy from the government creating unequal competition. Adopted by a vote of 1191 to 38.

Navy Engineers to Train at Stevens

The Navy Department, after consultation with President Humphreys, has designated the Stevens Institute of Technology, Hoboken, N. J., as the headquarters for the new United States Naval Steam Engineering School for training engineer officers for the Naval Auxiliary Reserve.

This school is the only one devoted to training engineer officers for steam-engine service, and is a branch of the large training school now located at Pelham Bay Park, New York. There is at Pelham, in addition to the school for general training of enlisted men, an Officers' Material School, Naval Auxiliary Reserve. Both the school at Pelham and the engineer officer school at Stevens are under the supervision of the supervisor, Naval Auxiliary Reserve. The education of the engineer officers at Stevens is directed by Prof. F. L. Pryor, of Stevens, who has been appointed by the Navy Department, with the approval of President Humphreys, civilian director.

It is contemplated to make a five-months course for the training of an officer; one month to be devoted to military and ship duties training at Pelham, one month at Stevens to receive the preliminary requirements and duties of an engineer, one month in inspection and repair duties at local shipyards, machine shops and boiler shops, one month at sea in the engine room of different type boats, and one month subsequent training and examination at Stevens. It is expected to have about one hundred men in each of these divisions, or five hundred in all.

Three of the divisions will be quartered in barracks now in the course of construction on the college grounds at the corner of Sixth and Hudson Sts., adjoining the Carnegie Laboratory of Engineering. The school divisions will attend classes in the lecture rooms of the college and will take their meals at the college mess hall at Castle Stevens.

The instructors for the school, with the exception of the civilian director, will be regularly appointed commissioned officers of the United States Naval Auxiliary Reserve, selected particularly for their especial work.

Quotas are furnished for this school by the various Naval Districts throughout the country as outlined by the Navy Department and are required to meet the following qualifications: (a) Men of ability and officer material; (b) age 21 to 30, inclusive; (c) completed high-school course and graduate of engineering course at a recognized technical school or an equivalent of the above; (d) must be regular Navy, N. N. V., or N. R. F. (any class) for general service; (e) physically qualified for line officer—standard of regular Navy.

Men may be newly enrolled specifically for this course by applying to their Naval District enrolling officer and then be transferred by the commandant of that district to the school in his weekly quota.

That the students will be required to perform hard work is evidenced by the routine of duty which has been posted as follows: 6, reveille; 6:15, assembly; 7, breakfast formation; 7:15, breakfast; 8:15, study call; 9:45, retreat; 10, study call; 11:30, retreat; 12:15, dinner formation; 12:30, dinner; 1:15, study call; 2:45, retreat; 3, study call; 4:15, retreat; 4:30, drill; 5:30, retreat; 6, supper formation; 6:15, supper; 7, study call; 9:30, retreat; 10, taps.

It was expected that the first course would start on Mar. 25 and the second course about Apr. 22. After the barracks are completed, a unit of 25 men will be enrolled each week, and after the school is in full operation about one hundred engineer officers will be graduated each month. The rank of the successful students will be that of ensign; the unsuccessful students will be given appropriate ratings by the Supervisor, Naval Auxiliary Reserve and transferred to Pelham Park for general detail.

Turbine Propelling Units Wanted

Quotations are requested by the Emergency Fleet Corporation, Washington, D. C., on one hundred turbine propelling units, to be constructed in accordance with the following general specifications: (1) Capacity, 3000 s.hp.; (2) propeller speed, 90 r.p.m.; (3) steam pressure, 210 lb.; (4) superheat, 50 deg. F.; (5) vacuum, 28 in.; (6) each propelling unit is to consist of a high-pressure turbine and a low-pressure turbine with backing turbines, and a double herringbone reduction gear and housing, and is to be complete with all necessary attachments including a forced-oil lubricating system, cross-connecting piping, overspeed emergency valve and other necessary appurtenances. The propelling unit shall meet the requirements of Lloyd's and of the American Bureau of Shipping.

Segregated prices are to be stated for complete sets of spare parts. No auxiliary equipment, such as condensers and circulating pumps, is to be provided with the main propelling unit.

The time of delivery is of prime importance. Bidders are to state in proposal the earliest possible delivery of complete units and are to tabulate a complete schedule of deliveries which are to be guaranteed.

Proposals are to be complete in every respect and are to be accompanied by a full set of specifications and general and detail drawings showing the equipment contemplated.

Bidders are to state the type of turbine proposed; the turbine speed; the steam consumption at ¼, ½, ¾, full load and 1¼-load (in pounds of steam per s.hp.-hr.); gear efficiency; the length, width, height and weight of the propelling unit; the sizes of the steam and exhaust pipes; and a list of all gages, valves, strainers, case-hardened wrenches, wrench-boards, packing, lifting bolt, and similar devices supplied with the unit. The name of manufacturer and the point of manufacture and delivery are to be stated.

It is contemplated that manufacturers will bid on their standard turbine propelling equipment complete in every respect. Proposals must be submitted within ten days after date hereof. No bidding bond is required.

Alternative proposals are expressly desired on equipment conforming generally to the specifications of this inquiry. Alternatives will be received upon turbines operating at a shaft speed of 100 r.p.m.

Washington, D. C., Mar. 23, 1918.

New Publications

THE PETROLEUM AND NATURAL GAS REGISTER 1917-1918. Published by The Oil Trade Journal, New York. Size 9 x 11½ in.; 548 pages. Price, $12.

This is a representative catalog of the trade and is a collection of much valuable information about the petroleum and natural-gas industries of the United States, Canada and Mexico, giving names of officers, capital stock, location of properties and other valuable data, together with financial statements that fit in with facts as to organizations and operations. The text is divided into lists of refiners of petroleum; manufacturers and compounders of lubricating oils, greases, petroleum, etc., and gives marketers and jobbers grouped under Eastern, Central and Southern, and Western States; producers of petroleum, Eastern and Central States, Oklahoma and Kansas, Texas and Louisiana, and Western States; also lists of oil pipeline companies, casinghead-gasoline manufacturers, natural-gas producers and distributers, manufacturers of and dealers in supplies and equipment for the oil and natural-gas industries, and a directory of officers and members of the oil and gas associations and clubs in the United States. The arrangement and classifications of data are well planned for enabling the reader to obtain the desired information with little difficulty.

Personals

Joseph Harrington, of Chicago, the well-known combustion engineer, has been elected vice president and advisory engineer of the Chicago Superheater Co. E. A. Geoghegan has resigned.

A. F. Ausman, formerly vice president of McMaster-Carr Supply Co., of Chicago, is now Chicago district manager of Nagle Corliss Engine Works, of Erie, Penn., with offices in the Monadnock Block.

Frederick L. Ray, past president of the National Association of Stationary Engineers, has resigned as chief engineer of the Merchants Heat and Light Co., of Indianapolis, Ind., to take a corresponding position with the Erie Lighting Co., Erie, Penn.

A. D. Alexander has purchased the Pittsburgh (Penn.) office of the Richard D. Kimball Co., consulting engineers, and will continue the business under his own name. Mr. Alexander has been resident engineer in charge of the Kimball office for the last three years and was formerly engineer with the Pittsburgh Board of Public Education.

C. H. Van Hooven, claim agent of the Manila, (P. I.) Electric Railroad and Light Co. who has been visiting the United States for the purpose of consulting with officers of the J. C. White Management Corporation, New York, the operating managers of the Manila Co. is returning to the Philippines by way of Hawaii and Japan. While in the United States, Mr. Van Hooven also devoted considerable time to inspecting the claim methods of electric railways in a number of large cities. He has been connected with the Manila Electric Railroad and Light Co. for the last ten years. He was recently admitted to the Philippine bar, having successfully completed the law course at the Manila University.

Miscellaneous News

The Wentworth Institute, Boston, Mass., held its seventh public exhibition of work done in the various departments on Mar. 21. It appealed especially to persons interested in modern methods of training young men for skilled occupations in the trades and industries. A short, intensive 12-weeks' full-time day course in military engineering will be given at the Institute, in coöperation with First Corps Cadet Veteran Association, April 8 to July 1.

Steam Power Plants Close to Save Oil—All but one of the steam plants of the three big electric power companies operating in San Francisco closed down on the night of Mar. 19 and will remain closed for the remainder of the season if possible. The Pacific Gas and Electric Co., Great Western Power Co. and the Sierra & San Francisco Power Co., have inter-connected their heavy power lines and plants and the one operating steam plant will act as a standby in case of accident to the transmission lines from the hydro-electric plants of the three companies. The shutting down of the steam plants is in line with the program adopted for the conservation of fuel oil. The Potrero plant of the Pacific Gas and Electric Co. will act as the standby at night and the steam plants of the other two companies will alternate as standbys during the day, each plant taking an eight-hour shift.

Business Items

The H. W. Johns-Manville Co. has opened a branch office at 1015 A Street, Tacoma, Wash.

The Duquesne Electric and Manufacturing Co., of Pittsburgh, Penn., announces the opening of a branch office at 230 South La Salle St., Chicago.

The Vulcan Soot Cleaner Sales Co. has transferred its general sales office from 230 So. La Salle St., Chicago, to Du Bois, Penn., in order to bring the sales, factory and engineers in immediate touch. G. L. Simonds is in charge.

The American Thread Co.'s general engineering department will be transferred from the Merrick Mills at Holyoke, Mass., to the company's head office at 260 West Broadway, New York City, on Apr. 1. Malcolm Curry, general engineer, Kenneth B. Millett, assistant general engineer, and A. C. Richardson will be located at this latter office.

The Jos. W. Hays Corporation, of Michigan City, Ind., has purchased the business and good will of the Combustion Appliance Co., of Chicago, manufacturers of the Hays line of combustion testing apparatus. The general offices will be maintained at Michigan City. Following are the authorized representatives of the company: For New England States, Eagle Oil and Supply Co., 45 India St., Boston, Mass.; New York City and vicinity, Stephen H. Payne, 30 Church St., New York; Pennsylvania, New Jersey, Delaware, Maryland, Virginia and West Virginia, the Paul B. Huyette Co., 5 So. 18th St., Philadelphia, Penn.; Ohio, the Hays Engineering Co., 614 Commerce Bldg., Columbus, Ohio; Indiana, Acme Engineering Agency, 423 Fletcher-American Bank Bulding, Indianapolis, Ind.; Illinois and Wisconsin, The Hays Instrument Co., 1426 Consumers Bldg., Chicago, Ill.; Minnesota, Montana, North and South Dakota, The R. B. Whitacre Co., 205 S. Robert St., St. Paul, Minn.; Oklahoma and Texas, The Chas. W. Hays Co., Tulsa, Okla.; Louisiana and Mississippi, Henry J. Malochee, 917 Hennen Bldg., New Orleans, La.; The Pacific Coast, The Braun-Knecht-Heimann Co., 576-584 Mission St., San Francisco, Cal., and The Braun Corp., 363-371 New High St., Los Angeles, Cal. Agency arrangements will be considered with aggressive and responsible people in unoccupied territory. E. A. Acers is president and general manager of the Jos. W. Hays Corporation.

NEW CONSTRUCTION

Proposed Work

Vt., Brattleboro—The Twin States Gas and Electric Co. has been granted permission by the Public Service Commission to build transmission lines in Brattleboro, Bennington and St. Johnsbury, and to improve its power plant at West Dummerstown. W. H. Richardson, local mgr.

Mass., Adams—The Renfrew Manufacturing Co. plans to build a power plant on Columbia St.

Mass., Fall River—The stockholders of the Fall River Electric Co. will petition the Gas and Electric Light Commissioners for authority to increase its capital stock from $1,400,000 to $2,100,000; proceeds to be used for paying its outstanding indebtedness, also for new high tension transmission system to be built over the Taunton River. A. H. Kimball, 85 North Main St., Gen. Mgr.

Mass., Millbury—The New England Power Co., 18 Grafton St., Worcester, is having surveys made for the construction of a high tension transmission line from here to Webster. S. C. Moore, Gen. Mgr.

Mass., Worcester—The W. H. Sawyer Lumber Co., 26 Lincoln St., is having plans prepared for the construction of a power house in connection with its new plant. Estimated cost, $70,000.

N. Y., Buffalo—The J. H. Williams Co., 400 Vulcan St., plans to increase the capacity of its power plant during the year.

N. Y., Lockport—The Lockport Light, Heat and Power Co., controlled by the United Gas and Electric Co., 61 Broadway, New York, has been authorized by the Public Service Commission to issue $106,700 capital stock; proceeds to be used for paying the outstanding indebtedness. J. A. Perkins, Gen. Mgr.

N. Y., New York—The Interborough Rapid Transit Co. has filed plans for the construction of a 3-story, 40x41 ft. transformer station on 74th St. east of Ave A. Estimated cost, $12,900. G. H. Pegram, Ch. Engr.

N. Y., Rochester—The Rochester Railway, Light and Power Co. has been granted permission by the Public Service Commission to issue $2,000,000 capital stock to cover the cost of the recent improvements in the equipment of its Genesee River hydraulic plant. T. H. Yawger, 34 Clinton Ave., Supt.

N. Y., Sandlake—The McLaren Knitting Co. has applied to the Town Board for a franchise to construct an electric transmission line to enable it to secure electricity to operate its mills here.

Penn., Chester—The Delaware County Electric Co., Lansdowne, controlled by the Philadelphia Electric Co., 1000 Chestnut St., Philadelphia, is building a large steam power station on the Delaware River here. A. R. Granger, Mgr.

Penn., Philadelphia—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, here, under Schedule No. 1725, plain enameled magnet wire; Schedule No. 1726, 300 counter scales; Schedule No. 1727, standard steel bolts.

Del., Bowers—W. E. Kelly is interested in a project to organize a company to install and operate an electric light plant here.

Md., Ellicott City—The Town Commissioners plan to issue bonds for the construction of an electric-light plant.

Md., Pylesville—The Fawn Grove Light and Power Co., Fawn Grove, Pa., will construct a new concrete dam at their Eden Mills plant on lower Deer Creek near Pylesville, about 300 ft. long to carry 30 ft. of which only 16 ft. will be built this season. The company will install water wheels and one 125 kva. generator, 3 phase, 60 cycle, 2200 volts with exciter, switchboard, etc., and require from four to seven miles of No. 6 copper transmission wire. Work will be done by day labor. William Russell Smith Co., York, Pa., Engr.

N. C., Southport—J. G. White & Co., 43 Exchange Pl., New York, has purchased property of Southport Electric Light and Power Co. The new owners plan to spend about $20,000 for improving same.

S. C., Charleston—Charleston Consolidated Railway and Lighting Co. plan to increase the capacity of its power house on Meeting St. P. H. Gadsden, Pres.

Ga., Jackson—City plans to improve the electric-light plant to include rebuilding 1½ mi. of pole line and installation of high pressure centrifugal pump, 2 stage, electrically driven. W. E. Merck, Gen. Mgr.

Ala., Ensley—The Tennessee Coal, Iron and Railway Co. will install a 7500 k.w. generator in power station No. 1 at the Ensley blast furnaces.

Ala., Mobile—The Chickasaw Shipbuilding Co. is constructing a power plant at its yards, here. Estimated cost $750,000. The plant will have two 4000 k.w. turbo generator units and three air compressors of 8800 cu.ft. per minute will be installed. Equipment has been purchased.

La., Oak Grove—City plans to install an electric lighting plant soon. Address L. Grathwell, Oak Grove.

Ky., Graham—The W. G. Duncan Co., Greenville, plans to construct a 75x100 ft. power house, also build from 4 to 5 mi. transmission line to connect Greenville, Luzerne and Depoy. Material and equipment purchased.

Ky., Hazard—The Perry Coal and Lumber Co. plans to install an electrically operated plant for a coal development on Louisville & Nashville Railroad in Perry County.

Ky., Indian Bottom—The Middle West Coal Co. will receive bids until Mar. 30, for the erection of a power plant midway between here and Jeremiah. Estimated cost, $50,000.

Ind., Attica—The city plans to rebuild its electric-light and water-works plants which were recently destroyed by fire with a loss of $60,000. G. McDonald, Mgr.

Ind., Gary—The Gary Street Railway plans to construct a new power station on 11th Ave.

Ind., Indianapolis—Bids will be received by the Board of Trustees of Indiana University, Bloomington, for the construction of a 1-story, 88x91 ft., brick and reinforced concrete power house in connection with the new medical building to be built on West Michigan St. Bids will be received at the same time for furnishing the electric equipment, boilers and heating equipment, refrigerating and ice-making equipment, hot water equipment, heating and ventilating apparatus, electric wiring, etc., for both buildings. R. F. Daggett, 956 Lemcke Annex, Arch.

Ill., Biggsville—The Biggsville Light Co. plans to change its system to alternating current, single phase, and extending its service to two small towns and farms along the line. A 75 kva. single phase, 2200 or 1199 volt machine will be required D. W Lee, Vice-Pres.

Ill., Charleston—Council authorized $20,000 bond issue, proceeds of which will be used for improving electric-light plant and water-works system.

Ill., Mt. Olive—City will hold an election Apr. 16 to vote on $8000 bonds to be used for the improvement of the electric-light plant. It is also proposed to equip the water-works pumping station with electrically operated machinery. W. S. Merkle, Federal Reserve Bank Bldg., St Louis, Mo., Engr

Ill., Rockford—City will hold election in April to vote on $500,000 bonds to install an electric-light plant.

Iowa, Boyden—Veenschoten Bros., Boyden, have been granted a franchise by the Board of State Railroad Commissioners to construct and operate electric transmission lines on certain highways and roads in Sioux County for a period of 25 years

Iowa, Dubuque—The Chicago, Milwaukee and St. Paul Railway plans to improve the power plant at its shops here. Estimated cost, $50,000. C. F. Loweth, Chicago, Ill., Ch. Engr

Iowa, Lanesboro—City will hold election March 8 to vote on $7000 bonds, proceeds will be used for building electric-light plant.

Ia., Ossian—Harry Bullard, owner of the local electric light and power plant, has sold same to A. G. O'Rear of Mason City The new owner plans to improve the same

Minn., Ionn—City plans to install electric-light and power plant to cost approximately $10,000.

Kan., Chapman—The United Telephone Co. is building a new transformer station here. Plans are also being considered by the company for other improvements.

Kan., Lawrence—The Bowerstock Mills and Power Co., Lawrence, plans to build a large boiler house soon. R. C. Jackman, Mgr.

Kan., Oakley—Plans are being considered by the city for the construction of a transmission line from here to Colby to secure electricity to operate the local system.

Kan., Ottawa—City plans to build a transmission line on South Willow St., from 11th to 15th St., thence on 15th St. from Willow to Locust Sts. W. O Myres, Supt.

S. D., Miller—The City Council contemplates calling an election to vote on $30,000 bonds to install an electric-light and power plant.

Ark., Helena—The Helena Gas and Electric Co. plans to enlarge its plant and install new machinery.

Tex., Bryan—City will purchase additional transformers for its electric-light and power system.

Tex., San Angelo—Plans are being considered by the Interstate Corporation, 141 Broadway, New York, for extending its electric transmission system now running from San Angelo to Ballinger to Coleman and Brownwood. E. Burrow, San Angelo, Ch. Engr.

Okla., Hominy—The Hominy Ice, Light and Power Co. has purchased an additional electric generating unit consisting of a 150 h.p. gas engine directly connected to a 100 k.w., 3 phase, 60 cycle, 2300 volt generator for its plant here

Okla., Laverne—City will spend $13,000 to construct an electric-light plant. Address The Mayor. Noted Dec. 18.

Okla., Miami—City will expend about $45,000 to improve and extend its electric-light plant. Address The Mayor. Noted Nov 6

Okla., Shattuck—City plans to spend between $20,000 and $30,000 to build electric-light plant to develop 150 to 300 h.p. A. C. Oliver, Mayor. Burns & McDonnell, Interstate Bldg., Kansas City, Mo., Engr

Colo., Colorado Springs—The Golden Cycle Co. has under consideration the construction of an electric lighting plant.

N. M., Des Moines—Village Trustees will call an election to vote on $50,000 bonds to purchase the local electric-light plant and water-works system and improve and extend same.

Ariz., Yuma—The City plans to improve and enlarge the electric-lignt and power plants and the water-works system. Among improvements contemplated is the erection of an electric transmission line of 6600 volts to supply nearby ranches. Fred Kuecke, Supt.

Wash., Tacoma—City will hold an election soon to vote to purchase either a completed power plant at a cost of approximately $5,000,000 or a site on which a plant may be built. L. Evans, Gen. Supt. Noted Feb. 8.

Wash., Tacoma—City is having plans prepared by its Electrical Department for the erection of a substation L Evans, Gen. Supt

Wash., Tacoma—Light and Water Department plans to replace conduits underground from Nisqually sub-station at 23rd and C Sts., to Winthrop Ave. New circuits will be for shipyards and tide flats L Evans, Gen. Supt.

Calif., Hanlon—The Imperial Irrigation District, Masonic Temple Bldg., El Centro, plans to construct a new power line from here to point on the Alamo Estimated cost $11,000.

Calif., Los Angeles—The Public Service Commission authorized the leasing from the Harbor Commission of a tract of land on the east side of the Harbor Blvd. to be used as a site for a sub-station for the municipal power system. The site adjoins the property of the Los Angeles Dry Dock and Shipbuilding Co. A Scattergood, Ch. Electrical Engr.

Calif., Los Angeles—The Riverside-Southern Sierras Power Co., 611-12 Lymes Bldg., Denver, Colo., plans to expend about $279,000 for reconstructing one of its main transmission lines, extending for distance of 60 mi. from hydro-electric plant located on Rush Creek. V. Presto, Riverside, Gen. Mgr.

N. B., Woodstock—The Woodstock Electric Railway Light and Power Co. plans to improve its plant here this summer. Improvements contemplated include installation of Hercules turbine, type D of Holyoke Manufacturing Co. developing 137½ h.p. at 13 ft. head, belt connected to a Westinghouse generator in synchronism with two generators. C. D Johnson, Mgr

Ont., London—The Helena Costume Co., 190 King St., is in the market for a 60 k.w., 110 volts, 680 r.p.m., compound wound, direct current generator.

CONTRACTS AWARDED

Mass., New Bedford—The Union Street Railway has awarded the contract for the construction of the superstructure of a 2-story, 98x126 ft., brick and steel building to be used as a boiler house and turbine room, to J. W. Bishop Co., 109 Foster St., Worcester. Estimated cost, $135,000.

N. J., West Orange—T. A. Edison, Inc., Lakeside Ave., has awarded the contract for the construction of a 1-story, 100x100 ft. reinforced concrete power plant, to the Underpinning and Foundation Co., 270 Broadway, New York City. Noted Oct. 23.

Penn., Nanticoke—The Board of Managers of the State Hospital, has awarded the contract for a 1-story, 50x65 ft. power house, to John Curtis & Co., 1 Hickory St., Wilkes-Barre.

Penn., Reynolds—The Atlas Powder Co. has awarded the contract for the construction of a power plant here, to A. Breslin, Summit Hill.

O., Salem—The Salem Lighting Co. has awarded the contract for a 1-story, 31x40 ft. boiler house addition, to Walker & Curley Co., East End Trust Bldg., Pittsburgh, Pa. Estimated cost, $30,000.

Ind., Robey—The Western Products Co., Robey, has awarded the contract for the construction of a 1-story power house, to the Industrial Building Co., 38 South Dearborn St., Chicago, Ill. Estimated cost, $5600.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1] Mar. 28, 1918	Individual[1] Mar. 28, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	1.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $1, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1] Mar 28, 1918	Individual[1] Mar. 28, 1918
Pea	$5.05	$5.80
Buckwheat	4.30—5.00	5.50—5.80
Barley	3.25—3.50	4.00—4.25
Rice	3.75—3.95	4.50—4.80
Boiler	3.50—3.75	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Mar. 28, 1918	One Yr. Ago	Mar 28, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties Mar 28, 1918	Mt. Olive & Staunton Mar. 28 1918	Standard Mar. 28, 1918
6-in. lump	$2.65-2.80	$2.65-2.80	$2.65-2.80
2-in.-lump	2.65-2.80	2.65-2.80	2.65-2.80
Steam egg	2.65-2.80	2.65-2.80	2.65-2.80
Mine-run	2.40-2.55	2.40-2.55	2.40-2.55
No. 1 nut	2.65-2.80	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.30	2.15-2.30	2.50-2.65
No. 5 washed	2.15-2.30	2.15-2.30	2.50-2.65

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1] Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0 11¼ each	110-200 amperes	$0.90 each
31-60 amperes	15¾ each	225-400 amperes	1.62 each
61 100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			¾-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27 30c.	26 20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS PLUG

S. P. M. L.	$0 11	T. P. to D. P. S. B	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31 60 Amp.	60-100 Amp.
D. P. M L.	$0.33	$0 84	$1.68
T. P. M L.	.48	1.20	2.40
D P. S. B.	.42	1.05	....
T P. S B.	81	1.80	....
D. P. D. B.	78	2.10	....
T. P. D. B.	1.35	2.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	12	100
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$21.50
No. 16 cotton twisted	29.00
No. 18 cotton parallel	24.00
No. 16 cotton parallel	36.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	39.40
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No 18 cotton Canvasite cord	21.75
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft in New York:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$10.50	$12.50	$15.00	$23.50
12	11.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	56.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	223.60	....
000	....	..	271.21	..
0000			332.40	

COPPER WIRE—Prices per 1000 ft for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$13.00	$15.00	$26.00	$13.50	$16.25	$31.25	$13.50	$16.25	$31.25
10	23.30	26.50	52.55	25.00	28.50	56 40	25.00	28.50	56.40
8	33.10	36.70	73.20	34.85	38.85	74.70	34.85	38.85	74 70
6	...	56.20	.....	59 75	64.25	....	59.75	64.25	....
4	..	80.55	.....	84 40	84.90	...	84.40	84.90	....
2	.	120.30	.....	125.50	132 00	...	125.50	132.00	...
1		156.25	.....	163.00	171.15	..	163.00	171 15	..
0		187.05	....	216 00	225.00	..	216.00	225.00	....
00	..	252.65	.....	263.00	273.50	.	263.00	273.50	...
000	.	309 35	....	320 00	331.50	...	320 00	331.50	..
0000	....	376.75	.....	388.50	400.50	....	388.50	400.50	....

LOOM—Price per 100 ft., in coils:

	Ft. in Coil			Ft in Coil	
¼	250	$2.25	¾	150	$7 00
⅜	250	3 50	1	100	10 00
½	200	4.50	1¼	100	12 00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$66.56	$71.66	$0.1602	$0 1716	$0 059	$0.0632
¾	87 75	94.65	.2108	.2258	0843	0903
1	129 71	139.91	3119	.3341	1096	.1174
1¼	175.49	189.29	4019	.4289	.1518	.162
1½	209 83	226.33	.5358	.5718	1875	.2001
2	282 31	304.51	.9823	1 05	.25	.268
2½	446.36	481 46	1 61	1 71	3572	.3812
3	583.70	629.60	4 28	4 57	5358	.5718
3½	729.56	784.76	9.17	10.10	7144	.7621
4	886.17	951 57	10.93	11.67	.893	.954

From New York Warehouse—Less 5% cash.

Standard lengths rigid 10 ft Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000 ¾- to 1¼ in., 100; 1½- to 2-in., 50

	Locknuts Per 100	Bushings Per 100	Flexible Condut Box Connections Per 100
½	$1 02	$1 68	$5.62
¾	1 75	4 00	7.12
1	3 00	6 15	10 50
1¼	5 00	8 20	15 00
1½	7 50	10 25	22 50
2	10.00	16 40	30 00
2½	12 30	24 60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$65.00	$4.50	$103.50	$4.50
12	101.25	4 50	127.50	4 50
10	138.75	4 75	176.25	4 75
8	176.20	5.75	247.50	6.00
6	277 50	6 25	362 40	7 50
4	431.25	7 50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight Side Bulbs				Pear-Shape Bulbs			
Mazda B—Watts	Plain	Frosted	No in Package	Mazda C—Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1 10	1.15	24
25	.30	.33	100	150	1 65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3 25	3 35	24
60	.35	.39	100	400	4.30	4 45	12
100	.70	.77	24	500	4 70	4.85	12
				750	6.50	6 75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb
Rubber tape, ½-lb rolls	45c per lb
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c per lb.

FANS—It is prophesied that there will be a scarcity of electric fans this summer

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2½-in.	75c. per ft.
Common, 2½-in.	40%

Air

	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.55	$0.30	$0.25

Steam—Discounts from list

First grade... 30%   Second grade... 30-5%   Third grade... 40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	50%	Best grade	20%
Standard	35%		

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	35%
Denver	35%	30%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.60
Duck and rubber for piston packing	1.00
Flax, regular	.90
Flax, waterproofed	1.10
Compressed abestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.90
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in	$0.27
2-in.	.36	1 -in	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		5% off
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5¼	6.1	7½	10
Fiber or sponge	8	6	6.4	15	15
Transmission	7	6	6.4	10	15
Axle	4½	4	3.3	..	5
Gear	4½	4½	6.5	7½	6
Car journal	22 (gal.)	3½	4.6	5	6

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Mar. 28, 1918	One Year Ago		
Colored mixed..	8.50 to 12.00	10.00 to 12.00	12.50	12.00 to 12.50
White	11.00 to 13.00	13.00 to 15.00	16.00	10.00 to 11.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13½ .... $45.00   13¼ x 20½ $52.00

In Chicago they sell at $30@33 per 1000.

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Mar. 28, 1918	One Year Ago	Mar. 28, 1918	One Year Ago	Mar. 28, 1918	One Year Ago
Raw per barrel	$1.56*	$0.99	$1.60	$1.05	$1.65	$0.98
5-gal. cans	1.66*	1.09	1.75	1.15	1.75	1.08

* Nominal.

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Mar. 28, 1918		1 Year Ago		Mar. 28, 1918	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50	10.50
12½-lb. keg	11.75	11.25	10.75	11.25	10.75	10.75
100-lb. keg	11.25	11.50	11.00	11.50	11.00	11.00
1- to 5-lb. cans	13.25	13.00	12.50	12.50	13.00	12.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7⁄16 and smaller	30%	35%	40%*
Tinned	30%	35%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York ..... $6.09½   Cleveland ..... $5.85   Chicago $5.50

Coneheads, same sizes:

New York ..... $6.19½   Cleveland ..... $5.95   Chicago $5.60

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$50.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	....
Magnesite brick, per net ton	135.00 to 145.00	....
Chrome brick, per net ton	135.00	....
Deadburned magnesite brick, per net ton	85.00 to 90.00	....
Special furnace chrome brick, per net ton	60.00 to 70.00	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $50.
Birmingham—Fire clay, $25 to $30.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	5c.	None
Mexican heavy, 12-14 Baumé	7c.	7⅒c.

Note—There is practically no fuel oil in Chicago at present time.

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Mar. 28, 1918	One Year Ago
New York	$15.00	$8.00
Cleveland	15.30	7.50
Chicago	15.00	6.00

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft	7.40	6.60	6.60	5.80
7 in. by 35 ft	10.70	9.60	9.60	8.55
8 in. by 35 ft	12.20	10.90	10.90	9.65
7 in. by 40 ft	12.35	11.00	11.00	9.75
8 in. by 40 ft	13.75	12.15	12.15	10.65
8 in. by 45 ft	18.20	16.20	16.20	14.30
8 in. by 50 ft	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$6.00
12-in. butts, 6-in. tops, length 30-40 ft	8.50
12-in. butts, 6-in. tops, length 41-50 ft	9.50
14-in. butts, 6-in. tops, length 51-60 ft	17.00
14-in. butts, 6-in. tops, length 61-71 ft	18.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
BUTT WELD					
¾ to 3	49%	35½%	¾ to 1½	33%	17%
LAP WELD					
2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			
BUTT WELD. EXTRA STRONG PLAIN ENDS					
¾ to 1½	47%	34½%	¾ to 1½	33%	18%
2 to 3	48%	35½%			
LAP WELD. EXTRA STRONG PLAIN ENDS					
2	40%	28½%	2	27%	14%
2¼ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

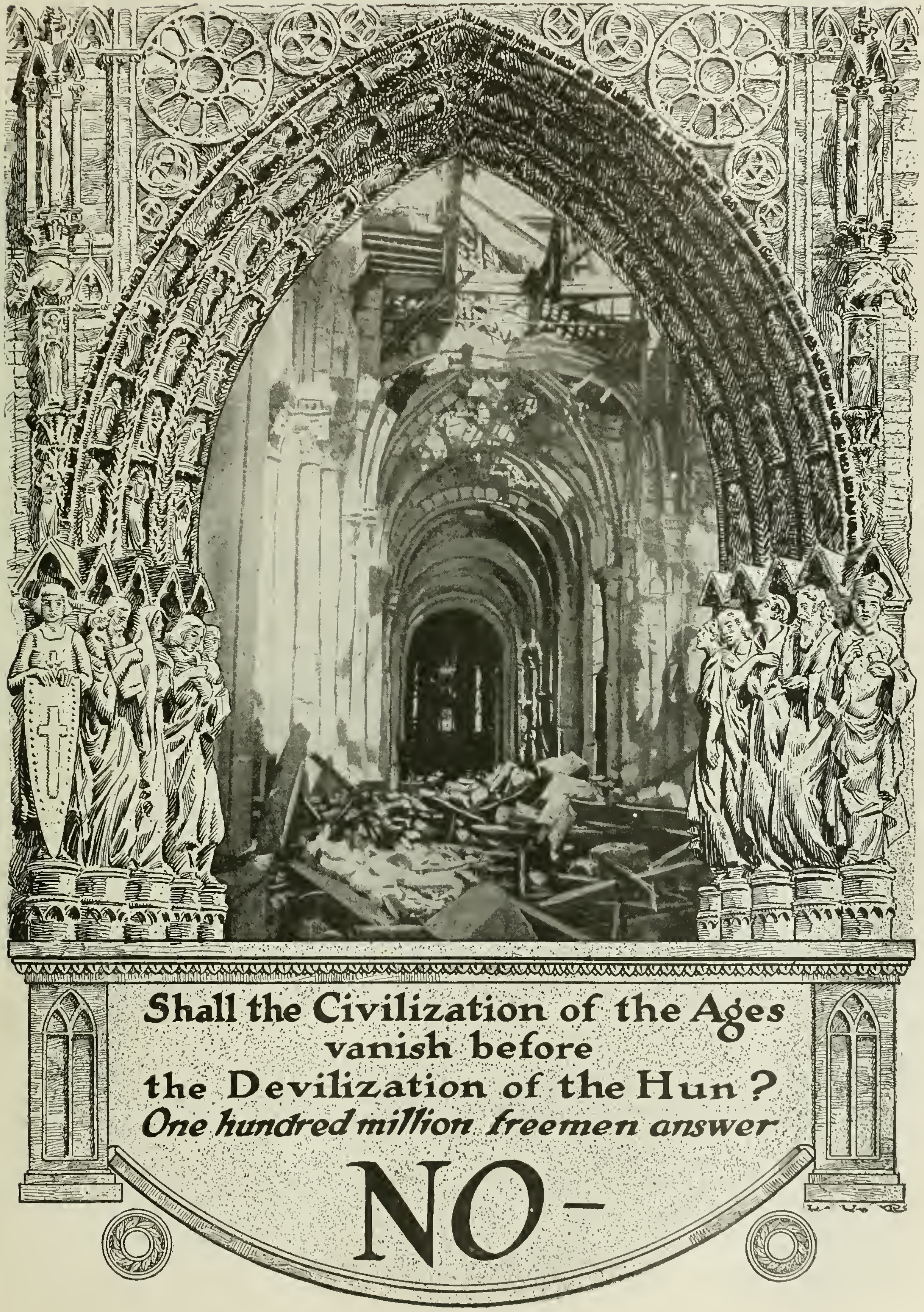
Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+5
2¼ in.	17½	2½ to 2¾ in.	+7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

	Per Net Ton		Per Net Ton
1 in.	$310	1¾ in.	$220
1¼ in.	280	2 to 2¼ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

Vol. 47, No. 15 POWER April 9, 1918



Reconnecting Induction Motors—For Changes in Number of Poles

By A. M. DUDLEY

Designing Engineer, Westinghouse Electric and Manufacturing Co.

The effect upon the operation of the machine caused by changing the number of poles in an induction-motor winding is discussed. Tables are given in which data are compiled for a 54-coil winding having a coil spread of 1 to 7, reconnected for 4, 6, 8, 10 and 12 poles. These data are discussed in a way that will make them easily applied to any induction-motor winding.

THE speed of an induction motor expressed in revolutions per minute = (cycles × 120) ÷ number of poles. The speed so determined is called synchronous speed and is very nearly the same as the no-load speed. When operating under full load the speed will be a few revolutions less than this—for ordinary motors, on an average of about 95 to 97 per cent. of the synchronous speed. The synchronous speed is the speed at which the rotating magnetic field is traveling around in the stator, and the difference between this and the full-load speed of the rotor (3 to 5 per cent.) is called the "slip" of the motor.

From the equation for revolutions per minute it can be seen at once that if the speed of the motor is to be changed, it is necessary to change either the cycles or the number of poles. Or, assuming that the cycles have been changed and that it is necessary to keep the same speed as before, it will be necessary to change the number of poles. So far as the cross-connections themselves are concerned, and admitting windings where all the pole-phase groups do not have the same number of coils, as discussed in the article in the May 22, 1917, issue of *Power*, it is evident that any winding might be connected for several different numbers of poles and for either two-phase or three-phase, by the simple expedient of changing the number of coils in each pole-phase group.

For example, a winding having 54 slots and 54 coils if arranged for three-phase 6 poles would have 3 coils per group and 18 pole-phase groups. If the same winding is rearranged for three-phase 4 poles there will be 12 pole-phase groups having alternately 4 and 5 coils per group. Or, if the same winding is arranged for two-phase 4 poles there will be 8 pole-phase groups, 6 of which would have 7 coils and 2 of which would have 6 coils, or 54 total. There are practical limits beyond which this form of reconnection cannot properly be carried and which are discussed farther on in this article, but before proceeding to a discussion of them attention is called to some typical cases of reconnection of this nature.

Fig. 1 shows a 54-slot winding having a coil pitch of 1 and 7 as arranged for 6 poles and connected series star. There are 3 coils in every group. Fig. 2 shows the same winding as Fig. 1 except grouped and connected for 4 poles. It will be noted that there are now 3 × 4 = 12 pole-phase groups containing alternately 4 and 5 coils per group. Fig. 3 shows the same winding as in Fig. 1 arranged and connected for 8 poles; there are 18 pole-phase groups with 2 coils and 6 with 3, making a total of 24 groups and 54 coils. Fig. 4 is the same winding as Fig. 1 connected for 10 poles. There are 24 groups having 2 coils each and 6 groups with 1 coil, making a total of 30 pole-phase groups and 54 coils. Fig. 5 shows the winding, Fig. 1, connected for 12 poles. There are 18 groups of 2 coils each and 18 groups of 1 coil each, making a total of 36 groups and 54 coils.

Of course all these connections would not normally operate at the same voltage, nor would the horsepower developed be the same, and the speed would vary inversely as the number of poles. Assuming, for example, that the motor was 100-hp. 60-cycle three-phase 440-volts and run at 1160 r.p.m. on the 6-pole connection, the characteristics for the other connections are shown in Table I. Three-phase is assumed throughout.

TABLE I. CHARACTERISTICS OF A THREE-PHASE MOTOR CONNECTED AS IN FIGS. 1 TO 5

Poles	H.P.	Voltage	R.P.M.	Connection
6	100	440	1,160	Fig. 1
4	110	484	1,750	Fig. 2
8	86	375	860	Fig. 3
10	68	300	690	Fig. 4
12	50	220	580	Fig. 5

The only commercial voltages in Table I are the first and last, 440 and 220. To operate the motor on the other connections would require special taps from the transformer, unless some other change could be made in the motor's winding at the same time that the number of poles was changed. For example, the 8-pole connection requires 375 volts. If it so happened that the 6-pole motor was connected in parallel star, then the 8-pole motor could be connected series delta, which would be the same thing as operating the motor on a voltage in the ratio of 1.73 to 2 or $\frac{375 \times 2}{1.73} = 434$, which is approximately the voltage required.

Table I of horsepowers and normal voltages is figured by taking account of the speed and of the chord factor in the following way:

One of the functions of the winding is to be acted upon by the rotating magnetic field and to actually generate a counter-electromotive force which is opposed to and almost equal to the applied line voltage. If, then, in reconnecting for a different number of poles, the assumption is made that the magnetic field in the teeth and air gap remains at a constant value irrespective of the connections, it is at once evident that the generated electromotive force, and consequently the applied line voltage, should vary directly as the speed of the rotating magnetic field, which is practically the same as the revolutions per minute of the motor at no load. For example, in the case cited in the foregoing, if the normal voltage on the 6-pole connection is 440, everything else being equal, the normal voltage on the 12-pole connection should be 220, since the revolutions per

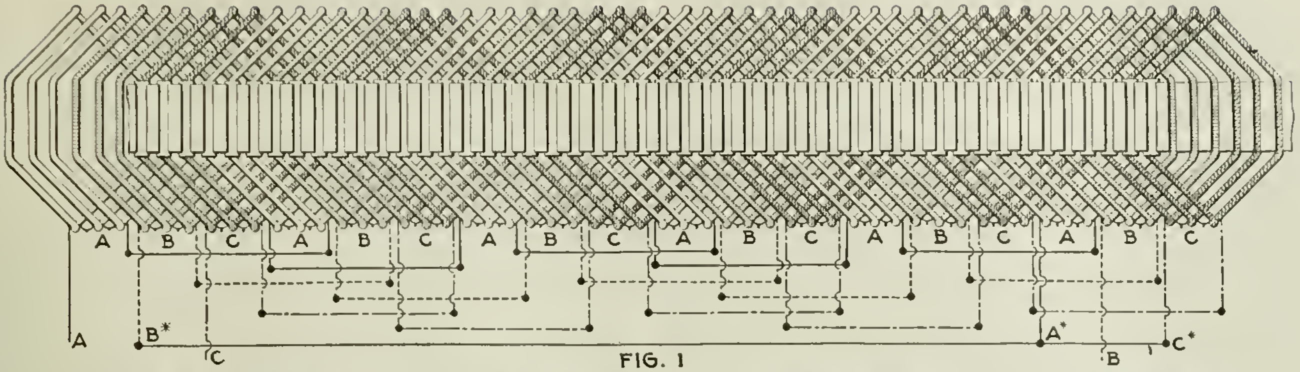


FIG. 1

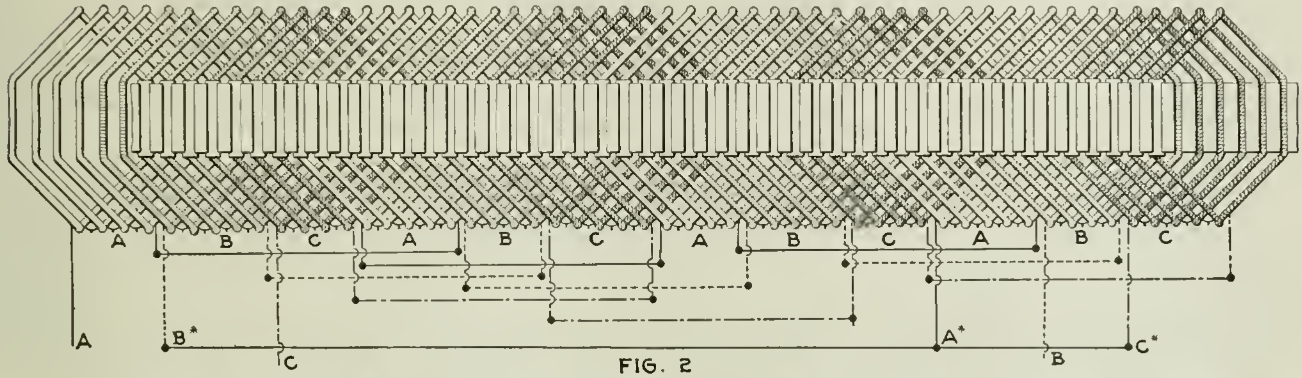


FIG. 2

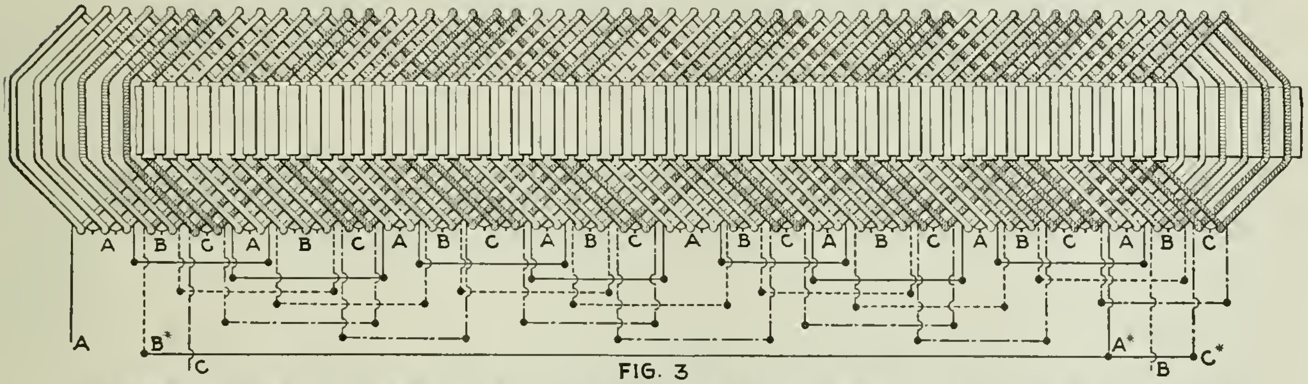


FIG. 3

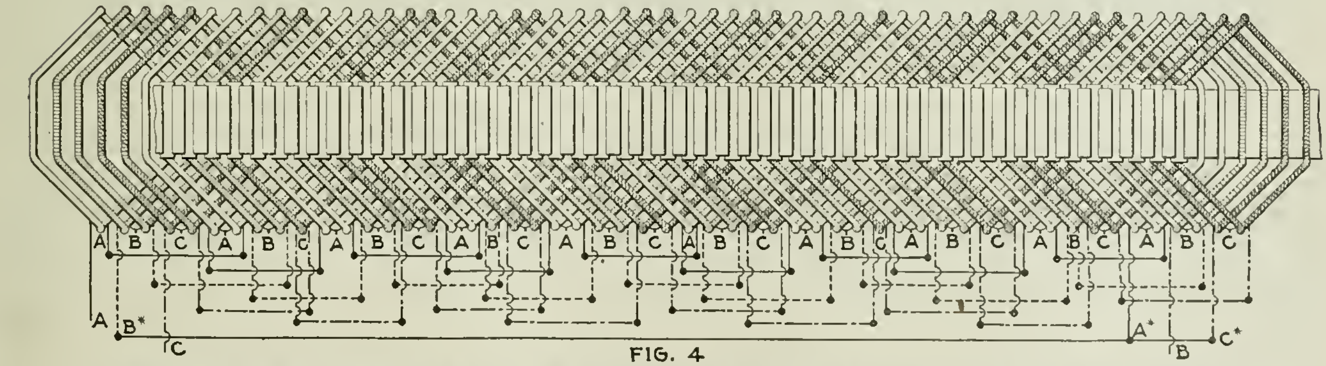


FIG. 4

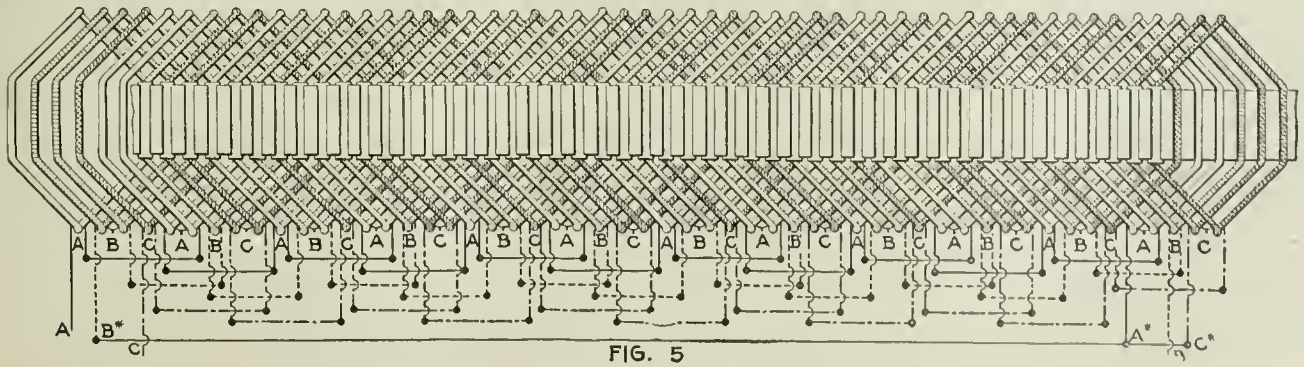


FIG. 5

FIGS. 1 TO 5. INDUCTION-MOTOR WINDING OF 54 COILS GROUPED FOR 4, 6, 8, 10 AND 12 POLES minute of a 12-pole motor are just one-half those of a 6-pole machine.

Practically, the only condition which enters to change the voltage from varying directly as the speed is the "chord factor," which is due to the throw or pitch of the coil. This was described under "Fractional Pitch Windings" in the July 31, 1917, issue. It will be recalled that this is a factor which reduces the voltage generated in a coil because one side of a coil is not exactly under the center of a north pole when the other side is exactly under the center of a south pole. The numerical value of this factor is expressed as the sine of one-half the electrical angle which is spanned by the coil. It may appear in the example given in Figs. 1 to 5 that the chord factor should remain constant since the physical throw of the coils is unchanged. It should be carried in mind, however, that while the coil spread remains unchanged, the number of poles is changed, consequently the pole arc is changed; hence, the relation of the throw of the coil to the pole arc is different in each case. The foregoing can be best shown by Table II, remembering that the throw of the coils is slots 1 and 7 in all cases.

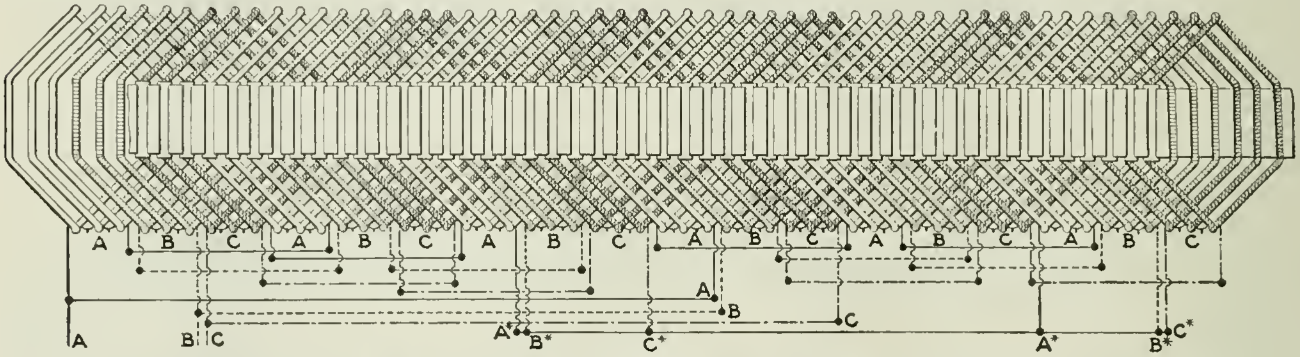


FIG. 6

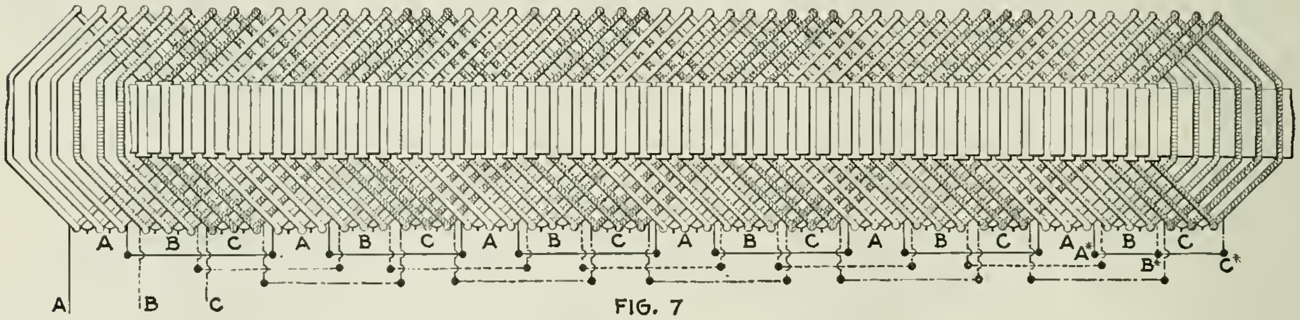


FIG. 7

FIGS. 6 AND 7. INDUCTION-MOTOR WINDING OF 54 COILS GROUPED FOR 6 AND 12 POLES

Fig. 6—Two-parallel-star, connected, 6-pole winding. Fig. 7—Same winding as in Fig. 6 reconnected series-star, consequent pole, for 12 poles.

TABLE II. EFFECTS OF CHANGING THE NUMBER OF POLES IN AN INDUCTION-MOTOR WINDING

Number of poles	4	6	8	10	12
Throw of coil	1–7	1–7	1–7	1–7	1–7
Slots spanned by coil	6	6	6	6	6
Number of slots equivalent to 180 electrical degrees $= \frac{54}{\text{No. of poles}}$	13.5	9	6.75	5.4	4.5
Electrical degrees represented by six slots	80	120	160	200	240
Sine of half the electrical angle covered by the coil throw or pitch = chord factor	0.64	0.866	0.99	0.99	0.866

Table II indicates that the normal 6-pole voltage of 440 must be modified by two factors to find its value for other speeds. These factors and their results are combined in Table III.

On first comparison of Tables II and III it seems peculiar that the 4-pole connection having the lowest chord factor, which is 0.64, operates at 484 volts, which is the highest voltage, while the 8- and 10-pole connections, having a high chord factor of 0.99, operate at 375 and 300 volts respectively. It must be remembered that the speed at which the magnetic field is rotating comes into effect and changes the result of the chord factor. Throughout this series of articles we have considered the induction motor as being an alternating-current generator, generating the counter-electromotive force, or back voltage. Hence, in this case, the assumption has been made that the magnetic field in the air gap remains the same in density for all these connections, and when connected for 4-pole this field will rotate twice as fast as when connected for 8-pole, and thus generate twice as much voltage. This is the reason that the two factors, one due to changing the speed of the field and the other due to changing the throw of the coil, are introduced, as shown in Table III. The product of these two factors governs the voltage which must be applied to the windings to give normal operation.

TABLE III. FACTORS, DUE TO CHANGE IN NUMBER OF POLES, MODIFYING INDUCTION-MOTOR VOLTAGE

Number of poles	4	6	8	10	12
Factor for changing voltage on account of changing speed	1.5	1	0.75	0.60	0.50
Factor for changing voltage on account of change in chord factor = chord factor for new No. of poles ÷ 6-pole chord factor	0.74	1	1.14	1.14	1
Product of Nos. 2 and 3	1.11	1	0.855	0.685	0.50
Resulting voltage = (440 × No. 4)	484	440	375	300	220

Table III determines the value of the proper voltage for the new connections as given in Table I. The horsepower is determined just as if it were an alternating-current generator by taking the product of the volts × amperes × 1.73 × power factor and dividing by 746. The cross-section of the copper has not been changed, hence the amperes remain constant. The power factor is assumed the same, although it will be somewhat higher on high speeds and lower on low speeds. Therefore, the output in horsepower will vary as the voltage, assuming 100 hp. at 440 volts. The horsepower for the new connections is figured in this manner, as given in Table I. Some general observations might be made about the examples chosen in this article: First, the question of starting torque or maximum torque required, or the saturation of the core when connecting for higher speeds might require a voltage somewhat higher or lower than Table I; second, as pointed out in the article in the July 31, 1917, issue of *Power*, on fractional-pitch windings it is not wise, in general, to chord up a coil so far that the chord factor is less than 0.707, which means that the coils span only halfway from the center of a north to the center of a south pole. The reason for this will be shown in the next article by plotting the shape of the magnetic field set up by windings having different coil pitches. For this reason the 4-pole connection, as shown and discussed in this article, should be avoided in practice, but the 6-, 8-, 10- and 12-pole connections would be satisfactory if the proper operating voltage could be secured.

From the foregoing it may be seen that there are three factors to be taken care of in changing the number of poles. These are:

First, if the new speed is to be higher than the original speed, the peripheral speed should not be allowed to exceed 7500 to 8000 ft. This figure is the diameter of the rotor in feet × 3.14 × revolutions per minute.

Second, the chord factor of the winding.

Third, the phase-insulation coils should be shifted so as to come at the beginning and ending of the new pole phase groups, as discussed in the article on "Phase Insulation," *Power*, July 31, 1917.

Sometimes, when a winding is connected in parallel star it is possible to reconnect it in series star with consequent poles, as explained in the Mar. 20, 1917, issue of *Power*, and have the motor operate at one-half its original speed. This reconnection is shown in Figs. 6 and 7. Conversely, if the motor was originally connected for series star, it might be reconnected for parallel star and operate at double speed if the motor would stand up mechanically. The counter-electromotive force generated by the consequent-pole connection is only 86.6 per cent. as much as with the salient-pole connection, which means that if the motor was run on normal rated voltage on the consequent-pole connection it would operate as if it had an overvoltage of $\frac{100}{0.866} - 100 = 15$ per cent. Such a reconnection should not be attempted if the throw of the coils is exactly or nearly full pitch for the high speed. The reason for this will be explained in a future article.

The effect of chording the coils or making the throw less than full-pole pitch, as in Figs. 6 and 7, brings out the point that it is often possible in reconnecting a winding to raise the side of all the coils lying in the top of the slots, and to spring the coils one or two slots longer or shorter and thus help out materially on the operating conditions after the change is made. For example, in Fig. 7, if the coils are raised and wound in slots 1 and 6 instead of 1 and 7, the new chord factor would be sine one-half of $\frac{5}{4.5} \times 180$ deg. = 200 deg., or 0.98 instead of 0.866. The winding connected, as shown in Fig. 7, would then operate as if on 102 per cent. of normal voltage instead of 115 per cent., which would have cut down the iron losses and improved the power factor.

In the next article a graphical explanation will be given of the effect of chord factor and reconnecting for a different number of poles. This will be shown by plotting the shape of the magnetic field set up by a three-phase winding connected for different numbers of poles and whose coils have different pitches. It will show the magnetic conditions inside the motor which give rise to the practical results discussed in this article. As is the case throughout this series no attempt is made to give actual diagrams for all possible changes of poles, but an effort is made to make plain what is physically happening inside the motor in such a way that the practical man may judge for himself the possibility and advisability of any suggested change in connections.

Coal-Pit-Mouth Electric Generation

A burning question of these fuel-short and freight-congested times is the feasibility of burning low-grade fuel at coal mines and delivering electric current to remote markets, instead of transporting the coal to plants near the market for current. As practiced now, coal is loaded on cars needed for other freight, hauled by burning a considerable percentage of it in locomotives, also urgently needed for other service, manned by a labor-short craft, delivered to a city where smoke and dirt are "all sorts of objectionable" and where even the disposition of ashes is a serious problem. What absurdity! Those living in some future period will perhaps wonder what manner of men—engineers—lived in what we now call the "advanced age."

For a long time we have been using pipe lines hundreds of miles long, with relay pumping stations, to handle crude oil from the producing fields to the refineries. The oil men seem to have gone the electricians one better and put it over years in advance.

Protest Power Company Rule

It is becoming the practice of electric-light companies to compel new customers to pay the cost of service connections. According to the *Review*, of East Liverpool, Ohio, the Ohio River Power Co. has adopted such a rule, and the taxpayers and citizens have circulated a petition to be presented to the city council as a protest against this extra charge and to ask the council to use its power to have this ruling discontinued. The company specifies that any person desiring to use electrical currents made by the Ohio River Power Co. shall pay all cost in connection with their lines (this includes time and material) the same to become the property of the company. The petition goes on to state that it is a rule in all cities that the power company shall connect any residence or factory within a reasonable distance of their line free of charge.

The citizens of East Liverpool do not see why they should pay for the installation of connecting line work to their property and then have it become the property of the power company.

Unpreventable Losses in Coal Combustion Under Boilers

BY HAYLETT O'NEILL

Calculations show the relative magnitude of the various unavoidable losses in the combustion of coal under boilers. A number of charts to assist in making these calculations accompany the article.

IT NEVER is possible in the ordinary boiler furnace to transform the total heat units in the coal, as determined by the calorimeter, into equivalent heat of the steam. It is the purpose of this article to show the effect of these losses on the ultimate value of coal for steaming purposes. The necessary losses are due to the following causes:

1. To heating the theoretical quantity of air required for combustion from the outside-air temperature to the uptake-gas temperature.
2. To heating the combustible from the outside-air temperature to the temperature of the exit gases.
3. To evaporating and superheating the moisture in the coal from the outside-air temperature to the boiler temperature.
4. To evaporating and superheating the moisture formed by burning hydrogen at outside temperature to the temperature of the exit gases.
5. To heating the moisture in the theoretical amount of air required for combustion, from the outside temperature to the temperature of the exit gases.

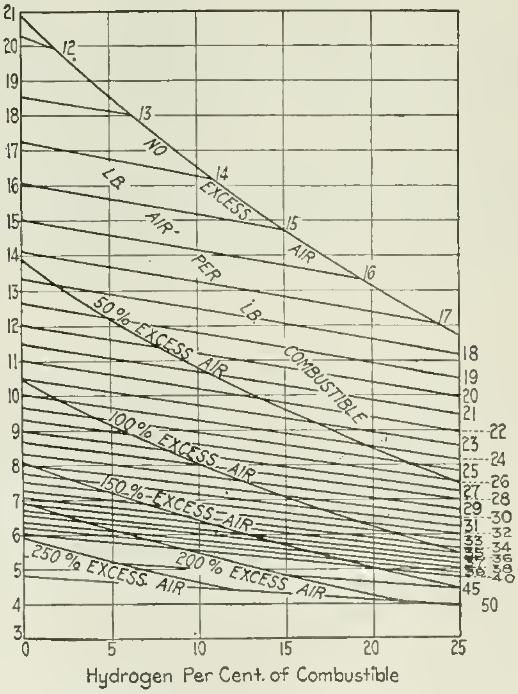


FIG. 1. RELATION BETWEEN HYDROGEN, EXCESS AIR AND CO$_2$

In addition there are other losses practically necessary and due to the following causes:

6. To sensible heat in the refuse to the ashpit with a practical minimum percentage of combustible.
7. To unconsumed combustible in the ash with a practical minimum percentage of combustible.

The effect of climate is obvious, and there will be greater necessary losses in winter than in summer. For example, assume:

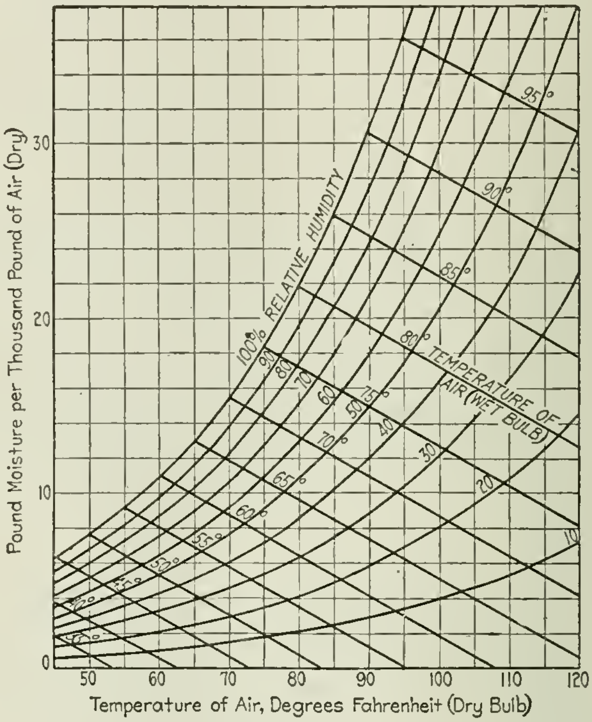


FIG. 2. RATIO OF MOISTURE TO DRY AIR FOR VARIOUS HUMIDITIES

1. Boiler pressure, lb. abs., 165.
2. Boiler-water temperature, deg. F., 366.
3. Outside-air temperature, deg. F., 70.
4. Relative humidity, per cent., 70.
5. Moisture in coal, per cent., 2.
6. Hydrogen in coal, per cent., 5.
7. Practical minimum combustible in ash, per cent., 25.
8. Temperature of ash, deg. F., 1800.
9. Ash in coal, per cent., 6.
10. B.t.u. (dry), per lb., 14,500.
11. Specific heat of refuse and coal, B.t.u., 0.2.
12. Mean specific heat of vapor in atmosphere, B.t.u., 0.46.
13. Dry coal = ash + hydrogen + carbon. This is approximately correct for high-grade Eastern coals—that is, neglecting the effect of sulphur, nitrogen and oxygen.
14. Specific heat of air, B.t.u., 0.2375.

Fig. 1 shows the relationship between percentage of CO$_2$, excess air, and hydrogen contained in the fuel, and the pounds of air per pound of combustible. For average good-grade coal the percentage of hydrogen is about 5. Referring to Fig. 1, with no excess air and 5 per cent. hydrogen, the pounds of air per pound of combustible equal 12.7.

The losses then are as follows:

1. Due to heating theoretical air required:

Air required per pound of coal, $(1 - 0.06)12.7 = 11.92$ lb.

Heat loss per pound of coal, $0.2375 \times 11.92 \times (366 - 70) = 839$ B.t.u.

2. Due to evaporating and superheating moisture in coal[1] (Values from Marks and Dans' Steam Tables):

H at 14.7 lb. abs. and 366 deg. F. = 1223 B.t.u.

h at 70 deg. F. = 38 B.t.u.

Heat loss, $0.02 \times (1223 - 38) = 24$ B.t.u.

3. Due to heating combustible:

Heat loss, $(1 - 0.06) \times 0.2 \times (366 - 70) = 56$ B.t.u.

4. Due to evaporating and superheating moisture formed by burning hydrogen:

Atomic weight of $H = 1$, atomic weight of $O = 16$.

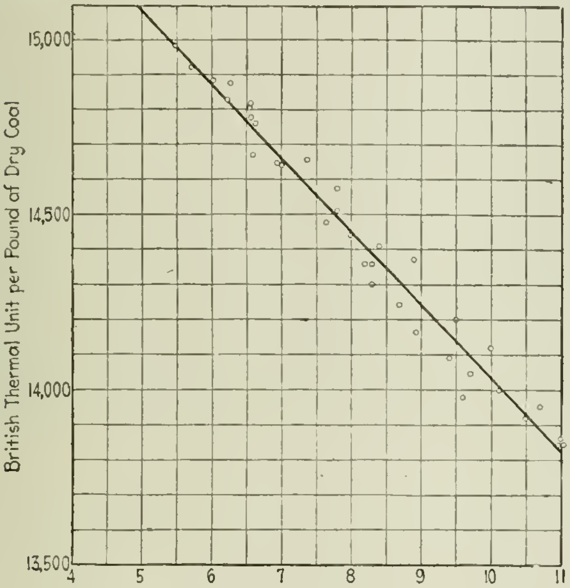


FIG. 3. RELATION BETWEEN ASH AND HEAT VALUE

Pounds of vapor per pound of hydrogen, $\frac{2 + 16}{2} = 9$.

Heat loss, $9 \times 0.05 \times (1223 - 38) = 533$ B.t.u.

Fig. 2 shows the ratio of moisture to dry air for various relative humidities at different air temperatures, as determined by the ordinary dry-bulb thermometer. With 70 deg. F. air temperature and 70 per cent. relative humidity, the moisture per pound of dry air equals 0.0108 pound

5. Due to heating moisture in air:

Heat loss $= 0.0108 \times 11.92 \times 0.46 \times (366 - 70) = 17$ B.t.u.

Total heat loss $= 839 + 24 + 56 + 533 + 17 = 1469$ B.t.u.

From this should be deducted loss due to heating the oxygen required for the combustion of the hydrogen that has been duplicated.

Pounds oxygen per pound of hydrogen, 8.

Heat loss, $0.05 \times 8 \times 0.2375 \times (366 - 70) = 29$ B.t.u.

Heat loss, net total, $1469 - 29 = 1440$ B.t.u.

Maximum possible efficiency $= \frac{14{,}500 - 1440}{14{,}500} = 90$ per cent.

6. Loss due to sensible heat in refuse:

$$\frac{0.06}{1 - 25} \times 0.2 \times (1800 - 70) = 28\ B.t.u.$$

7. Loss due to unconsumed combustible in refuse:

$$\frac{0.25(0.06)}{1 - 25} \times 14{,}610 = 292\ B.t.u.$$

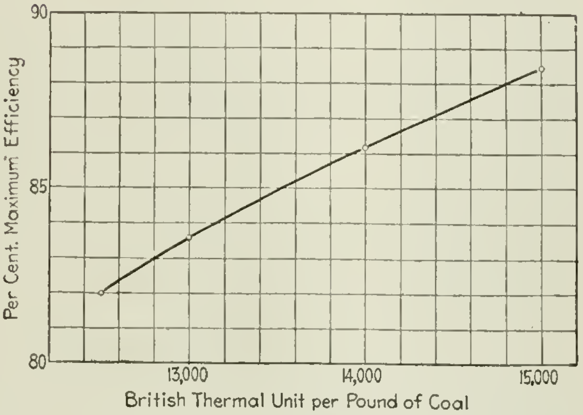


FIG. 4. THEORETICAL THERMAL EFFICIENCY WITH WEST VIRGINIA COAL

Total refuse losses = 320 B.t.u.

Total, all losses = 1763 B.t.u.

Practical ideal efficiency $= \frac{14{,}500 - 1763}{14{,}500} = 88$ per cent.

1. Heat loss on account of warming air:

$$\frac{12.7 \times 296 \times 0.2375(100\ per\ cent.\ ash)}{100}$$
$$= 8.94\ B.t.u.\ (100\ per\ cent.\ ash)$$

2. Heat loss on account of heating combustible:

$$\frac{0.2 \times 296 \times (100\ per\ cent.\ ash)}{100}$$
$$= 0.5920\ B.t.u.\ (100\ per\ cent.\ ash)$$

3. Heat loss on account of moisture in coal:

$$\frac{Per\ eent.\ moisture}{100} \times 1185 = 11.85 \times per\ cent.\ moisture;$$

assume this to be 1 per cent., or 12 B.t.u. constant.

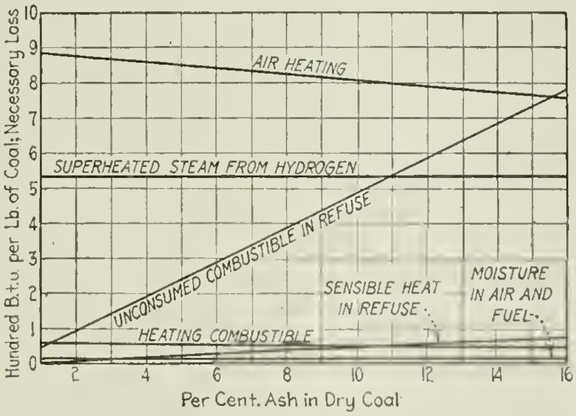


FIG. 5. SEPARATE AND TOTAL NECESSARY LOSSES

4. Heat loss on account of hydrogen = 533 B.t.u.; assume 5 per cent. H.

5. Heat loss on account of moisture in air = 17 B.t.u.; assume this to be constant.

6. Heat loss on account of sensible heat refuse:

$$\frac{Per\ cent.\ ash}{0.75} \times 0.2 \times 1730 = 4.62 \times per\ cent.\ ash;$$

assuming 25 per cent. combustible in refuse.

7. Heat loss on account of unconsumed combustible in refuse:

$$\frac{25}{75} \times \frac{\textit{per cent. ash}}{100} \times 14{,}610 = 48.7 \times \textit{per cent. ash};$$

assuming 25 per cent. combustible refuse.

Summing up all losses, we have:

Necessary losses in B.t.u. = 1486 + 43.8 × per cent. ash.

For good West Virginia coal, analyses taken from a bulletin of the United States Geological Survey show the following relationship between percentage of ash and heat content:

B.t.u. per pound dry is 16,130 — 210 × per cent. ash. This is shown graphically in Fig. 3.

$$\textit{Maximum efficiency} = \frac{\textit{B.t.u.} - (1486 + 43.8\,\textit{per cent. ash})}{\textit{B.t.u.}}$$

Substituting ash in terms of B.t.u.,

$$\textit{Maximum efficiency} = \frac{1.208\,\textit{B.t.u.} - 4832}{\textit{B.t.u.}}$$

This relationship is shown in Fig. 4.

Fig. 5 shows the separate and total necessary losses as calculated.

Cleaning a Condenser With Muriatic Acid

By D. C. McKeehan

The writer once took charge of a 500-kw. plant using a 1525-sq.ft. surface condenser containing 875 three-fourths-inch brass tubes. The plant had been in operation only about six months. Mine water containing a high percentage of scale-forming material was used for cooling, and the tubes were rapidly becoming "plugged." The scale was about as hard as gypsum, so that scraping or drilling was both costly and unsatisfactory. Few of the tubes were clear enough so that a light could be seen through them; only a ¼-in. rod could be pushed through quite a number, and dozens were closed completely. This was about the "limit" for condenser operation, particularly for apparatus in use for so short a time. The problem was to get the tubes clean or at least clean enough to maintain a "reasonably good" vacuum. At times a peak load would pull the vacuum from 19 or 20 in. (the best obtainable at light load) to zero and a clattering of the relief valve could be heard. However, zero vacuum was better than exhausting into the atmosphere, for it allowed the hot condensate to be returned to the boilers—when the pump did not balk; besides, the water was better than usual.

To clear the condenser of scale, it was completely filled with muriatic acid and water, about equal parts, acid being poured in about two quarts at a time, then two quarts of water. The cooling-water intake and discharge openings were of course sealed in order to retain the solution, and to prevent pressure suitable vents were provided for the escaping gas. Occasionally, a violent blowing would occur at the vents, due to the acid opening a tube that contained active material, also due to the increased surface acted upon. The solution was allowed to remain in the condenser until bubbling practically ceased, when it was drained into the circulating pump so that the unconsumed acid might remove the scale from it; and at times it was allowed to pass to the spray nozzles to clean them also. The operation usually required about eight hours, and the treatment was applied every month for about a year. Previous to the recent high price of acid the cost was not excessive, all things considered, and the method of procedure adopted was apparently the most economical available. Operating conditions have changed for the better in the last two years, the tubes requiring cleaning at intervals of two or three months only, as a purer cooling water is available and the pond is allowed to cool from 4 p.m. Saturday until 7 a.m. on the following Monday.

In four years we have removed about 400 tubes and given them individual treatment with acid in a trough, and some were set aside for the scale to air-slack. The percentage of tubes discarded owing to acid attacking the metal is negligible, probably not more than ten. Tubes with longitudinal splits, possibly due to expanding scale inside, number only eight. The corset-lacing packing at tube ends was badly eaten at the end of the first year.

The water-jacket space of the vacuum pump was also cleared of scale by the acid treatment. Then a peculiar turbine vibration suggested that scale or sediment had accumulated on the bottom of the rotor while standing idle. Examination was impossible except at the exhaust end, but these buckets showed a slight coating of dirt and scale. The turbine casing was half filled with a dilute solution of acid and the shaft then turned slowly with a bar. The usual boiling and bubbling sounds were heard inside and rank odors were emitted. When drained of acid and put into service, the turbine acted very well; a subsequent test showed better results, and there was no injurious action on the blading. Kerosene, previously tried, failed to clean the turbine rotor.

Suggestions on the Management of Boilers

By L. R. Hoffman

Assuming a properly installed and equipped plant, the attendant should be a sober, industrious man with enough intelligence to realize the responsibility of his position; he should be well paid and should give heed to the following:

Boilers should be kept free from scale, sludge and soot, inside and outside; frequency of cleaning depends on conditions, but they must be clean at any cost. At least one gage of water should be blown out of a boiler daily, and more as conditions demand. Pop valves should be lifted from their seats at least once a day, and they should be kept clean and free inside and out. Water columns should be blown out at least once a day, noting that the water returns quickly and does not stand dead still; the water should rise and fall gently in the glass at all times. Try-cocks should be blown at least once a day and kept free and clean.

If only one boiler is in use, two steam gages should show the pressure, and when they do not agree they should be inspected and adjusted at once. Sudden contraction and expansion of the metal of a boiler saps its strength. This should be avoided by keeping the feed water going into the boiler steadily, holding the water level near the same place when this is possible.

Government Control of Water Power and Electrical Distribution Abroad

By L. W. SCHMIDT

The writer gives an outline of what has been done in European countries to regulate the production and distribution of electrical energy. Indications seem to point in the direction of increased governmental control of electrical-power production and consumption.

THERE is today possibly no country in the world that has not attempted in one way or another to regulate the production and distribution of electrical power. As to the control of power production, a difference is made as a rule between power generated by steam and hydro-electric power. The reason for this is that while the former has to be regarded more or less as an industrial product, power generated by water is a natural product and therefore more or less the property of the nation as a whole. The systems that have been used for the control of power production and distribution differ very much in each country. Governmental control, where it exerts itself, may begin at the fountain of production, it may be confined to a regulation of the means of distribution, or, finally, it may attempt to control the price of power when sold to the consumer. There are examples of all kinds of regulations among the laws and administrative orders issued in one or another country of the world.

Early Laws Dealing With Electrical Power

The juridical conception of electrical power in the early days of electrical-power control was that of a merchandise produced by a manufacturer and sold to a consumer. Unfortunately for the law makers, this sort of merchandise embodied certain characteristics which necessitated a distribution and consumption different from that of other merchandise sold. The production and distribution of coal gas seemed to be the only precedent. Laws regulating the production and distribution of electrical power, therefore, were framed after the example of the laws dealing with the sale and production of coal gas. This explains some of the measures found in many of the earlier European laws dealing with the control of electric energy, which for a long time hindered the progress of the industry until they were removed by later legislation.

When governments finally came to formulate a policy as to their dealings with the new power, their first desiré was to protect the citizen against the real or imagined dangers connected with its application. The outcome of this generally has been laws dealing principally with the distribution of electrical power. They affect the right-of-way of electrical transmission lines and deal with such questions as protection of private property by falling wires, etc. With the progress made in overland transmission, many of these laws have been strengthened materially, especially as to their safety provisions, and they form today an essential part of the regulations controlling electrical-power distribution all over the world. With the coming of the public utility into the field of electrical enterprise, these laws have been used frequently in support of the public utility against the private electrical enterprise, and it is this side of their application that is of especial interest to the power industry.

This, for instance, is done by the French law of July 15, 1906, regulating electrical enterprise. This law, while providing for the right-of-way for electrical distribution, differentiates between the undertaking having the character of a public utility and such lacking this quality. Each kind of enterprise can obtain a local monopoly as to electric lighting, but only the public utility can claim the additional right of eminent domain. No monopoly is given to either with reference to the production and sale of power only. To prevent the private enterprise from enroaching upon the sales field and thus impeding the action of the public utility, an act has been passed which amends the law by giving a preferential right-of-way to the high-tension transmission lines of the public utilities and semipublic utilities against the ordinary commercial enterprise.

Switzerland Encourages Use of National Water Powers

The same tendency to favor special groups of enterprises is shown in Switzerland, where preferential right-of-way is given to the transmission lines of hydro-electric power stations with the object of encouraging the use of the national water powers for power generation. This Swiss law deals also with transmission lines in general.

Of late Prussia has made an entirely new use of its powers to regulate the transmission. Prussia formerly followed the principle of free development of electrical enterprise, reserving for the government only the right to control the conduct of high-tension transmission lines for which, to use the right-of-way, under the Prussian law, a special permission is needed. The result of this policy has been a rather irregular development of power distribution in Prussia, which often leaves out districts in the immediate neighborhood of the central stations in favor of others farther removed but promising a better financial return. In the absence of a special law Prussia has now decided to use its administrative powers to force the central stations to serve not only the districts where great profits can be obtained, but also those which are less promising but possibly not less deserving. The way selected for this purpose is surprisingly simple.

Right-of-Way for Prussian Transmission Lines

The usual procedure to obtain the right-of-way essential for the conduct of transmission lines is that of application to the provincial authorities. Since 1914 the Ministry of Public Works, which has the direct control of all matters of this description, has decreed that these applications can no longer be passed upon by the provincial presidents, but must be referred to the Minister of Public Works. All applications have to be accompanied by full explanations as to the intended extensions of the installation and the present activity of the central station. Permission for further extensions will be granted only if in line with the special policy followed by the Ministry of Public Works. The Ministry may make its permission dependent upon the condition that the central station, while making the extension, will also make extensions to districts needing supply.

The Netherlands, which has suffered from a similar development of its national electrical supply, has embodied into its new law for the control of electrical enterprise a paragraph reserving to the Crown the right to stipulate the extension or the limits of the distribution field of any licensed electric undertaking. This is done to prevent discrimination in favor or to the disadvantage of certain parts of the country or certain groups of likely subscribers. The law also gives to the government the right to decree the date at which all the districts comprised in the license must be fully connected.

Generally speaking, it appears that the regulation of electrical enterprise by simply exerting control over the distribution of power has not been accompanied by very satisfactory results from the national point of view. The governments realized, in fact, very early the great advantages which industry and public life were destined to derive from the new power. A change took place in the form of governmental control. While all the earlier laws rather inclined toward restricting the use of electricity, parliaments now began to enact measures with a view to aid its expansion. Laws were made giving electrical enterprises certain privileges similar to those enjoyed by railroads and other enterprises of that kind. A series of public-utility laws were made which placed the electrical-power industry in a special, favored position in comparison with other national industries. At the same time a tendency was shown to protect public electric undertakings against destructive competition. Laws, therefore, were passed regulating electrical concessions. Most of the big electrical enterprises having the municipal or public-utility character of today were created during the last twenty years of the past century.

ENGLAND TOOK LEAD IN ELECTRICAL POWER LEGISLATION

The lead in this kind of legislation doubtless was taken by England, which promulgated her first law regulating the generation and distribution of electrical energy during the year 1882. This law gave the control of electrical enterprise in England into the hands of the Board of Trade, which was and still is empowered to issue licenses to municipalities, companies and individuals wishing to operate electrical undertakings. Today the license is granted as a rule after consulting the local authorities, but the board can act without such consultation. According to the law of 1882 the authorities of the locality served had the right to acquire the enterprise after a period of 21 years at 10 per cent. of its value. As it was found that the shortness of this period tended to discourage private enterprise, it was extended to 42 years by the Act of 1888. The Board of Trade exerts considerable powers of control over all electrical undertakings in England, of which the most prominent is the right to review rates. Under a special act of Parliament of 1909 central stations in Great Britain have the right of eminent domain for the conduct of transmission lines and other purposes.

This law of 1882 is doubtless the fundamental law dealing with electrical enterprise today in the whole world. It was the first law that attempted to deal with the production and distribution of electrical power on the basis of a progressive national policy, and it has been copied later in part or in whole not only by most of the British colonies, but practically by all countries of the world. Its licensing provisions are recognized today to be an essential part of all legislation endeavoring to produce the best application of electrical power for the good of all, and there is hardly an agreement made between a public body and a private enterprise for the operation of a public utility in which there is not embodied the right of the licensor to acquire the property from the licensee after the expiration of a certain period with or without compensation to the licensee. As to the right of reviewing rates this is today recognized everywhere.

BRITISH BOARD OF TRADE FAVORS MUNICIPAL ENTERPRISE

While there is nothing in the English law compelling the Board of Trade to follow a certain policy in the issue of licenses to electrical enterprises, it appears from the actions of the board that it has been rather inclined to favor the municipal enterprise. Competition has been allowed to grow in the operating fields of private enterprise, but the municipal enterprise as a rule has been protected against the encroachment of private stations. But allowing even for this preference shown to the public undertaking, it appears that in principle at least the right of free competition has been upheld in England. This right seems to have found its widest application in the policy followed by Italy in dealing with electrical undertakings. In that country electrical enterprises have to obtain a license before beginning operation. This license, however, is obtained apparently without much difficulty, and the result is that there is hardly a city of any size where there are not two or even more electrical stations competing for business.

While competition, therefore, seems to have been held essential to rapid electrical-power development during the last twenty years, it seems that this policy is slowly changing in favor of consolidation of power production with a view to securing a cheaper and more even supply of power over the whole country.

This development has been favored by two considerations. The first has been the increasing use made of the water powers for electric-power generation and the necessity of passing laws for that purpose; the second, the growing demand by industrial and other consumers for the supply of power.

Before considering this last and most recent phase in the development of national power control, the following few examples of legislation dealing with the use of natural water powers in Europe may be given. The Norwegian law recognizes the right of the nation to regulate the use of the water powers of the country, but makes certain exceptions as to such uses of water as do not encroach on the public interest, do not increase or decrease the sea level of inland waters or produce powers above 368 kw. Application for the use of water power can be acted upon by the king provided the withdrawal of water does not exceed 7360 kw. If it is contemplated to use more power, permission can be obtained only by special act of the Storthing. The law does not exclude foreigners from the use of the water powers, but prescribes that concessions given to foreign enterprises as a rule shall not run for longer than sixty years. The Storthing is empowered to extend the duration for another ten years. In every case the nation reserves the right to acquire the property of the licensee after forty years of operation. No payment need be made in such a case where the acquisition takes place after fifty years of operation. The use of water power is dependent upon the payment of a license fee.

The French Water-Power Law

Very similar to the Norwegian water-power law is that of France. This law demands in the case of developments of less than 200 kw. a simple governmental authorization which is issued, as a rule, without much trouble to the applicant. Developments of 200 to 5000 kw. require a special governmental decree, while higher developments can be carried out only under a special law. The maximum duration of an authorization is 75 years, but the concession may be extended for another ten years if no new concession has been granted five years before the expiration of the original grant. The government reserves the right of expropriation after a period of fifteen years' duration of the grant if such action is in the public interest.

Similar action for the protection of the natural power resources has been taken by most of the South American governments. The water-power law of New Zealand represents today the final stage in this development reached so far by reserving the right of all hydro-electric development to the nation. The Dominion is now developing the most promising power sites under national management.

So far Europe does not seem to be ready to go all the way in the direction of public ownership of national power production. Nevertheless, it becomes now increasingly clear that future legislation in Europe destined to deal with the problem of power production and distribution will be vastly different from the policies followed before the war. It is generally held in Europe that electrical-power production has passed the stage of the public utility and reached that of national utility.

Prussian Government Adopts New Policy

The Prussian government only recently struck out for a new policy in hydro-electric power development by which it enters into direct competition with the existing private and municipal generating stations with the avowed intention finally to take control of the whole power generation in Prussia. So far the scheme provides for a system of interconnected hydro-electric and steam power stations owned by the Prussian government which will cover all of western Prussia from Bremen to the Main. The interesting feature of this scheme is that the different stations have been selected in such a way as to supplement one another. If, as it is expected, the station on the Main should suffer in effectiveness during the months of February and March, its losses can be equalized with the help of the two stations at the Elderthal and the Diementhal reservoir, where sufficient power will be obtainable for this purpose. Another hydro-electric station, according to press reports, is located at Dorverden. This, like the others forementioned, will be connected with the steam-power plant near Hanover, where the great peat coal beds of the neighborhood can be employed as a cheap fuel.

This Prussian system of power supply is continued in the south by a similar development in Bavaria. The center of the Bavarian scheme is the powerful government central station on the Walchensee. For the purpose of this enterprise it is proposed to combine all the power stations existing at present in Bavaria, the new combination to be conducted under governmental control. The Walchensee development will be connected with the most powerful of the other stations, and these together will be the principal sources of electrical power in the kingdom, while the small stations will continue to act merely as distribution stations for the central system. It is expected that such an organization would save approximately 20 per cent. on the present operation expenses, or about $1,000,000 a year.

France also will make a better use of its natural power resources after the war. It appears that so far no special legislation has been passed for this purpose, but a commission has been appointed to inquire into the existing hydro-electric possibilities of the country with a view to early exploitation.

England Adopts the Most Extensive Scheme

The most extensive scheme for national power control so far developed, however, has been put forward in England. The industrial reorientation in England forced by the war has provided for the opportunity also to reorganize the whole system of power supply in that country. According to the present scheme, which was worked out by a combined committee of the Municipal Electrical Association and the Incorporated Association of Electrical Power Companies, it is contemplated to divide England and Scotland into sixteen supply areas. These areas will not be formed by political divisions, but their boundaries will be defined rather by technical considerations so that the best results may be obtained in the distribution of power. In each area the production of power will be concentrated in such a way as to allow the closing down of all the generation stations that are not absolutely essential. The remaining stations will be interconnected to obtain a better equalization of the load over the operating district. It is thought that it may be possible to use most of the existing large power houses. Should additions be necessary, it is proposed that new power houses be erected in neighborhoods where special facilities are offered for their operation.

While all power experts in England seem to agree that the concentration of power generation in the form prescribed by the report finally will be the most satisfactory solution of England's power problems, public opinion is not as unanimous about the recommendation of the committee to exert the same control on power distribution. Most probably this will be left in the hands of the existing enterprises. Estimates seem to show that by reorganizing in this way the production of electric power, it will be possible for England to effect a saving of approximately 50 per cent. in the cost of electricity to the consumer. All in all about six hundred central stations would be affected by the scheme. The control of the enterprise will be in the hands of a national board of control.

As the existing powers of the Board of Trade will not be sufficient to carry into effect so vast a scheme of electrical organization, it will be necessary to obtain special powers by act of parliament, and the whole enterprise, therefore, will be discussed fully before being actually put into operation.

In Europe the war has been the principal cause of the reforms now contemplated. It is, however, certain that even if the war had not come, steps very soon would have to be taken for a reorganization of the legislation governing electrical-power production and development. The great progress made in the electrometallurgical and the electrochemical industries has widened the application of electrical power in such a way as to necessitate the employment of power which could not be foreseen originally by power experts and law makers. The war now has prepared a fertile ground for a new settlement of the whole question of power control. What will be the solution of the problems raised is still not quite clear. In Europe all indications seem to point in the direction of increased national control of electrical power in all its stages from production to consumption.

Boiler-Room Gage and Control Board

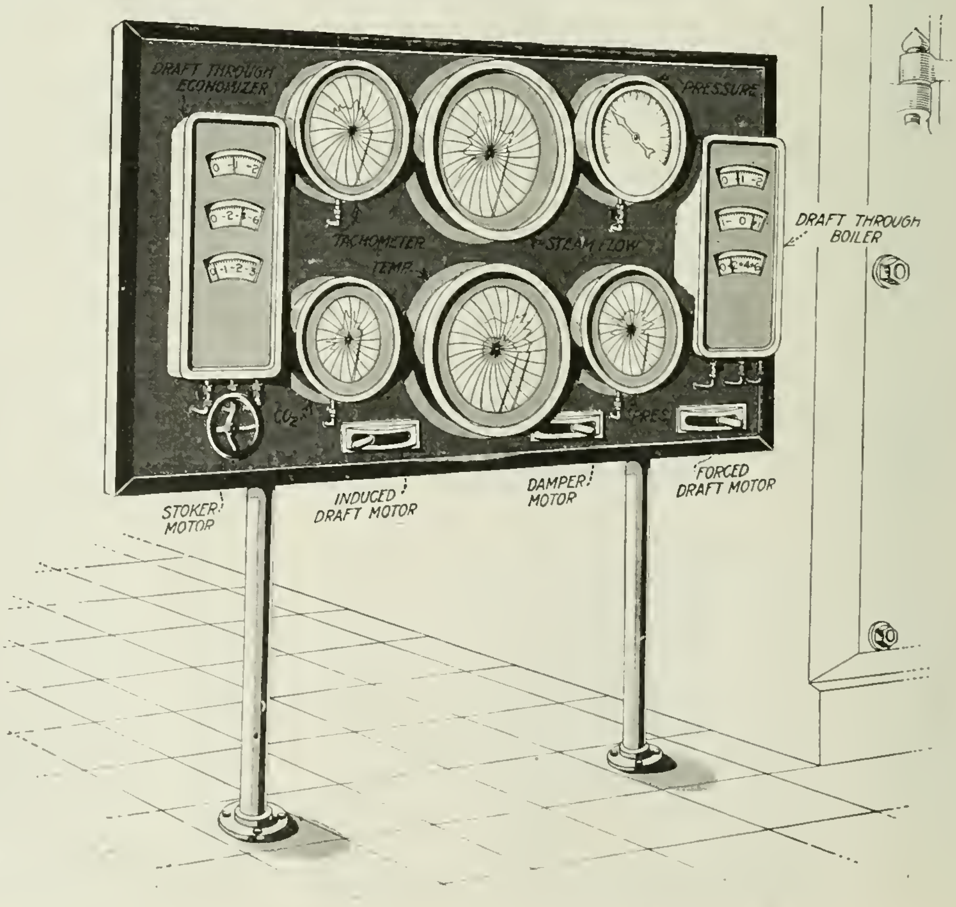
Centralization is the basis of economy in any branch of industry. A machinist would make but little progress in turning out his allotment of work if he were obliged to go from one side of the shop to the other each time he required a tool. In the power plant a fireman will be able to obtain better results from his boilers if the various gages, draft-fan control and other necessary operating devices are placed convenient for observation and manipulation instead of being scattered about the boiler room wherever it is most convenient to place them.

The idea of centralization has been adopted by the Precision Instrument Co., Detroit, Mich., in the design of a boiler-room gage and control board illustrated herewith. The recording gages include a tachometer for recording the speed of the stoker and a steam-flow meter for recording the steam flow in the main steam header leading to the power unit; there is also an indicating steam gage. These are arranged at the upper portion of the board; at the lower end there is a CO_2 recorder for furnace gases, a double-pen recording gage for furnace- and chimney-gas temperatures and a recording steam-pressure gage. At the right-hand end of the board there is a three-in-one draft gage that indicates the standard readings of the furnace draft which has a register of from zero to 2 in. of water for the flue; 1 in. vacuum to 1 in. pressure for the combustion chamber and from zero to 6 in. for the ashpit. These readings are shown on the boiler-draft gage beginning at the top of the instrument and reading downward.

At the left of the gage board is another three-in-one draft gage for indicating the draft through the economizer. The top gage is connected to indicate the draft in inches at the chimney, the center one shows the draft through the economizer, and the bottom one the draft at the entrance to the economizer when one is used.

Centralization of the motor control is also taken care of as shown by the handwheel and the switches at the bottom of the gage board. The handwheel at the left controls the rheostat of the motor that operates the stokers. Next to it is a switch for starting and stopping the induced-draft fan motor; the center switch is to control the motor used for opening and closing the main damper in the smoke flue, and the last switch is for controlling the motor that drives the forced-draft fan.

This gage board is supported on standards, and it can be placed at any point in the boiler room where the operator can conveniently get at it for operating the various controls and for reading the various instruments.



GAGE AND CONTROL BOARD FOR THE BOILER ROOM

The Electrical Study Course—Shunt-Connected Generators

Explains how an electrical generator builds up its voltage from the small pressure that is generated due to the residual magnetism in the polepieces. The relation that must exist between the field coil and armature connection for the machine to generate normal voltage is also pointed out.

IN THE previous lesson we considered that the field coils of the generator were excited from an outside source; that is, as in Fig. 1, the field coils are assumed to be connected to some source of electric current, for exciting them, separate from the armature. In alternating-current generators the field coils are always excited from a separate source of direct current, but in direct-current generators the field coils are in almost all cases excited directly from the armature. There are two ways of doing this, one by connecting the field coils directly across the brushes—that is, the field winding is in parallel with the armature, as in Fig. 3—and another by connecting the field coils in series with the armature, as in Fig. 4.

When the field coils and armature are connected in parallel, as in Fig. 3, the machine is known as a shunt-connected generator; when the field coils and armature of a generator are connected in series, as in Fig. 4, it is known as a series machine. The shunt-type machine, or modifications of it, which will be considered later, is the type that is generally used, the straight series type being seldom used and then in only special cases. To simplify the connection in Fig. 3 and subsequent figures, the commutator will be shown on the outside of the winding and the yoke will be dispensed with.

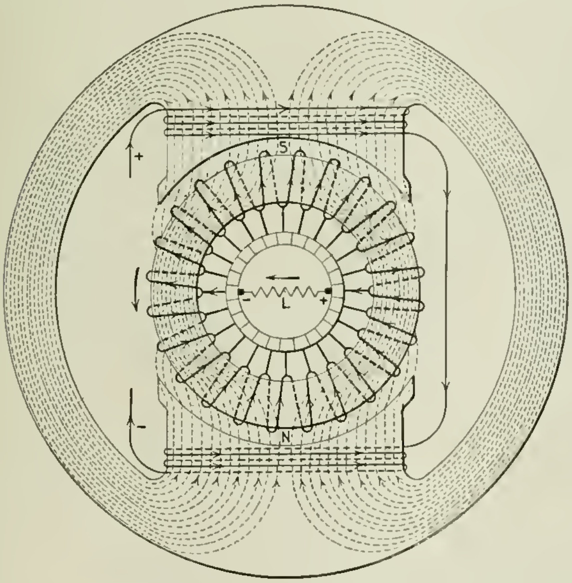


FIG. 1. SEPARATE-EXCITED SHUNT GENERATOR

With the machine that excites its own field coils, the first question that arises is, How does the machine start to generate? If the machine was new and never had been in service before, it would not generate until an electric current had been caused to flow through the field coils to magnetize the polepieces. When the field poles have been magnetized, they will retain a small percentage of the magnetism after the current has ceased to flow through the field coils. This generally amounts to about 5 per cent. of the normal field magnetism. The magnetic flux which remains in the field poles after the current has ceased to flow in the coils is called the residual magnetism. This residual magnetism is sufficient in a 110-volt machine to cause about 5 or 6 volts to be generated in the armature when running at normal speed and with the field coils disconnected from the armature, as in Fig. 5; in a 220-volt machine, approximately 10 or 12 volts will be generated due to the residual magnetism.

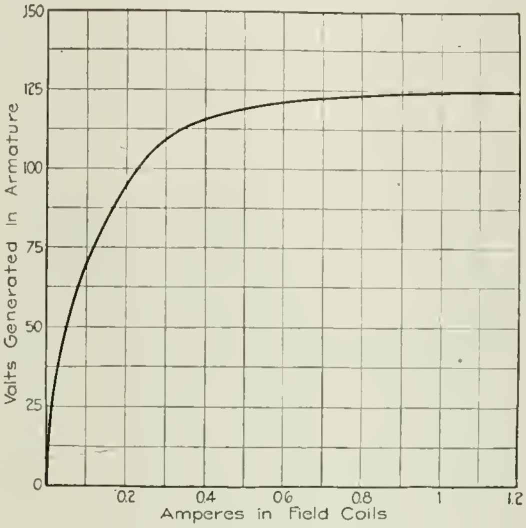


FIG. 2. DIRECT-CURRENT GENERATOR VOLTAGE CURVE

If the field coils are connected across the armature, as in Fig. 3, and the latter revolves in the direction of the curved arrow, a small voltage will be, as pointed out in the foregoing, generated in the armature windings. This small voltage, say 5 volts, will cause a small current to flow through the field windings; if in the proper direction, it will cause the field strength to be increased above that of the residual magnetism.

In Fig. 3 the polarity of the residual magnetism is denoted by *N* and *S*, which will, for the direction that the armature is turning in, cause the right-hand brush to have positive and the left-hand brush negative polarity. This in turn will cause a current to flow through the field coils in the direction indicated by the arrowheads. By applying the rule for the polarity of a coil of wire with an electric current flowing through it, it will be found that the field coils will have a polarity as indicated by *N'* and *S'*, which will be seen to be the same as the residual magnetism in the polepieces. Consequently the current flowing in the field coils will assist in magnetizing the polepieces, and the small current set up in the field coils by the 5 volts, which we assumed was generated due to the residual magnetism in the polepieces, will increase the field strength; that is, there will be a greater number of lines of force entering and leaving the armature. The armature will therefore be cutting a greater number of magnetic lines, hence causing the voltage to increase, which in turn will cause the field current to increase, thus bringing about another increase in the field flux and also the voltage in the armature. This process continues until the machine is generating full voltage.

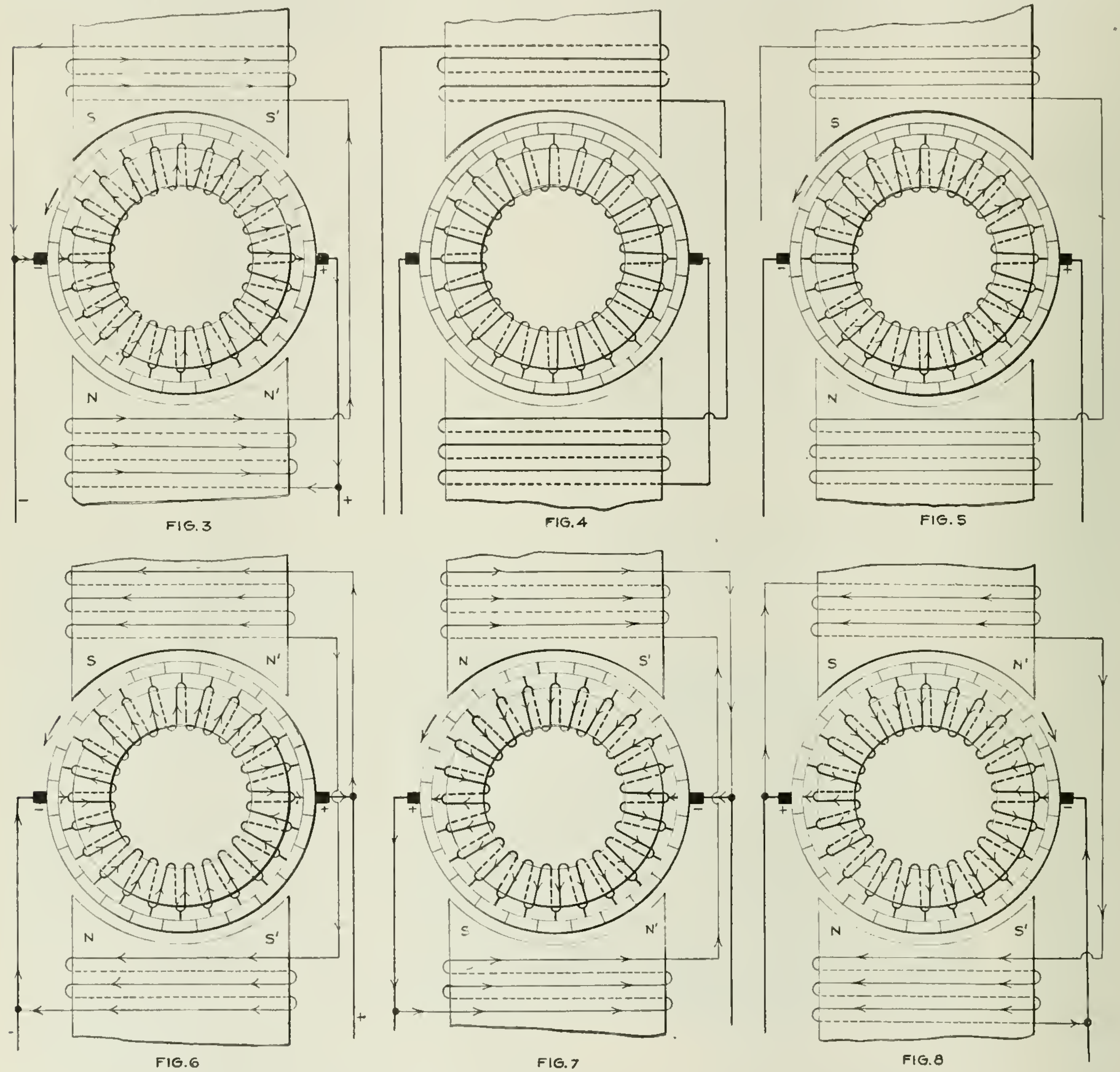


FIG. 3 FIG. 4 FIG. 5

FIG. 6 FIG. 7 FIG. 8

FIGS. 3 TO 8. DIAGRAMS OF SHUNT-CONNECTED AND SERIES-CONNECTED GENERATORS

The next question that naturally arises is why this process does not keep on indefinitely and the voltage continue to increase in value. The answer to this is found in the fact that the lines of force in the field poles do not increase in proportion to the current flowing through the coils.

If we were to take a generator with the iron in the magnetic circuit absolutely dead, that is, no residual magnetism in it, and connect a voltmeter across the armature terminal and drive the machine at normal speed, it would be found that the voltmeter would give no reading, indicating that no voltage was being generated. However, if the field coils are connected to a separate source of voltage and a small current caused to flow through the field coils, say 0.2 ampere, we would find that the generator would produce an electromotive force of, say 90 volts. Then if we were to increase the current to 0.4 ampere, it would be found that the voltage may not increase as much for the second 0.2 ampere as it did for the first. This, however, will depend somewhat upon the normal voltage of the machine. In this case assume the normal voltage to be 110 and that when 0.4 ampere was flowing in the field coils, the machine generates 115 volts.

The foregoing is indicated on the curve Fig. 2. Here it is shown that if the field current is increased to 0.6 ampere, the volts will only increase to about 120, and beyond this point if the current is increased to 1.2 amperes, the voltage only increases to 124. For the first 0.6 ampere supplied to the field coils the voltage increases from 0 to 120, but for the next 0.6 ampere the e.m.f. only increases from 120 to 124, or an increase of 4 volts. The foregoing indicates that the lines of force in the polepieces increase rapidly at first, but as the current in the field coils increases, a condition is reached beyond which increasing the current in the latter will not cause any increase in the lines of force. This condition is called the point of saturation; that is, the iron is saturated with magnetic flux, just the same as a sponge becomes saturated with water.

A fixed relation exists between the connection of the field winding to the armature and the direction of rotation. It has already been shown that the field-coil connections to the armature in Fig. 3 are such that the current flows through them from the armature, in a direction to make the field coils the same polarity as the residual magnetism in the polepieces, thus causing the machine to build up to normal voltage. However, suppose we interchange the field-coil connections as in Fig. 6. In this case the polarity of the field coils, as indicated by *N′* and *S′* is opposite to that of the residual magnetism, indicated by *N* and *S*. Consequently, instead of the small current caused to flow in the field coils by the voltage generated due to the residual flux, increasing the field strength, it has the opposite effect and the machine cannot build up its voltage.

At first thought it may appear that if the polarity of the residual magnetism is reversed, the machine connected as in Fig. 6 could build up. Considering Fig. 7 will show that this is not true. Since the residual magnetism is reversed, as indicated by *N* and *S*, the voltage generator in the armature is reversed; consequently, the current in the field coils is also reversed, as indicated by the arrowheads. This again brings the polarity of the field coil, as shown by *N′* and *S′*, opposite to that of the residual flux, and the machine cannot build up. Therefore it is evident that for the direction of rotation shown there is only one way that the field coil can be connected to the armature and have the machine generate, and that is as in Fig. 3.

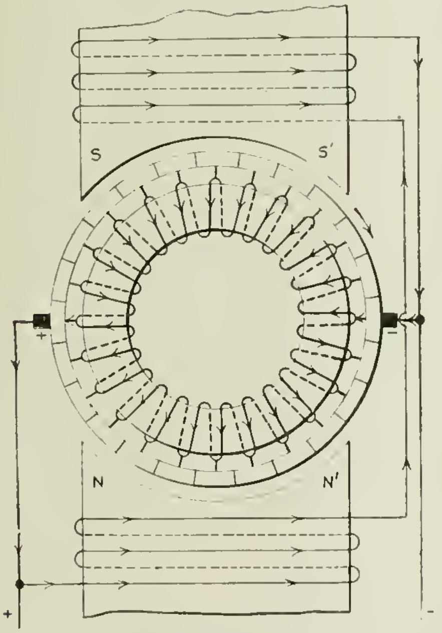


FIG. 9. SHUNT-CONNECTED GENERATOR. SAME AS FIG. 8 WITH FIELD CONNECTIONS INTERCHANGED

If the armature's direction of rotation is reversed, as in Fig. 8, then the field-coil connections to the armature have to be reversed before the machine can build up. Assume the same polarity for the residual magnetism as in Fig. 3; then, since the direction of rotation is reversed in Fig. 8, the voltage generated in the armature winding will be reversed, as indicated by the arrowheads. This voltage will cause a small current to flow through the field coils in a direction as shown, which gives the coils a polarity *N′* and *S′* which is opposite to that of the residual flux, and the generator cannot build up to normal voltage.

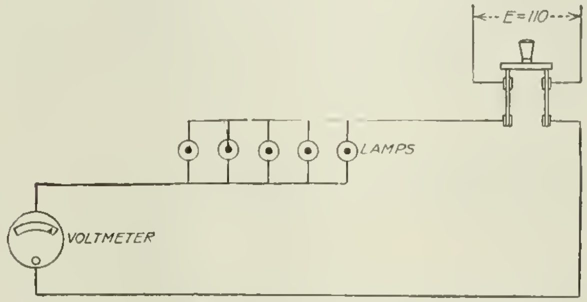


FIG. 10. DIAGRAM OF LAMP BANK CONNECTED IN SERIES WITH A VOLTMETER

To produce a condition where the machine can build up its voltage, it will be necessary to interchange the field connection to the armature terminals, as in Fig. 9. This allows the small voltage due to the residual magnetism to set up in the field coils a current that will give them the same polarity as the residual flux, as shown, and the machine will build up to normal voltage.

The foregoing is an important point to remember when putting into service a new machine or one that has been repaired. After the field poles have been excited by sending a current through the field coils from an outside source, to establish the residual magnetism, if the machine does not build up, then the shunt-field coil connection should be reversed.

One way of knowing when the field coils are connected in the right relation to the armature is as follows: First bring the machine up to normal speed with the field coils disconnected from the armature and note the voltage generated, which should, as pointed out in the foregoing, be about 5 or 6 for a 110-volt machine, 10 or 12 for a 220-volt machine, etc. After doing this connect the field coils to the armature, and if the voltage due to the residual magnetism decreases, the field-coil connections must be reversed for the machine to come up to normal voltage. Further consideration will be given the shunt generator, also the series generator, in the next lesson.

Fig. 1 is similar to the problem given in the last lesson. The two circuits through the armature from the negative brush around to the positive are in parallel, and each path was assumed to have 0.5 ohm resistance. Therefore, the resistance of the armature winding between brushes is one-half that of one path, or $0.5 \div 2 = 0.25$ ohm. The external resistance was assumed to be 4.75 ohms; then the total resistance of the armature and external circuit is $R = 0.25 + 4.75 = 5$ ohms.

When the armature is generated a voltage $E = 150$, the current flowing in the circuit is $I = \frac{E}{R} = \frac{150}{5} = 30$ amperes. This current will divide at the negative brush and one-half will flow through each of the two circuits in the armature winding. Consequently, each half of the armature winding will supply 15 amperes to the external circuit. The volts drop in the armature equals the joint resistance of the winding times the total current, or $0.25 \times 30 = 7.5$ volts. The volts drop also equals the resistance of one path through the armature winding times the current flowing in this path, or in this case $0.5 \times 15 = 7.5$ volts. If 7.5 volts is used up in the armature to cause the current to flow through the winding, then only $Ea = 150 - 7.5 = 142.5$ volts is available at the brushes. The current that Ea will cause to flow through the external circuit the resistance of which is $R' = 4.75$ ohms, is $I = \frac{E_a}{R'} = \frac{142.5}{4.75} = 30$ amperes, which checks up with the values obtained in the foregoing.

The value of one of two resistances connected in parallel is 6 ohms; the joint resistance of the two is 3.75 ohms and the resistance of the voltmeter is 10,956 ohms.

In Fig. 10 if the resistance of each lamp is 220 ohms and the resistance of the voltmeter is 10,956 ohms, what will the reading of the voltmeter be? Also will the lamps light, and if not, why not?

Coal Conservation Without Shutdown of Isolated Plants

THE continuation of the hearing before the Public Service Commission for the First District of New York on Mar. 18 was rendered unusually interesting by the testimony of C. T. Coley, who appeared for the New York Building Managers' Association. Mr. Coley, who is operating manager of the Equitable Building, proposed a plan whereby the isolated plant for combined lighting and heating could be operated in conjunction with the public-utility plant with a maximum of benefit to the community. The plan involved three suggestions, the common object of which was to save coal without detracting from the value of the various kinds of service.

According to Mr. Coley's argument, the seasons of the year may be divided into three groups, the first group being the winter months of December, January and February, the second group being the six months comprising spring and fall, and the third group being the summer months of June, July and August. A few buildings containing isolated plants produce insufficient exhaust steam from the manufacture of power or electric energy to heat themselves during the three winter months, and it is necessary to draw further on the coal pile by generating live steam, which is turned into the heating system so as to maintain the desired temperature. This is especially true of mornings, nights, Sundays and holidays. The remedy for this condition is to increase the electric production to a point at which enough exhaust steam will be produced to meet the heating requirements and to find a suitable outlet for the excess current generated.

Obviously, the extra energy produced must be used in such places as to save coal or to remove the necessity of burning coal. Two methods of accomplishing this result are suggested. First, to obtain permission to supply other buildings in the neighborhood—across the street, if necessary—with electricity, thus reducing their demands for energy on the Edison company's mains at such times; and second, to run separate units on independent busbars in the isolated plant and synchronize with the 240-volt direct-current mains, pumping electrical energy from the isolated plant out on the Edison company's mains and using the additional exhaust steam thus produced to make up the deficit for heating in the coldest weather.

To illustrate the amount of coal needed for live-steam generation for heating, in addition to the exhaust steam used, Mr. Coley submitted the following statistics of coal consumption in the case of the Equitable Building:

Month	Coal, in Lb.	Kw.-Hr.	Coal per Kw.-Hr.	
June, 1917	2,940,490	456,896	6.49 Aver.	6.43
July	2,982,080	496,034		6.01
August	2,928,690	461,329		6.34
September	2,913,120	416,866		6.98
October	3,201,030	475,962		6 72
November	3,205,150	411,562		7.78
December	3,826,190	405,129	9.09 Aver.	9.44
January, 1918	3,255,700	358,678		9.07
February	2,634,500	300,401		8.76

The second column shows the total coal used per month; the third column shows the electrical output; and the last column shows the pounds of coal used per kilowatt-hour for all services. During the first five months shown, the average coal used per kilowatt-hour was 6.49 lb., which was about the normal summer rate. During the three winter months an average of 9.09 lb. of coal was used per kilowatt-hour for all purposes. The increase, 2.60 lb. per kilowatt-hour, is due to heating requirements.

The electrical output during the three winter months was 1,064,208 kw.-hr. Then, $(1,064,208 \times 2.6) \div 2000 = 1383$ tons of coal, which was burned in excess of that required to produce the electrical energy so as to furnish live steam to help out in heating the building.

If this 1383 tons of coal had been used to generate electrical energy, and the exhaust had then been used for heating, it would have been possible to supply to the Edison company's 240-volt mains 553,200 kw.-hr. during the three winter months, assuming 5 lb. of coal per kilowatt-hour. Thus, the coal saved to the community as a whole would be the amount required at the Edison plant to produce that 553,200 kw.-hr. As a central station can produce a kilowatt-hour on 2 lb. of coal, or two-fifths of the quantity used in the isolated-plant calculation, the net saving of coal would amount to two-fifths of 1383 tons, or 553 tons.

The second suggestion for coal saving made by Mr. Coley was that during the months of March, April, May, September, October and November the isolated plant should be allowed to supply electric energy, and particularly exhaust steam, to its neighbors, whether over the street or under it. During these months some exhaust steam is used for heating, but at the same time great quantities are wasted into the atmosphere, while buildings close by are buying steam for heating or are producing it in their own heating boilers, merely because of lack of permission to run mains under or over streets. Much coal could be saved to a community if it were permissible to supply exhaust steam from engines to buildings across street and such permission should be granted as a war-emergency measure, if not permanently.

The third suggestion was that the Edison company should make a low-rate schedule to apply during the summer months of June, July and August, and maybe include May and September also, to enable isolated plants to shut down for this period and thereby save an amount of coal equal to the difference between what they would burn and what the Edison company would burn to furnish the electrical energy they needed.

Holding Plant Labor in Nonheating Season

It was pointed out by Mr. Coley that although isolated plants could be shut down during the nonheating period, it would not be feasible to discharge the operating forces; for if that were done, the men thus thrown out of positions would turn to other forms of labor, and there would be great difficulty, if not an actual impossibility, of getting trained men to put the plants into operation again at the beginning of the heating period. The men would have to be retained throughout the summer, and their services could be utilized in making overhauls and repairs to the plant equipment. On this account, any rate for that period made by the Edison company would have to be considered from the coal pile in order to be economic and would have to take into consideration the retaining of the plant operatives.

The impossibility of saving coal by substituting central-station current for that generated in an isolated plant having use for exhaust steam was further emphasized by the testimony of H. Goldstein, who operates two manufacturing buildings in which steam is required from 9:30 a.m. to 6 p.m. The steam is used for power, lighting, heating and various manufacturing processes. According to this witness, the cost of operating one of the buildings by purchasing Edison company current and generating live steam in his own plant amounted to $1000 a month. Later, he installed an engine and generator of sufficient capacity to furnish electric current to the tenants of both buildings, and discontinued the use of Edison company service, with the result that at present he is supplying current and steam to both buildings at a monthly expense of only $700.

Robert E. Dowling presented the cases of the Adams Express Co. building at 61 Broadway and the City Investment Building, in each of which is an isolated plant for furnishing light and heat. Neither building has any electrical connection with the Edison company. The average coal consumption in each building is in the neighborhood of 35 or 36 tons per day, the exhaust steam from the engines being ample to furnish heat for the buildings. If current were obtained from the street service during the warm weather, much of this coal would be saved; but during the seven months in which heating is required, the cost of running the plants to furnish heat would be equal to the present cost for combined current and heating, since all the exhaust is available for heating purposes.

Arthur F. Rice, representing the Coal Merchants' Association, deprecated the shutting down of isolated plants during the warm months, on the grounds that the coal man must have something to do in the summer if he is to maintain his facilities for winter deliveries. He insisted that no coal dealer could afford to keep his men, horses and trucks on the basis of a winter business only.

The hearing will be resumed on Apr. 8.

Unit Costs of the Cleveland Electric Illuminating Company

The table shows the unit costs of the Cleveland Electric Illuminating Co., as shown by Ballard Exhibit No. 6 in the Cleveland Electric Rate Case before the public utilities commission of the State of Ohio on Feb. 20, 1918.

These values are classified figures taken from Nau Audit, Commission's Exhibit No. 2, and reduced to cents per kilowatt-hour sold by F. W. Ballard & Co. These figures will be of general interest to engineers and city officials.

It should be noted that the unit cost for practically every classification of expense has decreased during this four-year period, notwithstanding the fact that the cost of labor and material has increased owing to war conditions. The kilowatt-hours sold during the four years was: 1913, 123,767,142; 1914, 167,226,182; 1915, 180,800,669; and in 1916, 248,465,487.

EXPENSES AND DEDUCTIONS FROM INCOME FOR YEARS ENDING JUNE 30, 1913, 1914, 1915, 1916
CLEVELAND ELECTRIC ILLUMINATING CO.

	Year 1913		Year 1914		Year 1915		Year 1916	
Item	Amount	Cents per Kw.-Hr.	Amount	Cents per Kw.-Hr.	Amount	Cents per Kw.-Hr.	Amount	Cents per Kw.-Hr.
Total power production	579,036 20	0 4680	654,261.86	0.3908	605,513 83	0.3350	796,136 46	0 3208
Total transmission	36,888 00	0298	50,964 03	.0305	62,977 85	0348	64,059 19	0258
Total storage	2,435.81	.0019	3,522 00	.0021	3,237.29	0018	5,485 60	0022
Total distribution	145,065.55	.1173	195,657 26	.1170	209,567 21	1159	219,034 88	0882
Total utilization	85,833 13	.0694	93,791.60	.0561	92,282 69	0511	82,573.78	0332
Undistributed	2,027 31*	0016*	2,544.17	0015	3,751.27*	0021*	11,359 82*	0046*
Administrative	185,948.38	.1520	202,351 96	.1210	211,726 94	1170	256,411 79	1032
Commercial	104,796 51	.0846	124,842.01	.0745	129,156.66	0715	143,644 78	0577
Business promotion	105,045 80	0850	140,414 13	0839	156,348 14	0865	177,284 61	0713
Injuries and damages	27,906.28	0225	43,398.00	.0259	36,340.00	0201	15,487 00	0062
Public regulation expenses and undistributed	15,480.26	.0125	7,348 59	.0044	7,944 06	0044	8,395 79	0034
Deferred upkeep	403,029 11	.3260	513,461.75	.3070	445,215.38	.2465	566,962 94	2280
Interest on funded debt	294,409 51	.2380	300,625 00	.1793	318,456 96	1760	339,667 70	1365
Other interest	26,852 23	0217	28,901.13	.0173	12,471.16	.0069	2,277 89	.0009
Taxes	246,151 92	1991	301,872.07	1802	324,989.24	1798	341,180 77	1372
Amortization of discount	60,539 70	0490	12,876 00	0077	13,355.15	0074	13,378 72	.0054
Employees fund	37,124 33	0300	82,559 70	0494	63,860.71	0352	63,823 89	.0257
Valuation and regulation reserve	..	.....	46,250.00	0276	23,125.00	0128	57,323 20	0230
Total	$2,354,515.41	1.906	$2,805,641 26	1.675	$2,712,816 99	1 500	$3,141,769 17	01 264
Total, excluding deferred upkeep, and interest on funded debt	1,657,076.79	1 339	1,991,554 51†	1 192	1,949,144 66†	1 078	2,235,138 53†	0 900

* These figures are deficits. † These amounts shown on Complainant's Exhibit No. 25, Page 1.

Secretary Lane Supports the Water Power Bill

He Points Out That Water Power Will Not Be Developed Under Revocable Permits, but That Long-Term Leases with Fair Recapture Provisions Furnish a Workable Plan

SECRETARY LANE of the Interior Department appeared at the hearing on the Administration water-power bill before the Joint Special Water Power Committee of the House of Representatives in Washington Wednesday, Mar. 27. After pointing out that the bill now before the committee has a long history and reciting some of the attempts to bring about water-power legislation during the last five years in which he and others have been concerned, Secretary Lane said that the matter of developing one bill in Congress was taken up, and that there was strong opposition in some quarters against any kind of leasing system. "Perhaps a very considerable portion of the time I have devoted to this matter," he said, "has been spent in attempting to convert members of the House and Senate, who had notions in opposition, that the leasing system was the only practicable one."

Revocable Permits Unsatisfactory

The Secretary pointed out that there is still on the books a statute under which revocable permits are granted, but that the men who have money to invest in water-power propositions are not willing to allow any official to say when the investment they have made shall be thrown to the winds. The result, he said, has been that "we have stood for five years of which I know almost entirely without development of one of our great resources. Now, it is not merely the West that is concerned in this; it is the East just as well. Right now I can call your attention to one particular matter that shows how intimately East and West are tied up on such a proposition. You know John D. Ryan, of the Montana Power Co. He has private rights, or his company owns certain dam sites and rights along rivers in Montana. I sent out a general request some time ago that the Eastern minerals which had not been heretofore developed in very great quantities, such as manganese and chrome, should now be developed for the purpose of saving ships. We get manganese, as you know, from Brazil. It takes a very large tonnage. We import some 800,000 tons a year. We get chrome from Africa and New Caledonia. We get nitrates from Chile, and for all those things a very large number of ships are at present required. We are short, the Allies are short, for the carrying of nitrates to the other side and to this side, . . . short for carrying pyrites from Spain to this side, . . . short for carrying manganese from Brazil, . . . short for carrying food to our own boys on the other side, and munitions and food for the Allies; and no matter what comes out of this German drive now going on over there, there is an obligation upon us, and the pressure of necessity that we should supply those people on the other side.

"For that we must have ships. Now, Mr. Ryan came to me and said he had a plant in Montana which will develop 150,000 hp. That horsepower can be used in a process by which the low-grade manganese ores we take out of the Butte mines can be reduced, and by their reduction they can be made commercially available to the plant in Pittsburgh. So that a water power 2000 miles away in Montana makes possible the development and the support of industries in Pittsburgh and relieves ships that come all the way from South Africa."

Secretary Lane then again went into the history of the various bills that have been before Congress and said that the executive branches of the Government, in the present bill, had united upon a measure under which "leases could be made that would govern the navigable waters and the unnavigable waters, and control as to public lands and as to forests." He told the committee he felt sure its members would find the House and the Senate in support of a measure, such as that under consideration, which does the following:

"Gives a lease for a definite term of years not to exceed fifty years; gives an opportunity for the Government to take over the property at the end of that period; gives an opportunity if the Government does not want to take over the property at the end of that time for the lessee to take it over, and I should say that reasonable terms to him would be that he should have that property if the Government does not wish to use it and that he should have that property upon terms that would be no more favorable to him than those that others might offer, but that he should have a preference. . . . Into the hands of the men capable of developing them should be given sufficient to make a wise and large investment and development; we cannot save things for men who have no capital or men who go about things with a spade where a steam shovel is needed."

Right of the People Is Paramount

The Secretary spoke of the right of the community, of the nation, pointing out that the right of the people of the United States is superior to any right "that you or I might have to speculate upon those things that are primary resources," and adding that he believes as to lands and as to minerals and as to water powers that no man is entitled to anything unless he uses it.

"If we had money enough," he continued, "if this were not a time of war, if we could think in the terms of money that we are now thinking of, or if four or five years ago Congress had been willing to expend hundreds of millions of dollars in the development of water power as it is forced now to spend millions of dollars for war, it would be a wise thing to put a large part of the public revenues into such projects where they are found to be needed.

"I have no doubt in my own mind but that such schemes as water-power schemes are perfectly practicable from a Governmental standpoint, no matter what your sympathies may be respecting Government ownership, as a rule, of large utilities. A thing that is as well standardized as a water-power scheme can be operated successfully by the Government. But I do not take it that this is a practicable proposition at this time, nor probably will it be for many years to come, and it is necessary that there should be real development, and that soon." Mr. Lane elaborated his point of view in regard to the impracticability of devoting Government funds at this time to the building of water-power plants by discussing the immense demands being made upon the Treasury now and in prospect.

"The news now coming from the other side of the water," he said, "is disheartening, discouraging, but it leads me to believe that all the conclusion we can come to is that we are in this thing for a longer time than we thought. Not that there is to be any cessation of effort on our part, but there is to be renewed effort, a stronger fight, and a longer fight. And if we are to have a long fight, and if we are to get into this thing with our full strength; if a larger portion of the burden of beating von Hindenburg and the other Germans is to fall upon us, then, surely, it becomes necessary that we should not delay longer in the development of every resource that we can."

Secretary Lane spoke at this point again of the nitrate situation, pointing out that it is not one that can be looked upon with equanimity and remarking that "the more nitrates we have the more food we can get," as well as "There is a large portion of the acreage of this country that is now coming to need fertilizers of one kind or another."

The speaker then told of an offer he had had from a company in Washington five years ago for the development of a water-power proposition. "That proposition," he said, "could have been financed successfully at that time if we had had such a bill as the one which is now before you. Then they wished to go into the business of developing nitrates. The power is still there and is still unused." He said that there are propositions of this kind all over the country, that there is a supreme obligation upon all the people of the country at this time, as well as its officials, to think more seriously of such things, and that "we will get no development under the present law."

Not in Sympathy With Government Loans to Private Enterprises

Answering questions by Chairman Sims, Secretary Lane, before entering upon a general discussion of his remarks, participated in by almost all members of the committee, said that if there is a determination by Congress that there shall be water-power development—for instance, along the Columbia River, or the Snake River, or the Colorado River, for the production of low-grade manganese, or for the development of nitrates, either for gunpowder or for fertilizer—and such works could not be financed, "it is the duty of the Federal Government at this time to help out the proposition and put it on its feet." He added: "I am not sympathetic generally with the idea of having the Government lend money to private enterprises because it is a hard thing to get it back. But I am very much in sympathy with the Government doing what it pleases with its own money, provided it knows where it is going and what it wants and how that money can be properly handled; and I am not afraid at all of the Government undertaking the development of water-power propositions, because we have had some experience with them in the Reclamation Service. The Salt River proposition which I have turned over to the water users is practically paying its own way now out of the power developed out of the Roosevelt dam. That was a venture at the time. All these propositions are gambles. That is one reason why a man who puts his money into a water-power project has got to have very real consideration. He is a developer, and every man who is a pioneer of any kind takes the risk, and for his risk he ought to be compensated."

Mr. Lane was asked some questions as to whether it will be possible for water-power plants to be built in time to be of service before the war is over. Very close attention was paid to the answer of the Cabinet officer on this point because men in public life in Washington have not recently been hazarding guesses as to the length of time which the struggle will continue. He said: "I have no expectation that this war will be over before water-power projects such as many that we know of can be developed. I think you have got to look at that thing with a long range."

Why I Buy Liberty Bonds

By George W. Munro

Assistant Professor Mechanical Engineering, Purdue University

Last spring twenty students of my class responded to the call of the nation and joined the colors, and this response was prompt, spirited and enthusiastic. Some of these boys are already on the fighting front and a few weeks will see them all at the grim business. These twenty men who have left my classroom for a place on the very lips of the bloody jaws of hell represent me in a very personal way, and I expect great things of them. I expect them to be brave with a courage which knows no faltering; I expect them to be chivalrous before an enemy wholly savage; and I expect them to reflect honor on my nation, my state and my university in all their dealings with men and women, friend and foe alike.

Of me they have a right to expect in return that I will not send them into a strange land to die of want and neglect. From me to them must flow a never-ending stream of food, of shelter, of clothes, of arms and munitions, of hospital supplies, of encouragement and good cheer. I must provide ships for their passage and provisioning, convoy for their safe conduct, aircraft for their battle eyes; and all the things which are necessary for their well-being, without limit or stinting. It is evident that I cannot serve these men directly but must use the agencies provided. I must support the Y. M. C. A., the Salvation Army, the Red Cross. I must pay cheerfully and gladly such war taxes as come within my reach and must buy Liberty Bonds and War Saving Stamps to the limit. Only so can I meet the reasonable expectations of those who have gone forth from my classroom to the edge of the abyss.

We are loud in our praise of James Watt for what he accomplished, but it is doubtful whether Watt would be as proud of his successors who are throwing away steam in the form of exhaust that is as good as some he used initially.

Why we should Buy Liberty Bonds

One year ago President Wilson said: "We will not choose the path of submission." Buy Liberty Bonds and show that you agree with him.

Germany has announced her eighth tyranny loan. We have offered our Third Liberty Loan. Can we allow ourselves to be outdone by Germany?

"When innocent blood from the four corners of the world cries out for justice," what will your answer be? Speak through the Third Liberty Loan.

Time enough to beat the sword into plowshares after the Kaiser is beaten into submission. The Third Liberty Loan is an effective weapon against him.

That man in khaki, to whom you wished "best luck," wants you to buy Liberty Bonds and show that you meant what you said.

If you don't believe in the premature peace that the pacifists demand, if you don't want to see the United States "Russianized," buy Liberty Bonds.

The time to talk peace is when the Germans lay down their arms. Just now, let your money talk in terms of Liberty Bonds.

Our Allies keep on supporting their war loans; Americans cannot afford to hang back in this Third Liberty Loan, when most of the civilized world is united against Germany.

You buy Liberty Bonds because you believe with every American in backing this war to the last dollar, the last soldier, the last ounce of energy.

Uncle Sam is offering you one kind of bonds, and the Kaiser another. The Kaiser's don't fit Americans of the breed of Washington, Lincoln and Wilson.

You owe a debt of freedom to America. Buy a Liberty Bond and help pay your debt.

Buy Liberty Bonds because they help to arm, outfit and feed the soldiers and sailors who are fighting democracy's battle under your flag.

Buy Liberty Bonds because they give you a chance to enter the richest partnership in the world, the United States of America.

Buy Liberty Bonds because the man behind the gun is doing his all and you want to do yours. He cannot fight long without your help.

The campaign for the Third Liberty Loan is a spring drive in which every American is summoned over the top. And let us all be shock troops.

Translate your good intentions into Liberty Bonds. Russia today is paved with good intentions—for the Germans to walk upon.

Our boys in France are as anxious as the Germans to know whether the Third Liberty Loan has been oversubscribed. Which will you disappoint?

You must buy a Liberty Bond to preserve your self-respect, to still your conscience and to prove your patriotism.

Purchasing a Liberty Bond will mean helping insure these United States against depredatory powers for ages to come.

Each of us should buy Liberty Bonds to assume at least part of the individual responsibility which the war imposes on the nation as a whole.

Unless we lend to the Government voluntarily by investing in Liberty Bonds, the Government will be forced to conscript our wealth.

Because those who have enlisted set an example of sacrifice, knowing that Liberty would be won by the small sacrifice made by those who remained behind.

Because by buying Liberty Bonds you are helping yourself and your country.

The American Citizen Should Buy Liberty Bonds Because they are for the Purpose of Defending His Country and His Home

Editorials

Daylight Saving the Year Around

THE Calder Daylight Saving Bill that provides for changing the working hours throughout the United States has been signed by the President and is now in force and will so continue until October 27 of this year, when the clocks will be set as they were before the change. It would seem that the idea might be carried still farther and the law so amended as to become effective throughout the year.

There are several features favorable to this change of working hours which would affect the home, the factory, the office and also electric-light plants. During the summer the saving in the home would center around the evening illumination, an hour's less lighting being required each day. During the winter months lights would be used both morning and evening, but the extra hour's lighting during the morning would be more than offset by the greater number of lights that would be shut off an hour earlier at night.

In the office buildings, in the larger cities at least, opening for business one hour earlier in the morning would not require the burning of lights and would save an hour's lighting in the late afternoon during the winter months. The lighting period in the factory would be shortened to some extent, depending upon the natural light conditions. During the period when the days are the shortest, the morning and evening lighting load would about balance, but during the early and late winter months the change of working hours would result in a saving of light.

These savings of light would result in a cash gain to the user, but to the electric-light companies it would mean a loss in revenue. On the other hand, such a loss would be beneficial in that the power load for the day and the evening lighting load would not overlap. Furthermore, it would not be necessary to maintain expensive equipment to carry the peak loads, as it is now. With a more even load on the stations, the boilers that are now held in reserve with banked fires in order to carry the peak loads caused by the lapping of the power and lighting demand would not be required.

Just what such a daylight-saving plan would amount to in coal saved by the power plant and to the consumer of electricity is shown by the statement of Samuel Insull, chairman of the Illinois State Council of Defense and president of the Commonwealth Edison Company of Chicago, which is to the effect that the enactment of an all year's daylight-saving law would save the electric industries of Chicago alone about fifteen thousand tons of coal per year and about two hundred and thirty thousand tons of coal for the entire country; and then it would save the electricity consumers in Chicago about three hundred and sixty-five thousand dollars and for the country seven million and a half dollars per year, which, by the way, would be the loss to the electric companies in revenue. This loss, however, would be largely offset by an improved load factor because of the reduction of winter peaks, and in many instances it would mean real economy in operation as well as a saving to the country as a whole.

Invest To Destroy Autocracy

THERE are two kinds of power. The first is the kind that is developed from the latent heat of coal or the self-perpetuating source of energy of waterfalls. The second is what is being temporarily exerted by Germany today—man power gone mad.

The former is the mainstay of all industry; the climax of man's intelligence. Through it vast distances have been opened for transportation, vast enterprises carried out to a successful end. Indeed, it is safe to say that the wheels of all industry would never have rolled in the wealth they do today if energy had not turned them into proper channels. With the wheels of industry yet unborn, the whole fabric of our every-day existence would be still an impossible dream. Your work, then, is the work of progress, development and the conquest of man over the uncurbed forces of nature.

The second phase of power has no part in the progress of civilization. Its presence is intolerable. By the power gained through ruthless savagery, Germany has conquered a large part of the unfortunates who have been unable to escape. Her power is the mad frenzy of a beast drunk with the blood of her helpless victims. It is well that that kind of power lost its place among mankind when civilization first made itself felt.

Those of us who are not in the army can stand together in helping to put down this uncontrolled and autocratic power, by subscribing to the Third Liberty Loan. Save for it; every cent you invest in Liberty Bonds goes toward helping to destroy the power of the beast of Europe, that power which is striving to destroy all that every true American holds dear.

Government Control of Water Powers

THE article "Government Control of Water Powers and Electrical Distribution Abroad," in this issue, deals with a question that demands the close attention of those interested in central-station work and the development of the water powers in this country. The policies of governments in their attempts to deal with the production and distribution of electrical power have undergone frequent changes following the rapid development of the central-station industry. The progress made in the development of overland transmission and the great saving to be derived from centralized production have opened the way for a new development in power legislation which seems to lead in the direction of complete governmental control over all agencies of power production if not finally to national ownership.

It is interesting to see how the attainment of this end is approached in the different countries. In England the power engineers and those interested in power consumption have worked out an extensive scheme which will centralize power production in a comparatively few generating stations which will supply a territory now served by more than six hundred central stations. Prussia forces its central stations to fall in with its own policies by simply taking administrative action which will make it impossible for the existing enterprises to expand unless they do the will of the government; it has also entered the central-station business on its own account and now competes against the existing private and municipal enterprises, assisted by large generating stations conveniently situated. Finally, there is the example of New Zealand, where government ownership has been in successful operation for many years.

The importance of reserving the existing water-power resources of the country so that they may be used to the best interest of the nation is now generally realized throughout the world, and many laws have been passed regulating the use of waterfalls and other natural power sources. With increasing industrial activity it has become essential that this power should not be squandered and that it should be provided for all at the cheapest possible rate. This can be done by a better use of the existing natural resources and by centralization of the existing central stations. While the means to that end used in the different countries differ, it seems that the final outcome in each case will be identical.

So far there is no evidence that it is also contemplated to nationalize the means of distribution. On the contrary, opinion seems to be very largely in favor of continuing the existing organization, which has proved itself to be the most practicable for the purpose.

The development is one which certainly cannot be lost sight of in our own power industry. With the whole world striving today for a cheapening of power production, it is certain that similar action will have to be taken very soon in our own country.

Bonus for Boiler-Room Crews

THE world was never so aroused to the need of saving fuel, indeed never was so astounded by its wasteful use, as it is now. *Power* has watched with keen interest the effect of the great volume of publicity directed chiefly to firemen and engineers, pleading with them to save coal. The good this publicity has done is not the measure of fuel actually and immediately saved. This is yet to come. The great good comes through the channel in which, unwittingly, the manufacturer and manager have stood as obstructions. Of course there are many exceptions. But many of these men did not realize before the coal shortage how vital a factor is coal and how important it is to check its use in the power plant. Thousands of such men, who heretofore would not listen, or would listen unconvinced, to pleas of their engineers for instruments to gage power-plant performance or for equipment to better such performance, will give a willing ear from now on.

Begging firemen and engineers to save coal, appealing to their patriotism to do this, will do some measure of good. But to him who knows, there are limitations soon reached by such a course. In last week's issue, Haylett O'Neill, well known to *Power* readers, proposes a plan by which boiler-plant crews may receive bonuses for fuel saving effected by careful attention to operation and maintenance of boiler-room equipment. Here is something that gets the enthusiastic support of the crew just as soon as they understand what it is all about.

The author proposes paying a bonus only to the firemen, fire cleaners and boiler cleaners—that is, to those whose work it is to burn the coal economically and keep the boiler and furnace in the "pink" of condition physically. Assumably he includes the foremen when applied to large plants, and the engineer also in plants where he is responsible to the management for the condition and performance of the boiler plant.

The Daily Grind

THOUSANDS of men in thousands of power stations in the United States and, in fact, throughout the world are obliged to go through with the daily grind. One day is very much like the next, and it frequently gets to be an old story for some. The duties of the engineer and fireman are not always pleasant. There is a continual handling of coal, feeding of water, disposal of ashes, blowing down, cleaning, oiling, wiping, repairing, making of reports—all necessary and responsible work, but ofttimes dull and irksome. The boiler or engine room is no place for the mollycoddle. There are dirt, soot, scale, heat, poor ventilation, inadequate equipment--all enemies of the self-respecting operator. One is really tempted at times to ask himself the fruitless question, "What's the use?"

But there is another side to all this. If the work of any man in a power plant is uninteresting, it is his own fault. The very fact that there are enemies to conquer makes life interesting. Even the simplest duty is worthy of the best efforts and calls for the exertion of the greatest powers of the whole man. Many people, whatever their occupation, only live half a life. They fail to recognize their opportunities. They spend their energies bemoaning their fate or cursing their luck or wishing that they were born rich or good looking. What a waste of time! How much better would it be if they took an equal amount of pains to improve conditions. Nothing is so bad but that it can be made better, and the way to make it better is to think, talk, decide and do.

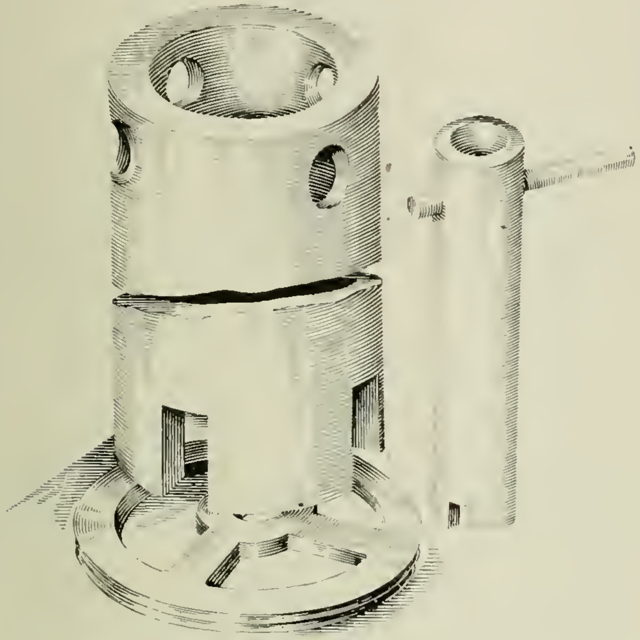
Cheerfulness is the best servant of any man. Some men about a plant are so disagreeable that they are actually shunned by their fellows. They are not only burdensome to themselves, but they are a pest. Whatever good they may wish to accomplish is already nullified by their very attitude.

We are said to be creatures of our environment, and to some extent this is doubtless true. Fortunately, however, it lies within our power to alter our environment. If you don't like your job, get out and secure one that you do like, but make sure first that it is the job, and not you, that is disagreeable. If the daily grind seems irksome, do your best to make it interesting. Do not be discouraged by setbacks. The best fighter is the man who cannot recognize failure—who does not know when he is licked.

Correspondence

Pump-Valve-Seat Wrench

A valve-seat wrench made of pipe with slots cut in the end to match the spider of the seat will prove effective and will serve in awkward places, such as depressed decks or where there are projecting studs.



PUMP-VALVE-SEAT WRENCH

It may be turned with a Stillson wrench or with a bar in holes drilled in the pipe.

I have taken seats out without injuring them where it took two men with a 6-ft. pipe on a 48-in. wrench to start them—the wrench being made as described of 3-in. extra-heavy pipe. The pipe should be the largest size that can be put into the valve to bring the force as near the point of resistance as possible.

San Francisco, Calif. **Arthur B. Saunders.**

Gas Engines of Former Times

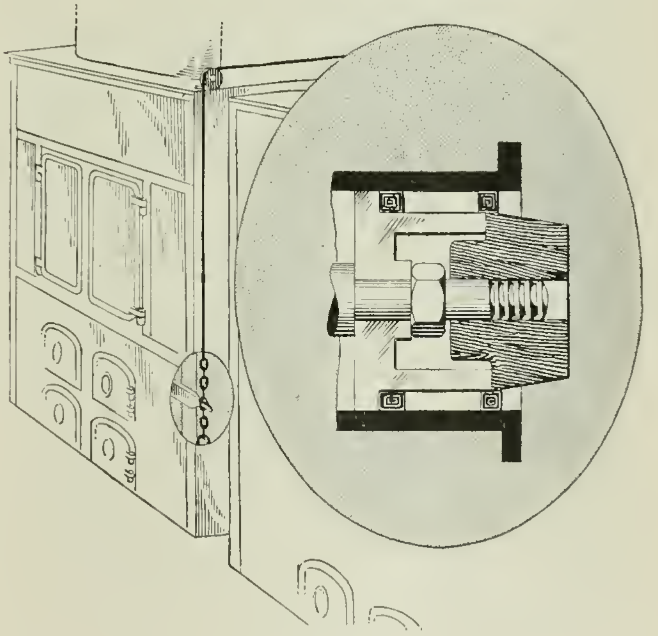
Referring to the letter, "Gas Engines of Former Times," on page 164 in the issue of Jan. 29, it may be interesting to *Power* readers to know more about a gas engine called the Automatic, which was manufactured at Oil City, Penn., about the date referred to. This engine had the following earmarks: The ones that I came in contact with were horizontal four-stroke-cycle with one rotary valve driven by a camshaft. This valve controlled the air inlet and also an exhaust. Ignition was obtained by the old-time hot tube, and the governor was of the throttling type, controlling the quantity of admission. The engine was nicely balanced, was almost noiseless and would run at a high rate of speed. Trouble, however, always developed in the rotary valve, cutting and causing loss of compression.

This made a bad job to repair, and I think that was what put the engine off the market. I have heard that some shops fitted poppet valves to these engines and got good service from them. It occurred to me that the writer of the letter referred to may have had one of these engines or that some other contributor might be able to give some interesting reminiscences in regard to it. **Lloyd R. Hoffman.**

Oil City, Penn.

Holding Damper in Position

A damper control can be put in in a cramped place if ¼-in. wire sash cord is used with "side pulleys" at necessary turns, and it will last indefinitely. I use a section of light chain down the boiler front, of a length equal to the travel of the damper lever, securing it over a hook at any desired damper opening—the chain serving also as an indicator of the damper position.



TWO SELF-EXPLANATORY SUGGESTIONS

For the relief of distressed worthy brothers whose patience and stock of profanity runs out when they try to pack the water end of a feed pump, especially when it is hot and valves leak, I would recommend the kind of device I use, for I can drive the packing into place as fast as a helper can cut it. It is a tapered wooden plug, the large end of which is the same size as the body of the piston, with a hole in its center of the same size as the projecting end of the plunger rod or the locknuts and deep enough for the plug to butt against the piston. The packing rings can be easily slipped over the small end and driven into place by this means. **Arthur B. Saunders.**

San Francisco, Calif.

Favors an Ash Inspector

The editorial on page 267 in the issue of Feb. 29, regarding appointing ash inspectors strikes me as being mighty good dope. Last winter at my home we burned eight tons of pea coal, not sifting any of the ashes. This winter, sifting them, we have not burned six tons yet, and we expect to use not more than six and one-half tons. If a ton and a half out of eight can be saved by sifting the ashes as we have done this season, I can easily imagine what a big saving can be made in the nation's coal pile by having an ash inspector or someone to take care of the ashes not sifted.

One large city in the East has considered the proposition of building an ash-sifting plant, and it was thought that enough coal could be obtained from the ashes gathered to run the city several months of the year. This estimate, I believe, is not far wrong, for in walking along the streets in the morning I have noticed that the contents of the ash boxes are nearly half coal.

New York City. D. R. **Hibbs.**

Protection of Furnace Walls

In the Jan. 8 issue of *Power* appeared an interesting article on "Ventilated Side Walls." In hand-fired furnaces with natural draft it is highly desirable to eliminate abrasion from firing tools and clinkers. As pointed out in the previous article, perforations in side walls are of little effect in furnaces of this type. We have used with success side grates of special design, not only to overcome the clinker troubles, but also to improve combustion conditions when the coal contains a considerable amount of volatile.

Fig. 1 shows the side grate in position. By correctly proportioning the free area and height of these grates, the quantity of air entering over the top of the fuel bed is practically self-regulating. After a new charge the fuel bed is thicker and offers greater resistance to the air than after the fuel is partly consumed. The air will seek the path of least resistance and, when the new charge of fuel is introduced, will pass through the openings of the side grates at a greater velocity when it is needed above the fuel bed to consume the volatiles. The greater velocity will also help to effect a better mixture of air and combustible gases. The lower resistance of the fuel bed during the later part of the period decreases the inrush of secondary air through the side grates. This difference seems comparatively small, but has proved its effectiveness in practice. Care must be taken to supply these side grates with proper cooling surface. The proportioning of the cooling ribs and the air openings spell success or failure. In the furnace shown in Fig. 1 there is also provided a flame port formed by an arch over the bridge-wall, as a means of enhancing the mixture of the furnace gases and air. Openings are provided to hinder the formation of gas pockets.

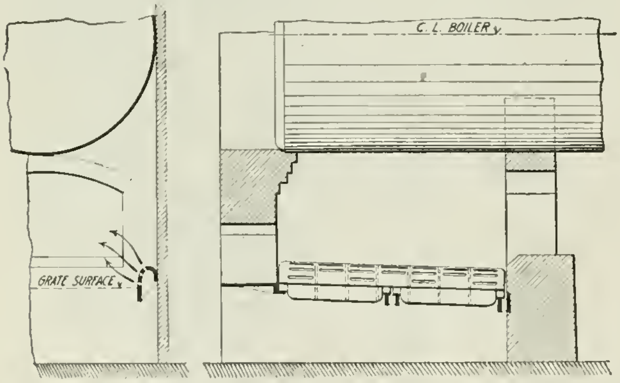


FIG. 1. PERFORATED SIDE GRATE TO ADMIT AIR, OVER FURNACE

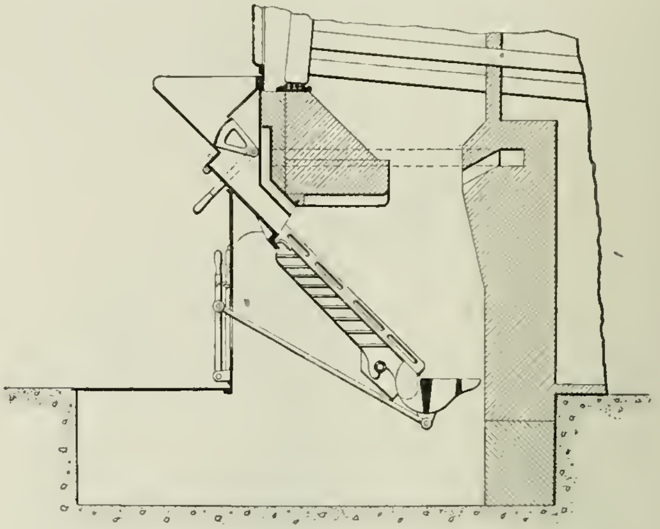


FIG. 2. SIDE GRATE FOR SLOPING FURNACE

Fig. 2 shows a successful side-grate installation for a sloping-grate furnace. In this case the construction of the side grates is more simple. The only delicate point is the provision of sufficient cooling surface to prohibit excessive temperatures and premature destruction of grates.

Joseph Goder,
Chicago, Ill. Boiler Efficiency Engineer.

Using a Pitot Tube

In the issue of Feb. 5, page 195, Mr. Brye gives suggestions concerning the use of a pitot tube. It is not my purpose to discuss the construction of the tube as shown; although one might criticize some features of it, there are other features that are admirable. I wish to call attention only to the difficulties connected with his plan of determining the average velocity in the pipe. In the first place it is somewhat troublesome in practical work to divide the cross-section of the pipe into concentric areas that are equal; then, after having thus divided the cross-section, it is exceedingly hard to locate the tube at exactly the right position in each of these equal concentric areas. In the third place there would be a comparatively large distance near the middle of the pipe in which but one velocity reading would be taken. Under certain conditions it would be very desirable to have more readings from this central area.

I would suggest that it is much easier to take the velocity readings at definite distances (which may be equal or unequal) along the diameter of the pipe. In determining the average velocity it would be necessary to calculate the area in cross-section of the water traveling at any of the obtained velocities, then giving proper weight to each of the calculated velocities, the average velocity is obtained.

E. J. **Fermier.**
College Station, Tex.

Operating Induction Motors at Reduced Frequency

A mill operator requested that the motor drives in his plant be investigated for the purpose of reducing the speed of practically all the machinery. It was found that there were about thirty motors in the mill, most of them direct-connected to the machines they were driving and all operated from the mill's electric plant. The trouble, it appeared, had come about by the mill designer's errors in calculating the motor speeds, and the machinery was considerably overspeeded, so much so in fact, that the quality of the product was seriously impaired.

The power plant was found to be operating at the proper frequency and voltage and was in excellent condition. As an experiment the governor on the engine was changed to reduce the frequency 10 per cent., or from 60 to 54 cycles. The mill machinery operated properly at this speed with the exception of one or two belted motors on which the pulleys could be changed easily, so it was determined to continue the operation at the reduced frequency. However, when heavy loads came on, it was found that the voltage dropped seriously although it was controlled by a regulator.

After some testing it was found that the exciter, which was belted to the alternator, was running too slow to generate sufficient voltage to properly excite the alternator's fields. The pulley was changed so as to increase the speed of the exciter slightly above normal, and after this change no further trouble was encountered, and the plant and mill have been operating continuously since.

During the test after the governor had been adjusted, attention was given to the electrical operating characteristics of the equipment, but the instrument changes were slight except on the frequency meter. The kilowatt output was slightly decreased and so was the power factor; the amperage increased slightly, and the voltage remained constant. D. R. SHEARER.

Johnson City, Tenn.

Different Rate of Scale Formation in Boilers

The letter by Mr. Bennett in the issue of Feb. 12, page 231, regarding the different amounts of scale to be found in boilers interested me very much. At one of our boiler plants we have six large B. & W. boilers, all working under the same pressure and using the same feed water, but one-half of each boiler will always have more scale than the other half. The difference is so great that, when cleaning, three or four tubes on the easy side can be bored in the time it takes to bore one on the hard side.

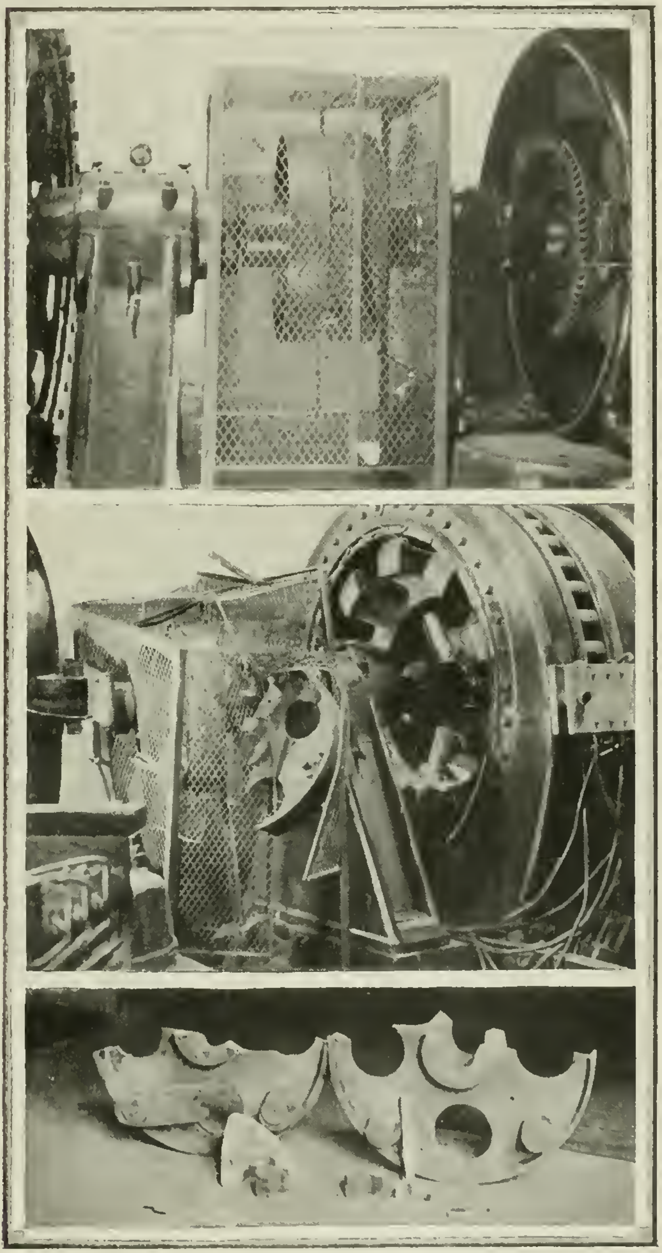
These boilers have been in use for many years, and this condition has always been the same. During the time they have been in operation, the feed water has been taken from three different sources; still the same condition exists. The soot is removed by inserting a blowpipe at one side through openings provided for this purpose, and this is the side that is always found with the greatest amount of hard scale. Whether this is what makes more and harder scale on that side than on the side where no blowing is done, I am unable to say. THOMAS J. PASCOE,

Norway, Mich. Oliver Iron Mining Co.

Safety Guard Prevents Injury

The upper photograph shows a wire-mesh guard around a 30-in. (diameter) shaft coupling on a motor-generator set operating at 360 r.p.m., the middle one shows the broken coupling with all the pieces retained within the guard or directly underneath on the floor, and the lower one shows the broken coupling after removal. This accident happened in one of the substations in the San Francisco District on Dec. 27, 1917. I am sending these photographs, thinking that they may be of interest to *Power* readers, bringing out the effectiveness of this guard not only as a protection from contact with revolving parts, but also from flying parts in case of breakage. V. R. HUGHES,

San Francisco, Calif. Safety Inspector.



CONFIDENCE IN GUARD JUSTIFIED

Telescopic-Oiler Discussion*

The discussion of telescopic oilers recently appearing in *Power* has brought out useful points. As H. Hamkens pointed out at the beginning of the discussion, the main disadvantages of most telescopics, especially the older ones, are too many parts, leakage of oil, tendency to irregular feeding, too rapid wear. He might have added, the almost general difficulty of nonalignment after repairs and cleaning.

It is true that the older telescopics were somewhat complicated and, what with numerous springs, locknuts, washers, etc., they were hard to keep in repair and in good working order. But the design has gradually been simplified and improved until today oilers can be procured which are apparently as simple as it is possible to make them.

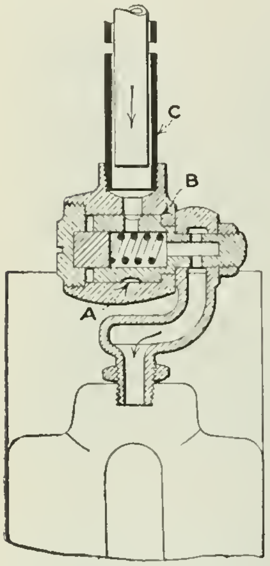


FIG. 1. MR. FENNO'S ARRANGEMENT

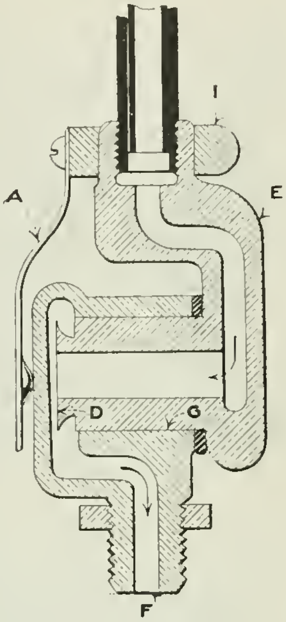


FIG. 2. MR. NUGENT'S DESIGN

As Mr. Fenno pointed out in his article in the July 17, 1917, issue, the tendency to pumping and irregular feeding can be overcome simply by providing suitable clearance between the inner and outer telescopic tubes.

The rapid wear of the tubes noticed by Mr. Hamkens in some instances, is the result of their binding upon each other due to imperfect alignment either when installed or after reassembling. This can be avoided by due care when installing and, with some telescopics, extreme care when reassembling. It all depends upon the type of joint employed.

By employing the special design of true male and female joint shown in the illustration, all wear due to imperfect alignment, except that due to poor installation, is completely avoided, because no threading is even disturbed. Also, because this joint permits of gravity feed, the pumping tendency is practically, and leakage completely, eliminated.

With the arrangement shown by Mr. Fenno and illustrated in Fig. 1, the oil accumulated at the bottom of the outer element as at *A*. In other words, the flow of oil is against the direction of the joint instead of with it. Hence, the fiber packing *B* is always in contact with the oil and subject to deterioration and leakage.

In most of the older designs the joint could not be taken apart without first unscrewing the telescopic pipe *C*. This meant that with any irregular alignment whatsoever in the initial assembling, the pipe would have to be screwed up to exactly its original position when reassembled, or extreme wear was sure to ensue.

With the type of joint shown in Fig. 2, both wear and leakage are practically overcome. The overhanging lip *D* drops the oil from the movable element *E* directly into the hollow of the fixed element *F*, and hence, unless the oil is fed in a flood greater than the latter can conduct it to the pin, the joint *G* remains leakless.

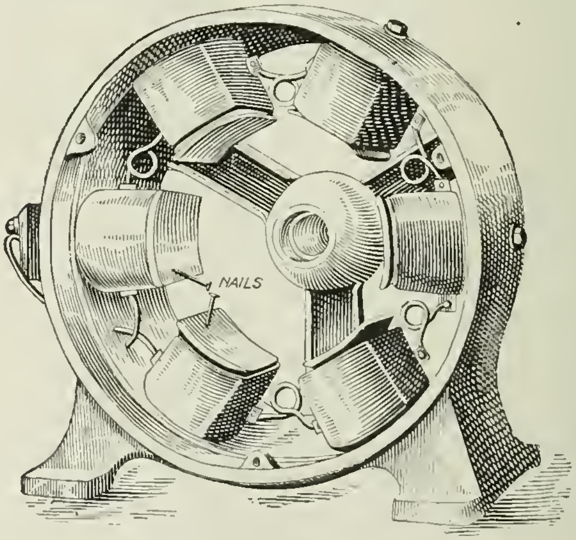
The joint is taken apart by sliding off the spring clip *A*, which is attached to the loose collar *I*. The movable element *E* then slides out of the fixed element *F*. As the construction at the top of the telescopic is similar, the telescoping pipes may both be removed without detaching them from their parts of the joints. Hence, they can always be replaced in alignment. As no nuts or screws are used in putting the joints together, they may be taken apart for cleaning or inspection while the engine is running unless the speed is uncomfortably high.

Chicago, Ill. WILLIAM W. NUGENT.

Testing Field-Pole Polarity.

In putting into service a new generator or motor or one that has been repaired, it frequently requires considerable testing to find whether the field poles have correct polarity; that is, alternate north and south poles. The figure shows a simple way of determining the correct polarity. First, excite the field coils and then take two wire nails and placing their points on adjacent polepieces, then bring their heads close together, as in the figure; if they attract, the poles are the correct polarity, since unlike poles attract. On the other hand, if the nails repel each other, the polarity of the polepieces is wrong and must be corrected by interchanging the lead on one field coil. In this way it requires only a few minutes to examine the whole machine

New York City. D. R. HIBBS.



FIELD FRAME, SHOWING TWO NAILS IN POSITION TO TEST FIELD-POLE POLARITY

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*See "Power" 1917, Jan. 30, p. 142; Mar. 6, p. 325; Apr. 3, p. 463; May 22, p. 707; May 29, p. 748; July 17, p. 96; Sept. 18, p. 399; Dec. 11, p. 806. The illustrations were inadvertently omitted from this letter as published in "Power" of Apr. 2. Therefore it is reprinted here.

Inquiries of General Interest

Relative Dimensions of Extra-Heavy and Standard Pipe—Is the difference in thickness of extra-strong pipe and tubing from that of commercial standard pipe and tubing in their variation of inside or outside diameter? J. L.

The greater thickness of the extra-heavy pipe and tubing is provided by having smaller actual inside diameter than the same nominal size of standard pipe, the external diameter being made the same so as to be suitable for standard-pipe screw threading.

Pressure Equivalent to Zero Inches Vacuum—When a vacuum gage shows 0 inches of vacuum, what is the pressure? R. A. S.

"An inch of vacuum" signifies one inch of mercury column pressure less than the pressure exerted by the atmosphere. Hence the pressure for zero inches of vacuum would be the same as zero gage, or the pressure of the atmosphere above a perfect vacuum, which, unless otherwise qualified, is assumed to be equivalent to the intensity of pressure exerted by a column of mercury 30 in. high when at the temperature of 62 deg. F., or an absolute pressure of 14.7 lb. per square inch.

Length of Open Belt—What would be the length of an open belt to go around pulleys respectively 8 ft. and 4 ft. 6 in. diameter and 24 ft. center to center? H. C. B.

The approximate formula for obtaining the required length is

$$L = 2C + \pi\left(\frac{D + d}{2}\right) + \frac{(D - d)^2}{4C}$$

where

L = Length of open belt;
C = Distance center to center of pulleys;
D = Diameter of larger pulley;
d = Diameter of smaller pulley.

By substituting,

$$L = (2 \times 24) + 3.1416\left(\frac{8 + 4.5}{2}\right) + \frac{(8 - 4.5)^2}{4 \times 24} = 67.76$$

or practically 67 ft. 9 in.

Latest Cutoff of Single-Eccentric Corliss Engine—In ordinary operation of a single-eccentric Corliss engine, why cannot cutoff take place later than one-half stroke? F. E. G.

Each exhaust valve must be opened and closed by a forward and backward motion of the wristplate to one side of its central position during one stroke, and as the operation must be accomplished during 180 deg. of the revolution of the shaft, the motion of the wristplate to one side of the central position must occur during 90 deg. of the revolution, or about one-half of the stroke of the piston. As a steam valve must not open until the exhaust of the same end has closed, and cutoff must be effected by the cutoff cam while the steam valve is carried by the wristplate in the initial direction for opening, and before the wristplate begins to return toward the central position, cutoff cannot occur later than 90 deg. of revolution of the eccentric, from the time the wristplate is in its central position or about one-half stroke of the piston.

Setting Common D-Slide Valve—What is the method of setting the valve of an ordinary D-slide-valve engine? A. N.

Uncover the valve chest and adjust the length of the valve rod so each end of the valve will overtravel the steam ports the same amount, either from turning the engine over with the eccentric fastened to the shaft or from turning the loosened eccentric all the way around the shaft. Then put the engine on a center and set the eccentric at such a position on the shaft that, with forward direction of rotation of the shaft, the end of the valve would begin to uncover the steam port on the end of the cylinder that contains the piston, or set the eccentric forward far enough to obtain the desired amount of lead opening. The engine should then be turned over on the other center to ascertain whether the same amount of lead has been obtained for the other end of the valve. If not, take out one-half of the difference by readjustment of the length of the valve rod. If more lead is desired for both ends, it can be obtained by shifting the eccentric forward on the shaft or less lead by shifting it backward.

Whole-Coil and Half-Coil Windings—What is the difference between a whole-coil and a half-coil winding? A. R.

In concentrated winding sometimes used on alternating-current machinery, a whole-coil winding is one in which there is one complete turn or coil per phase per pole, as in Fig. 1. A half-coil winding is one which has only one complete turn or coil per phase per pair of poles, as in Fig. 2.

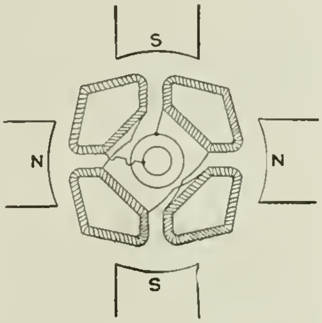

FIG. 1. WHOLE-COIL WINDING

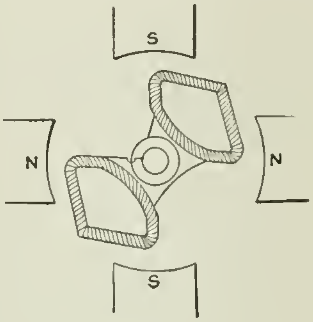

FIG. 2. HALF-COIL WINDING

Advantage of Inclosing Heating Returns—When steam at 105-lb. gage is supplied to drying coils in which the pressure is maintained at 5 lb. gage, with the condensate discharged against atmospheric pressure and returned to the boiler at 180 deg. F., what percentage of saving would be effected by returning the condensate under 5 lb. pressure? H. L. W.

If the coils discharge direct to the atmosphere without being trapped, no comparison of economy can be made without knowing the percentage of steam thus wasted. If the present discharge consists only of condensate that is formed in the coils and returned to the boiler at 180 deg. F., then as one pound of steam at 105-lb. gage or 120 absolute contains 1189.6 B.t.u. above 32 deg. F., for reconversion into steam each pound of the return water must receive from the boiler 1189.6 − (180 − 32) = 1041.6 B.t.u. The relatively small amount of heat that would be saved by reason of supplying the boiler feeder with water at 5 lb. higher pressure can be neglected. The principal consideration would be the temperature of the returns as received by the boiler. The temperature of the condensate when formed in the coils would be the same as the temperature of dry saturated steam at 5 lb. gage, namely, about 228 deg. F., but there would necessarily be some reduction of this temperature in handling the returns. Assuming that the actual temperature of the condensate as returned to the boiler is 220 deg. F., each pound of steam generated would require 220 − 180 = 40 B.t.u. less than with the feed temperature at 180 deg. F. and the saving would be 40 × 100 ÷ 1041.6 = 3.84 per cent., practically 1 per cent. for each 10 deg. temperature of the feed in excess of 180 deg. F.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Central or Independent Power Service[*]

BY FREDERICK B. KENNEY[†]

A survey of the reasons for the development of the central electric light and power industry. Discussion of the paper is given.

THE term "central station" has today lost, through popular application to central stations for the distribution of electric light and power, its inclusiveness of all central sources of supply of a commodity or service essential to the well being of a community. In the widest significance of the term can be included all central sources of supply which time and economic conditions have developed through a knowledge and realization that certain essentials can be manufactured, developed or supplied to best advantage on a coöperative or community-of-interest basis.

The coöperative store is perhaps the first central station worthy of note, followed by the metropolitan water system, the central gas plant, the central electric light and power plant, and finally by the utilities for the transportation of ourselves or our goods, for either short or long distances.

THE CENTRAL STATION A NATURAL DEVELOPMENT

The central station is the natural development of such realization, for while each family in a community could today maintain a private well for its water needs, the absurdity of attempting this for any reason is apparent. Again, the family which once was content to make its own tallow dips could today maintain its own little acetylene-gas plant, but where such a plant can be found within the territory supplied with illuminating gas from a central gas plant, common sense is not one of the factors responsible for its maintenance. The same argument can be applied to our transportation needs, for were we as individuals compelled to rely today upon our physical ability to fill them, we would indeed be sadly limited in our travels and in all supplies not available in our immediate vicinity.

Centralization is decidedly apparent in manufacturing, for the origin of all manufactured articles can be traced to the individual home until demand and economic needs developed the factory.

To confine ourselves to the popular interpretation of the term "central station" and to attempt to compare its value with that of the "isolated plant," a knowledge of the history and development, with a full realization of the field occupied by each, is essential. Since light, heat and power are the products of each, a slight review of the present and past needs is not out of place.

In the Eighteenth Century Newcomen produced the first steam engine which seemed commercially practicable. A number of these engines were installed for pumping purposes in the mines of England, but not until late in the same century was the steam engine, as we recognize it today, placed on the market by Watt and his associates.

It is of interest to note that at this period illuminating gas was developed from coal by a Scotchman named Murdoch and utilized in the shop of Boulton and Watt in Birmingham, England. Shortly following, London Bridge was illuminated with coal gas, and for the distribution of this new illuminant was born the central-station idea coincident with the prime mover which is today the backbone of the isolated plant.

The steam engine as improved by Watt found a receptive field in various industrial plants, notably in the cotton industry, which at this time in England was rapidly undergoing radical changes in mechanical equipment. The beam type was accepted as standard until the middle of the Nineteenth Century, at which time the horizontal type came into favor, followed shortly by the Corliss type, which with certain refinements, is standard today.

Though engines of many types and arrangements of valve gear appeared from time to time, the reign of the heavy slow-speed engine was undisputed until 1879, when the perfection of the incandescent lamp by Edison ushered in a new phase of the light and power problem and gave birth to the electric central station as it is popularly known. The need of high-speed engines to drive the new generators devised by Edison was first met with an engine designed by Edison himself, followed by engines of other manufacturers quick to realize the possibilities of the new incandescent lamp. Designers of the steam turbine renewed their efforts to perfect their machines.

Late in 1882 was established in Appleton, Wis., the first central electric-light station for the distribution of electricity. Curiously enough this little station of 250 ten-candlepower lamp capacity was a hydro-electric plant, the generator being driven by a waterwheel. This seems almost prophetic of what to many seems to be the ultimate of economic efficiency with such apparatus as is now available.

The following year saw the establishment of central stations in many of the larger cities, and the demand throughout the country for such service for a while exceeded the ability of the manufacturers to supply the necessary apparatus and lamps.

The growth of the central station from that time has been rapid and is perhaps best reflected in such figures as are available from the Federal Census since that date as follows:

Commercial Only	1902	1907	1912
Central stations	2,805	3,462	3,650
Kilowatt capacity	1,099,000	2,500,000	4,766,000

Figures for 1917 are not yet available, but it is interesting to note that while the total number of stations in 1912 had increased by less than 6 per cent. over the total of 1907, the total capacity had increased by over 90 per cent. This rate of increase has probably been maintained during the last five years, and it is reasonable to suppose the present total capacity approaches very closely 9,000,000 kilowatts.

Development of the electric motor, together with consolidations, reorganizations and centralization of management, soon put the central station upon a solid foundation and direct competition with the isolated plant was the inevitable result. With the large field for power opened to the central station by the electric motor, a greater output over which to spread overhead charges resulted. With increased demands, larger units followed, with higher efficiencies and lower operating costs. Some idea of the net results relative to steam prime movers and motors operated with purchased current in industrial plants can be obtained from the census figure for the years 1899 and 1909 as follows:

Capacity In	1899	1909
Steam generated power, horsepower	8,200,000	14,200,000
Purchased electric, horsepower	182,500	1,750,000
Total of both sources	8,382,500	15,950,000

While the total capacity in steam power had increased by 75 per cent., the total purchased power had increased by 960 per cent., and whereas the purchased power in 1899 was a trifle in excess of 2 per cent. of the total, in 1909 it had become in excess of 11 per cent. of the total. Figures for the last eight years will no doubt prove equally as creditable to the central station.

Meanwhile the sponsors for the isolated plant have not been idle and, profiting by the experiences of the central station, have disposed of obsolete equipment, eliminated wasteful methods of transmission, installed modern and efficient equipment and taken measures to obtain the maximum economies possible. For these the day of surrender to central-station service is deferred, but not entirely eliminated. For the plants that have not profited by the experiences of the central station and have neglected to im-

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[*] A paper before the Providence Engineering Society, Providence, R. I., Jan., 1918.

[†] Mechanical Engineer, Blackstone Valley Gas and Electric Co., Pawtucket, R. I.

prove their conditions, the handwriting on the wall is clear. There always will be exceptions to this probability, dependent upon peculiar and local conditions.

Probably no better method of outlining the truth of this can be employed than to apply the arguments for and against central-station service to a typical plant familiar to the writer. The plant in mind furnishes light, heat and power for a cotton mill of the usual type, spinning its own yarn and utilizing it all in the weaving of plain cotton fabrics.

The engine plant consists of two old Corliss cross-compound engines operating condensing, one of approximately 1200 hp. rating and the other of approximately 600 hp. rating and both about thirty years of age. Transmission is mechanical throughout. Steam is furnished from a battery of water-tube boilers. Heating is done with live steam. A mixture of about one part bituminous to three parts buckwheat coal is burned. The average load carried approximates 1400 i.hp. The actual operating costs for the year 1912 were $25,000, which includes no overhead charges, with slight repair or maintenance charges. The engineer in charge is a most capable man and is obtaining results that could hardly be bettered with any apparatus that could be installed. The physical conditions in transmission are, however, extremely bad, and fully 40 per cent. of the power generated is dissipated in friction. It is estimated that 900 hp. in motors would handle this mill to much better advantage than it is being handled at present. With 2,000,000 kw.-hr. per year at 1c. per kw.-hr., the cost of current to this mill would be $20,000; overhead charges on motor equipment (based on 1912 figures), $1500; heating and all other charges, $6500; total, $28,000; apparent balance in favor of the isolated plant, $3000 yearly.

Eventually, this plant for physical reasons must be replaced. At such time overhead charges must be considered, and assuming the installation of a 1000-kw. plant with a minimum cost of $100,000, the immediate yearly burden approaches $12,000. Add to this the item of $1500 burden on motors and $6500 for heating and incidental operation, a total of $20,000 is chargeable to the power plant before the generation of a single kilowatt. Since the central-station price for the service is estimated at $28,000, $8000 is available for the generation of 2,000,000 kw.-hr., necessitating a generation figure of $0.004 per kw.-hr. Assuming this new plant operated at an economy of 2.5 lb. of coal per kw.-hr., with coal at $3.50 per ton as in 1912, the resultant coal charge becomes $7700.

Similar illustrations could be furnished, but probably this is sufficient to illustrate the facts where the average industrial plant is concerned. In considering hotels, bleacheries and plants where the utmost use of exhaust steam can be made, different conditions are encountered which make it more difficult for the central station to justify abolishing the isolated plant, but since the same is being done daily, it would seem that such action in many cases can be justified. However, in each of such cases, the proper course can be determined only by individual analysis. Aside from all the considerations outlined, the question of coal supply is important. Reverting to the case of the mill outlined, the total coal required for power purposes in this mill was in excess of 4000 tons yearly. To furnish 2,000,000 kw.-hr. yearly to this plant the coal required by the central station would approximate 2000 tons. The application of this ratio to the requirements of the many isolated plants throughout the country furnishes abundant food for thought in view of the present coal situation.

In conclusion, it must be apparent that in the mind of the writer the isolated plant, except for isolated cases where geographical or peculiarly local conditions prove the exception to the rule, is surely bound toward central-station service. The day for a large number of plants may be long deferred, but eventually economic efficiency will prevail.

Discussion

Warren B. Lewis, consulting engineer, Providence, R. I.: If, before I finish, I appear to be harshly critical of some of the features of Mr. Kenney's very excellent paper, it will not be by reason of antagonism to either the speaker or his subject, but will arise from an attempt to emphasize the weakness of some of the arguments advanced for and against central-station service.

Mr. Kenney says that this is an era of centralization. This is the strongest argument that he uses, and I think that he might have carried it farther by saying that there is no more reason why manufacturers should generate power than that they should enter into the business of manufacturing the raw materials that they use. Up to within a few years ago it was necessary that they should manufacture their own power because they could not get it any other way; and I venture to say that most of them have always considered it as one of the most irritating departments of their business and looked upon it as a "necessary evil." Now that they can purchase power delivered f.o.b. their factory, there would seem to be little excuse for considering any other method. Power bears no relation to manufactured product as far as being a constituent element; and specialization is as logical in the manufacture of power as it is in the manufacture of machinery or textiles.

Again, there is little justification in investing one's money in power plants as a mere department of one's regular business on the basis of a net return of 5 or 6 per cent. (which is the rate usually charged into the costs), when the same amount of money would probably earn from two to three times that amount when invested in the business itself. However, while these are perfectly good arguments, they are very general ones; and, after all, the question is not the central station vs. the isolated plant, but it is the central station vs. some particular isolated plant.

Mr. Kenney, for instance, states that for one to maintain a private well for his water needs would be an absurdity from any viewpoint. Private wells are quite general in the midst of large cities, and the matter is purely one of the amount of water used and the cost of pumping it. It certainly would be an absurdity for each individual family to run its own water-works as suggested, but it is not an absurdity for an individual who needs large quantities of water at a fairly uniform rate of flow. So with other facilities. Expediency of individual effort is determined largely by the particular characteristics of the case in question.

Mr. Kenney goes on to give the history of the development of steam engines and the electric-lighting industry, arriving ultimately at the conclusion that the huge units made possible through the centralization of the power business have brought about efficiencies that could not be attained by the individual producer. This is true when referred to small users, but is not always true in the case of the larger users. Furthermore, the centralization of the industry has added expenses of distribution, management, cost accounting, investigation, research, etc., which makes the actual cost of power at the point of generation a comparatively small percentage of the whole. These expenses, not being incidental to the cost of the power produced by the individual, are in many cases a handicap.

If we are to indulge in general arguments, it is safe to say that the cost per unit of power installed must, in the case of the central station, be as great, if not greater than for the case of an isolated plant of considerable size, when one takes into consideration the investment in auxiliary equipment, distributing systems, real estate, etc. The central station must earn fixed charges, as well as the isolated plant; and if there is any advantage in this respect it is that the central station can figure lower fixed charges than can the isolated plant.

From the viewpoint of running costs, I doubt whether the pounds of coal consumed per kilowatt-hour are much, if any, less in stations of from 25,000 to 30,000 kw. than in many textile plants of a thousand kilowatts. Here again Mr. Kenney might have emphasized the fact that the central stations have a corps of technical experts who are constantly studying problems of economy where the usual isolated plant does not, and that the central station will maintain its efficiency for a much longer time than will the isolated plant; and therefore, the figures for the latter, previous to its installation, may not be of much weight five years after.

Mr. Kenney goes on to cite the case of a cotton mill. I find the figures rather general, which always leaves one in doubt as to whether any conclusions can be drawn after all. He admits at the start that the plant had a most inefficient drive and was wasting 40 per cent. of the power generated. Whether this mill continued to make its own power or purchased it, it is evident that it would have to spend considerable money not only to install motors but to rearrange entirely its shafting, belting, etc., to reduce the load from 1400 to 900 hp.; and the expense would be put upon the mill in any event. The real comparison would then come as to whether power could be purchased at the switchboard at the price at which it could be made in the isolated plant; and it would not be necessary to take into consideration overhead charges on motor equipment, shafting, etc., nor on heating or steam used for processes.

He quotes a price of one cent per kilowatt-hour; but few of us have realized the benefits of any such price, even on total bills aggregating $20,000 a year. Most rates are based on a service charge and a running charge, and the service charge is generally much higher than the fixed charges placed on isolated equipment. I am assuming that for a mill using 1000-kw. maximum demand, the service charge would probably be $15,000 a year, which is $3000 more than the burden that he places on a 1000-kw. isolated plant. If the service charge is $12 per kw., then the burden becomes the same. Through the advantages of the diversity factor, the central station realizes very much greater revenue from service charges than is at first apparent. I venture to say that if the total maximum demand billed to all customers was added together, it would greatly exceed the actual maximum demand of the central station, owing to the peculiar workings of the diversity factor.

Mr. Kenney refers to plants where exhaust steam can be used, as presenting a more difficult problem for the central station. He could have made a strong point for his case in this particular direction, by showing that few plants use as much exhaust steam as they think they do, and that many use exhaust steam most inefficiently just because they have it, and then console themselves with the thought that they are operating economically. There is many a plant that, if it started with its uses of exhaust steam and reduced them to the actual minimum requirements, would find that the supposed efficiency had disappeared.

With reference to the economic consideration it is hardly fair to compare the central-station requirement of 2000 tons with the mill requirement of 4000 tons. The 4000 tons referred to were admittedly more than should have been the case; and then one must not forget slashers, heating and other equipment which require the use of coal.

It might be interesting, in connection with this paper, to cite the case of a cotton mill having a generating equipment of 1250 kw. and a modern and efficient plant throughout. The heating of the mill was a very considerable item, owing to the peculiar processes carried on. The mill was heated by the use of a hot-water system, the water in turn being heated by live steam on the theory that the temperature of the mill could be nicely controlled with varying temperatures out of doors. Investigation developed that it was possible to heat the water in the hot-water system by using the surface condenser as a water heater; or, to put it another way, by using the water in the heating system as the circulating water for the condenser. It was found possible to vary the temperature of the circulating water by varying the load on the turbine and carrying varying degrees of vacuum. The net result was the production of 300 kw. with the steam previously used for heating purposes alone. It is quite probable that the saving that can be effected during the heating season through this method of operation would justify the operation of the plant the whole year round even in the face of extremely low rates for central-station current.

Engine-Room Design

The engine room is universally recognized as a hazardous department. Admittance is denied even to the initiate except when required by their duties.

It is because of this condition that great care should be exercised to guard against accidents. In many ways this care is noticeable. Engineers are experienced, trained specialists who recognize the potential destructiveness of their machines. Engines are the product of the highest type of engineering skill and have been perfected to an extent equalled in few other branches of mechanical construction. The efforts of the best designers are centered on producing material surroundings within which the heart of the plant may beat safely and with the greatest efficiency.

An engine room should have at least two means of entrance and exit, each of which should be easy of access and within reasonable view of the engineer in charge. (Too many entrances, however, for obvious reasons, are inadvisable.) All passageways and exits should be free of obstructions, and doors should open outwardly and should not be so close to operating equipment as to create a hazard. Basements of engine rooms should have exits so arranged that men may not be trapped in the basement.

A sign should be conspicuously posted outside each doorway forbidding entrance except on business.

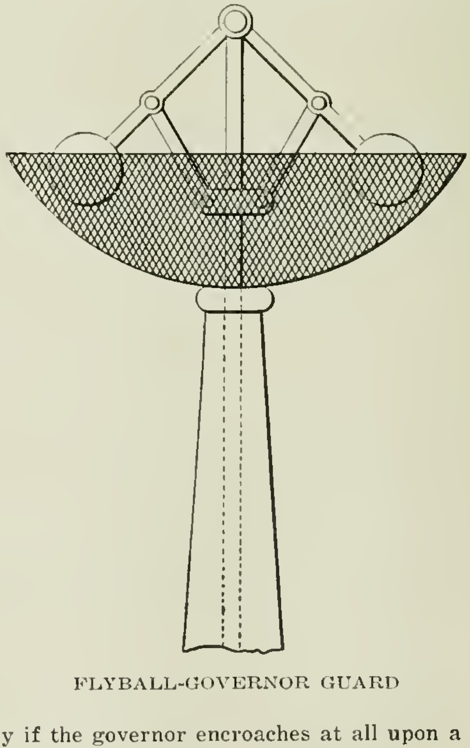
If entrance ways are kept open for ventilating or other purposes, bars or gates should be placed across the entrance.

A gallery for visitors is sometimes provided, as the department exercises a fascination for plant visitors. Entrance to such a gallery is preferable by an outside stairway. If entrance to the gallery is from the main entrance, substantial guard and intermediate rails should clearly prescribe the limit of welcome, and signs indicating entrance to gallery should be displayed. The gallery or balcony should be of fire-resisting construction, rigidly built, and should be securely railed to a height of at least 42 in., with intermediate rails and toe-boards, or the space between the top rail and floor entirely filled in. Conversation between visitors in gallery and engineers or assistants in room below should not be permitted.

Floor of engine room should be of concrete or abrasive surface to eliminate the slipping hazard. When approach is had to any engine or machine, the nonslipping provision should be emphasized. Frequently, inserts or mats of nonslip material are used at these points when the entire floor is not of nonslip material.—*National Safety Council.*

Flyball Governor Guard

A hemispherical sheet-metal or wire-mesh basket strong enough to hold the balls in case of breakage, placed under the flyballs as shown is a useful guard and is absolutely necessary if the governor encroaches at all upon a passageway or a position occupied by an attendant in the performance of his duties.—*National Safety Council.*


FLYBALL-GOVERNOR GUARD

Gasoline Substitute Full of "Pep"

Dr. Lewis Clements, who claims to have produced a substitute for gasoline at a cost of 2¼c. per gal., gave a demonstration in New York on Mar. 19. First of all, the doctor was arrested recently on complaint of a party who had been induced to invest in the substitute that could not, it was claimed, be made for the price stated, and the police agreed to this contention. The district attorney, however, gave the doctor a chance to prove that this substitute would work.

According to the New York *Sun* the thing that sticks in the crop of Assistant District Attorney Renaud is that all the chemists who looked over Doc Clement's formulas said that when it came to producing a low-cost fuel the Standard Oil Co. was an eleemosynary institution compared to the doctor.

They admitted that something ought to happen when all that benzine, alcohol, kerosene, naphtha, sugar and sulphuric acid was poured into a gas tank, but they didn't see how the Doc could make it even at his revised figures of 8c. a gal. They said that solemnly and with forethought, and then put their names after it and went away, so that the Doc was really licked before he started.

It wasn't his fault. He picked things up and put them down, washed them out and then washed them again, sipped kerosene as if he liked it every time he started a siphon working, spilled benzine and alcohol and naphtha all over the place, built little fires and put them out again, and generally had a lovely time. It was the verdict at the ringside that the Doc put up a game fight.

Before the show began, however, the chemists herded the Doc off in a corner and got his formula. Then they deliberated for about an hour and produced the following:

> At the request of Mr. Renaud we have today conferred with a person introduced to us by Mr. Renaud as Louis Clement (they weren't taking any chances), and have received from said Clement a statement of what he declares to be a full and complete formula for his motor fuel.
>
> We know that a motor fuel made according to said formula will cost more than 2½c. a gal., which you stated said Clement represented that it would cost, and further that it would cost much more than 8c. a gal., as said Clement represented to us today.
>
> In our conference with said Clement we noted that he used chemical terms incorrectly, and he did not impress us as possessing scientific or technical knowledge of the subject. Signed: Charles Baskerville, Charles F. McKenna, Gustave W. Thompson, Francis P. Smith, J. C. Olsen, William Gies.

With which deathbed bulletin they all went away save Dr. Gies, who is professor of biological chemistry at Columbia University, and who waited till the bitter end. This pronouncement did not bother Doc Clement a bit. He listened to it being dictated to the reporters waiting to give the news to expectant owners of little flivvers, and then rolled up his sleeves, removed his hat, but kept his overcoat on.

To show that he had nothing concealed about him the Doc permitted detectives to search him in the most approved manner of the stage. He got behind his big board table and proceeded to unwrap, and as he did so it was hard to make out whether the Doc was going to take up light housekeeping or not.

This is what he produced:

Four glass gallon jars
Ten test tubes
Four graduated glasses
Two glass funnels
More corks
One can of alcohol
One washtub
One bottle of cedar oil
Sodium bicarbonate
Weighing scales
Five rubber tubes
Two towels
One pair of scissors
One piece of chamois
Two porcelain spoons
One oil can
One bottle sulphuric acid
Nine corks
One bunsen burner
Two boxes talcum powder
One wash boiler
One bag of sugar
One package of alum
Alcohol stove
Thermometer
More test tubes
Three gallons distilled water
Four gallons kerosene
One suit case

To these were later added a Stillson wrench, an oil stove, which was purchased halfway through the experiment, a cut on the hand acquired by the Doc in opening the kerosene can, a frown and a bad taste from drinking kerosene.

Just to make the scene a bit more reminiscent of Mr. Kellar, Assistant District Attorney Renaud opened some of the packages with an explanation something like this:

> Gentlemen, in this package we have talcum powder, or what purports to be talcum powder. Is it talcum powder? It is. Martini, pour it back.

Hours and hours had gone by and the spectators shifted about, watching the doctor unpack and get ready, and listened to his attorney, William Bosler, explain that the Doc hadn't eaten a thing since the night before and had only slept an hour in four days.

No blushing debutante ever awaited the hour of appearance with greater trepidation than the urbane Dr. Clement. He finally got started about 1:20 and at 1:56 had his picture taken, with cries of "Look thoughtful, doctor!" from the photographers.

He Gives 'Em a Little Action

1:57. Weighs graduated glass excitedly.

1:58. Rubs talcum powder on the graduated glass and puts it down.

2:00. Somebody says, "What does the labor cost?"

2:01. Pours water into a jar.

2:02. Pours it into another jar. Movie machines clicking.

2:03. Puts naphtha flakes, the stuff mothballs are made of, into a graduated glass. More movie activity.

2:05. Little bird up in the rafters says: "Tweet, cheep, tweet."

2:07. Puts sulphuric acid in glass and pours in cedar oil. Stirs it violently while it turns red. Movie men angry because their machines won't take red.

2:11. Assistant district attorney eats a sandwich.

2:15. Mixes oil and water. Somebody explains that the cedar oil gives the car a woody smell so that in driving through Central Park the squirrels will follow the car.

2:25. The Doc siphons kerosene and gets a mouthful.

2:26. Assistant district attorney takes seat on a motor truck to referee the match.

2:38. Drinks more kerosene. Somebody denies the rumor that he has it for breakfast instead of orange juice.

2:40. Makes salad dressing of kerosene and sugar, lights the mixture and then throws it away. Look of perplexity on the faces watching.

2:41. Mixes water and alcohol and burns it.

2:42. Puts benzine in the wash tub.

Then hours and hours and hours while search is made for a stove to heat the mixture which has been consigned to the wash tub. People go in and out and send for more lunch. The stove is produced and the firemen run in a hose from the hydrant outside. Nothing happens. The stuff is stirred up by the doctor with a thermometer and he announces that it is cooked. It is strained and ready for the experiment.

Outside a big two-ton fire truck had been prepared for the experiment. A gallon can with connections all in sight was fastened above the engine and the mixture, which was a pale lemon color, with little bubbles of what a chemist said was water, was poured in. Battalion Chief Marshall superintended this and when the Clement mixture had been poured in, a large husky workman was detailed to turn over the engine.

He turned. Nothing happened. He turned and turned and turned. Still nothing happened. Then he tinkered with the carburetor, and turned some more. Not a kick. The engine was primed and the exhausted cranker relieved by another, but still no response.

Deep gloom and words of indignation on the part of Doc Clement's attorney and friends. The engine should not have been cold; the water in the radiator was cold; it was not fair.

"Let me try the flivver," said the doctor. It was permitted, and with a few deep inhalations the engine raced as if it had picric acid in its innards. Large clouds of smoke drifted from the exhaust and brought back memories of kerosene lamps in the days of one's youth.

One recalled that according to Don Marquis a flivver will run on Stutter's Stomach Bitters, Stewroona, Doctor Bunkus' Discovery for the Kidneys, Lily Gingham's Discovery or Siwash Injun Soorah. It seemed even so.

It was tried on a six-cylinder car with a self-starter and worked beautifully, but all the efforts of Chief Marshall's mechanics would not cause that fire-department machine to cough once. The chemist explained that it was because the water had dissolved and settled to the bottom and no engine will run on water, except apparently a Ford. So the experiment ended, with both sides claiming victory.

But the scientific gentlemen were all on the side of the district attorney, for they showed that all the ingredients in the mixture, with the exception of kerosene, cost as much as gasoline—some of them more. Kerosene costs less, but even that is 15c. per gal., and the Doc claims he can make his stuff for eight cents. He produced at the test from the $9 worth of material about 5 gal. of substitute.

No Strikes or Lockouts During the War

The War Labor Conference, which has been in session at Washington for several weeks, on March 29 submitted to Secretary of Labor Wilson a comprehensive program for the settlement of industrial disputes during the war period, by means of which, if adopted, lockouts and strikes would be averted and production kept at a maximum. Under the proposed agreement, the right of workers to organize in trade unions and to bargain collectively is unreservedly recognized and the open shop is also protected; the basic eight-hour day is recognized; the right of all workers to a living wage is guaranteed; and women doing the work ordinarily performed by men are to receive the pay of men.

In case of disputes there is to be investigation and arbitrament by a National War Labor Board to consist of five representatives of capital and five representatives of organized labor. If the efforts of the National Board fail to bring about a voluntary settlement, provision is made for the appointment of an umpire by the unanimous vote of the National Board. Failing such choice, the name of the umpire shall be drawn by lot from a list of ten suitable and disinterested persons to be nominated for the purpose by the President of the United States. This umpire shall have power, under simple rules of procedure prescribed by the National Board, to make final decisions, from which there can be no appeal.

Ex-President William H. Taft and Frank P. Walsh, selected counsellors respectively of capital and labor, in statements made on Saturday, gave their full approval to the recommendations of the board.

Rules of Procedure

The principles and policies to govern relations between workers and employees in war industries for the duration of the war are stated substantially as follows:

There should be no strikes or lockouts during the war.

The right of workers to organize in trade unions and to bargain collectively, through chosen representatives, is recognized and affirmed.

The right of employers to organize in associations of groups and to bargain collectively, through chosen representatives, is recognized and affirmed.

Employers should not discharge workers for membership in trade unions, nor for legitimate trade-union activities.

The workers shall not use coercive measures of any kind to induce persons to join their organizations nor to induce employers to bargain or deal therewith.

In establishments where the union shop exists, the same shall continue and the union standards as to wages, hours of labor and other conditions of employment shall be maintained.

In establishments where union and nonunion men and women now work together and the employer meets only with employees or representatives engaged in said establishments, the continuance of such condition shall not be deemed a grievance. This declaration, however, is not intended in any manner to deny the right or discourage the practice of the formation of labor unions or the joining of the same by the workers in said establishments, nor to prevent the War Labor Board from urging, or any umpire from granting, under the machinery herein provided, improvement of their situation in the matter of wages, hours of labor, or other conditions.

Established safeguards and regulations for the protection of the health and safety of workers shall not be relaxed.

If it shall become necessary to employ women on work ordinarily performed by men, they must be allowed equal pay for equal work and must not be allotted tasks disproportionate to their strength.

The basic eight-hour day is recognized as applying in all cases in which existing law requires it. In all other cases the question of hours of labor shall be settled with due regard to governmental necessities and the welfare, health and proper comfort of the workers.

The maximum production of all war industries should be maintained and methods of work and operation on the part of employers or workers which operate to delay or limit production, or which have a tendency to artificially increase the cost thereof, should be discouraged.

For the purpose of mobilizing the labor supply with a view to its rapid and effective distribution, a permanent list of the number of skilled and other workers available in different parts of the nation shall be kept on file by the Department of Labor, the information to be constantly furnished: (1) By the trade unions; (2) by state employment bureaus and Federal agencies of like character; (3) by the managers and operators of industrial establishments throughout the country. These agencies should be given opportunity to aid in the distribution of labor, as necessity demands.

In fixing wages, hours and conditions of labor regard should always be had to the labor standards, wage scales and other conditions prevailing in the localities affected.

The right of all workers, including common laborers, to a living wage is hereby declared.

In fixing wages, minimum rates of pay shall be established which will insure the subsistence of the worker and his family in health and reasonable comfort.

Fuel Administration's Fuel-Oil Rules

President Wilson, acting through the United States Fuel Administrator, on Mar. 25, promulgated revised rules and regulations governing the distribution of fuel oil in that section of the United States east of the Rocky Mountains. These regulations supersede those issued Jan. 31, 1918.

Under a proclamation issued by the President Jan. 31, every manufacturer and distributer of fuel oil (including gas oil) whose gross sales aggregate more than 100,000 bbl. per annum was required to secure a license from the Fuel Administration on or before Feb. 11, 1918. The regulations promulgated Mar. 25 control these licensees.

The reason for revising the regulations is that under the former provisions it was found that distributers controlling only a small supply of fuel oil were unable to meet the requirements of all their customers. Distributers controlling larger supplies were able to meet the requirements of all consumers on the priority list. This situation worked a hardship to the customers of the smaller distributers and deprived essential industries of their fuel oil.

Under the new regulations if a distributer is unable to meet the requirements of all of his preferred customers, another distributer may be required by the Fuel Administration to meet this demand before he is allowed to supply his own customers who are not on the preferred list.

Twelve classes of consumers are specified in these regulations, and manufacturers and distributers are required to give priority in the distribution of fuel oil to them in the order in which they are named.

Deliveries must be made in conformity with this list regardless of any existing contracts between licensees and consumers in other classes. After the requirements of consumers entitled to priority are satisfied, licensees must carry out their contracts for other deliveries to the extent of their supplies.

These rules and regulations are for the purpose of assuring an adequate supply and equitable distribution of fuel oil for purposes vitally essential to the national security and defense and to the successful prosecution of the war.

The shortage in the amount of fuel oil which can be delivered, because of transportation conditions, is such that it is clearly a wasteful and unreasonable practice to deliver such fuel oil for uses which are not intimately and directly connected with the prosecution of the war.

Rule 1. No licensee engaged in the distribution of fuel oil in that part of the United States east of the Rocky Mountains shall, without the consent of the United States Fuel Administrator, make any deliveries of fuel oil to any customer or consumer of any one of the classes mentioned below, whether the licensee is under any contract to make delivery to such customer or consumer or not, until such licensee shall have delivered to the customers or consumers of every class designated by a lower number with whom such licensee may have contracts, or to whom such licensee shall have been directed to deliver by order of the United States Fuel Administrator, all fuel oil to be delivered upon such last-mentioned contracts or such orders of the United States Fuel Administrator. Preferential deliveries as between members of the same class may be made only with the consent and under the direction of the United States Fuel Administrator. This rule shall apply to all deliveries of fuel oil, regardless of any contracts therefor or hereafter made.

Provided that this rule shall not prevent the delivery of fuel oil by any licensee to any jobber or distributer if such fuel oil is to be used for a purpose for which the licensee could deliver such oil direct, nor in any case where the jobber or distributer shall have been licensed or designated by the United States Fuel Oil Administrator.

The classes referred to and the order of their preference are as follows: (1) Railroads, bunker fuel and oil refineries using or making fuel oil; (2) export deliveries or shipments for the United States Army or Navy; (3) export shipments for the navies and other war purposes of the Allies; (4) hospitals where oil is now being used as fuel; (5) public utilities and domestic consumers now using fuel oil (including gas oil); (6) shipyards engaged in Government work; (7) navy yards; (8) arsenals; (9) plants engaged in manufacture, production and storage of food products; (10) Army and Navy cantonments where oil is now being used as fuel; (11) industrial consumers engaged in the manufacture of munitions and other articles under Government orders; (12) all other classes.

Rule 2. Licensees shall promptly comply with all orders of the United States Fuel Administrator with respect to the delivery of fuel oil, the submission of reports, and other matters proper and necessary to carry into effect the President's proclamation of Jan. 31, 1918.

Rule 3. Neither these rules and regulations nor the orders of the United States Fuel Administrator shall relieve any licensee from his obligation to deliver fuel oil which he has contracted to deliver as soon as the prevention resulting from such rules, regulations, or orders shall have ceased to operate and the fuel oil shall be available for delivery under such contracts.

These rules and regulations shall apply to all licensees heretofore or hereafter licensed under the proclamation of the President dated Jan. 31, 1918, and shall supersede the rules and regulations issued with the approval of the President on that day.—H. A. **Garfield**, United States Fuel Administrator.

Speaking recently at Dewsbury on coal conservation, W. B. Woodhouse, chief engineer and manager of the Yorkshire Electric Power Co., said that in the United States the production of coal per man was 660 tons, as against 250 tons in Great Britain; in the textile clothing trade, the annual value of the production per person employed in the United States was £484, as against £158 in Great Britain; the primary cause for the difference was that American industry used approximately three times as much power as was used here in corresponding trades. The solution of the problem was the more economical use of fuel and the cheapening of power supply, the one being a consequence of the other.—*Engineering (London).*

Syracuse Garbage-Digester Explosion

An explosion of one of the garbage digesters at the Syracuse Municipal Reduction Plant at about 8 o'clock on the evening of Mar. 20, badly wrecked the plant (Fig. 1), causing an estimated loss of $80,000, but fortunately without loss of life or injury to any of the six men who were employed in the plant at the time.

It is understood that several of the digesters had been installed recently, and that the older ones had all been overhauled during the winter. They had been examined by boiler inspectors a few days previous to the explosion and had been pronounced in excellent condition.


FIG. 1. WRECKED BY AN EXPLODING GARBAGE DIGESTER

The top of the exploded digester, Fig. 2, was thrown several hundred feet over the buildings and landed in an adjoining marsh. No details of the condition of the digesters has been obtained other than that an examination of the drums showed that the plates were much thinner than when first installed and that they were not strong enough to withstand the steam pressure carried, which was not supposed to be over 80 lb. The metal of the drums, which should have been $\frac{5}{16}$ in. thick, had so deteriorated that the plate was extremely thin in places and incapable of withstanding the pressure carried.


FIG. 2. TOP OF THE EXPLODED DIGESTER

It is to be remembered that digesters, although operating under comparatively low steam pressure, are subject to the corrosive action of acids and gases, which causes the wasting away of the plates and greatly reduces the strength of the riveted joints. These are probably responsible for the explosion, although the theory of frozen dynamite having been placed in the digester with the garbage, and that of the explosion of an accumulation of gas and steam in the digesters had been advanced.

Fortunately no fire followed the accident; and as a protection against further danger the fires were drawn from the boiler furnaces and the employees ordered from the building later on on account of the danger from falling walls.

Points About Storing Coal

So many inquiries reach the Bureau of Mines, Department of the Interior, concerning the spontaneous combustion of coal that the bureau has issued the following general statement on the subject. The point of view of the bureau is as follows: The wisdom of establishing large storage piles is, of course, another matter which must be determined from the facts in each case.

The conditions of storage of coal are so various as to make it necessary to apply general principles in each case rather than specific directions.

It is to be recommended that coal should be stored in small quantities as near to the point of consumption as possible. Small coal piles rarely ignite from spontaneous combustion. Coal should be stored near the point of use to avoid rehandling, extra transportation, and the degradation of size which follows each rehandling. For these reasons the bureau would advocate storage, so far as possible, in the bins and yards of the ultimate consumer, thus dividing the risk of loss from spontaneous combustion. If large storage piles are necessary, certain general principles must be borne in mind. The generation of heat is the result of slow oxidation of the coal surface. The oxidation is much more rapid from freshly mined coal or from freshly broken surfaces. The oxidation rate increases rapidly with increased temperature. Different coals have different oxidizing rates. These facts lead to the following recommendations:

Where there is choice of coal to be stored, that having the lowest oxidizing rate should be chosen, if known. Between two coals, that which is least friable, and therefore which presents the least total coal surface in the pile, should be selected. The method of handling should be such as to produce the least freshly broken coal surface. The coal should be as cool as possible when piled. Piling warm coal on a hot day is more likely to produce spontaneous combustion. The coal must be kept from any extraneous source of heat. Alternate wetting and drying of coal during piling is to be avoided if possible.

The fine coal, or slack, which furnishes the larger coal surface in the pile, is the part from which spontaneous combustion is to be expected. Piling of lump coal where possible is therefore desirable. In the process of handling, if the lump coal can be stored and the fine coal removed and used immediately, the practice prevents spontaneous combustion in coals which would have otherwise given trouble.

The sulphur content of coal is believed by many to play an important rôle in spontaneous combustion. The evidence on this point is still conflicting, but to play safe, it is desirable to choose coal having a lower sulphur content, when choice is possible.

There is a current belief that dissimilar coals stored in one pile are more liable to spontaneous combustion. The evidence on this point is also conflicting, but to play safe, it is advisable to store only one kind of coal in a pile. The ground on which a coal pile is built should be dry.

The foregoing recommendations are all derived from the factors affecting the heating of coal.

There should be no spontaneous combustion, whatever the heating rate, provided the heat is carried away as rapidly as produced. This fact brings about the following recommendations: Coal piles should be so made that there is ready movement of air for ventilation throughout all parts of the coal pile. This is the condition when the entire pile is made of coarse lump coal. With ordinary coal piling, this is difficult.

The surfaces of coal piles should be so exposed as to allow the pile to cool; or else the coal should be so stored that air circulation within the pile is very small. When the air circulation is reduced to a minimum, as in an air-tight bin with no opening in the bottom, the oxygen of the air is soon removed and the mass of the coal lies in an inert atmosphere, except for small local circulation near the surface. Air-tight bins are usually impracticable, but the following practice is recommended to approximate these conditions:

In making a coal pile of mixed sizes, the coal should be so handled as to make a homogeneous pile and prevent the segregation of coarse and fine coal. This frequently determines the most desirable machinery for unloading coal.

It is common practice to limit the height of a coal pile; this for two reasons: A pile too high crushes the lower layers of coal, producing more fines; the larger the pile the less heat-dissipating surface there is exposed in proportion to the heat-generating capacity of the pile. Twelve feet in height is a common limit.

Whatever precautions are taken in the choice and handling of coal, provision should be made for keeping track of the temperature rise in a coal pile and for rapid rehandling of portions of a pile in case of excessive heating. In a coal pile covering a considerable area, it should be so subdivided that in case of spontaneous combustion of a portion, the heat will not be transmitted to the whole pile, thus accelerating the heating of portions of the pile which normally would have remained cool.

To keep track of the temperature of coal piles, it is recommended that half-inch iron pipe be driven vertically into the pile at distances of fifteen or twenty feet apart. A maximum thermometer lowered into the pipe to varying depths will indicate the temperature of the pile opposite the thermometer.

A survey of the pile and a survey of the temperature of all parts of the pile should be made twice a week during the first three months after the pile is made, and once a week thereafter until the pile has evidently ceased to heat. As soon as any portion of the pile reaches a temperature of 150 deg. F. provision should be made for removing that portion of the pile. Actual removal need not begin until the temperature has reached 180 deg. F., but at these temperatures the rate of oxidation is dangerously rapid. The object of rehandling the coal is to allow it to cool below a dangerous temperature. Any method of rehandling which does not allow of cooling will only transfer the difficulty from the old pile to the new one. It is generally useless to employ water in an attempt to cool a coal pile.

Lack of provision for rapid reloading, cooling and repiling of coal is the cause of serious loss from spontaneous combustion.

Zone Distribution for Bituminous Coal

United States Fuel Administrator Garfield on Mar. 30 signed formal orders instituting the zone system of distribution for bituminous coal. Twelve general orders, imposing upon the movement of coal the limitations arranged by the Fuel Administrator and the Director General of Railroads were issued. They will be communicated at once to those charged with the enforcement of the zone-system distribution plan. Each order covers a single consuming zone.

The orders of the Fuel Administrator are directed to the operators in the various producing fields, which are limited in their shipments to specified consuming territory. They are supported by embargoes imposed by the Director General of Railroads on all coal movement except along the lines laid down in the zone-system plan.

The orders directing coal producers to restrict their shipments to the coal-consuming territory alloted to them became effective at 7 a.m., Monday, Apr. 1.

The Municipal Electrical Association, comprising 187 towns in England, has been discussing the question of linking up stations, so that one can assist the other with current if necessary. In this connection it is proposed to divide the country into 16 areas.—*Commerce Reports.*

Electrical Energy from the Volterra "Soffioni"

The large works of Count Larderel for the recovery of borax from the hot springs that abound in the volcanic district to the south of Volterra have long been known. There the volcanic district for many miles round is punctuated with *soffioni*—blasts of hot borax-bearing steam which breaks through the natural crevices of the soil.

For many years it was only for the recovery of the borax that this steam was utilized, but of late a new departure has been made which is interesting both for the ingenuity of the methods devised for overcoming technical difficulties and for the importance it may reach.

The earliest experiments for utilizing the Volterra steam for producing power date back to 1903, when Prince Ginori-Conti had a powerful jet of natural steam directed onto the vanes of a waterwheel, but the apparatus was little more than a toy. Later on he used the steam in a reciprocating engine which sufficed to drive a small dynamo and provide current for a few lamps. Encouraged by the development of these experiments, the prince set up a larger engine of 40 hp., which also was actuated by the natural steam just as it rose from the ground. The results obtained were satisfactory in a way, but the rapid corrosion of the metal work by the sulphuric acid and other impurities that contaminated the raw steam were a serious drawback. However, in the hopes that this obstacle might by some device be overcome, several borings were made reaching from a depth of from 100 to 180 meters (328 to 590 ft.), in which iron tubes, of a bore varying from 20 to 40 centimeters (7.87 to 15.75 in.), were fixed. Jets of superheated steam were thus obtained in large quantities. The production of the several shafts varies from 5000 to 20,000 kg. (11,023 to 44,092 lb.) of steam per hour, the pressure from 2 to 3 atmospheres (29.4 to 34.1 lb.), while if the aperture of the tube is completely closed the pressure rises to 4 or 5 atmospheres (58.8 to 73.5 lb), and the temperature ranges from 150 deg. to 180 deg. C.

This source of possible power is clearly important in quantity, and is susceptible of great development, for experience shows that shafts can be sunk as close to each other as are the oil wells in a Pennsylvanian field without interfering with their respective production, and the ground in which they can be sunk with good results extends over several square miles. But before this source of power could be made commercially available some means had to be devised for getting over the corrosion of the metals in the apparatus used.

The first attempt on anything like a large scale was made with a jet of 25,000 kg. (55,115 lb.) of steam per hour at a pressure of 2 atmospheres (29.4 lb.). Theoretically, this would provide about 4000 hp., 40 per cent. of which could be practically utilized. What was actually done was to install in 1912 a turbine of 300 hp., coupled to an alternator, providing a current sufficient for lighting the Larderel establishment. The results obtained were considered good enough to justify the erection of a plant on a larger scale, and the huge increase in the cost of coal caused by the war, owing to which coal has actually been sold on the wharves of Genoa up to £20 ($97.33) per ton, provided an additional motive for pushing on the work. Three turbines were built by Tosi, of Legnano, coupled to alternators for the production of 3000 kw. each. The corrosion problem was tackled in this way. The steam from the *soffioni* was not sent direct into the turbines, but was used to heat three groups of low-pressure (1¼ atmospheres or 18.37 lb.) tubular boilers supplied with pure water, the condensed steam being collected for the recovery of the boracic acid and the other byproducts which it contains. The boilers that produce the steam for feeding the turbines are vertical and the tubes are of aluminum, as being less affected by the acids contained in the steam which provides the heat for boiling the water in the secondary boiler. Each of these turbines develops about 4000 hp., and they are coupled to three alternators of 3000 kw. each. The electric current, which by the transformers is raised to 36,000 and 16,000 volts, is distributed by five distinct lines to various towns. Last summer only two of the groups were used, the third being held in reserve, but other turbines were under order, and the power produced will probably be largely increased in the near future. The latest information to hand is that the company has sold more power than it can at present produce. It is in contemplation to provide motive power from this source, in substitution for coal-raised steam, to the two important steel works situated on the cost at Piombino—the Alti Forni and the Magona d'Italia. A scheme of treatment is also under consideration for the recovery of helium and other rare gases, which may be used for the making of electric lamps and other purposes.

Of the economical results of the scheme it is as yet too early to say anything positive. Even if the management were willing to divulge them, it is hardly likely that it has yet been able to determine their costs with any accuracy. With coal at its present price almost any source of energy may be scrambled for, but when normal times return the question of finance will assume a different aspect, and the plant now working must therefore still be looked on, from the profit and loss point of view, as something of an experiment, though the able men who work it are not lacking in confidence. It will take a longer experience to determine, not only the ultimate efficiency of the plant, but also what will be the cost of repairs for boilers working under the trying conditions to which they are subject. How will this cost compare with that of water turbines?

For the technical details of these notes and the illustrations we are indebted, says the *Engineer*, to Engineer Professor Luigi Luiggi, inspector of the Genio Civile, and an authority of unquestionable competence.

If the War-Savings and Thrift-Stamp campaign attains the goal set, it will cover the entire cost of the Government's shipbuilding program for the year. Already the Government is receiving from the buyers of War-Savings Stamps daily, enough money to build more than 10,000 tons of shipping. It has already received funds for the building of 420,000 tons or 84 ships of 5000 tons each.

STEAM FROM EARTH FISSURES, STEAM-PIPE LINES AND STEAM JET ISSUING FROM A PIPE

Water-Power Legislation Agreement Made

It is understood in Washington that the Special Joint Water Power Committee of the House of Representatives has agreed to incorporate in the Shields bill, passed by the Senate some time ago, all the features of the so-called Administration water-power bill agreed upon by the committee. The Shields bill, when it passed the Senate, was referred to the House Committee on Interstate and Foreign Commerce, and that committee has referred it to the special committee which has been holding hearings on the Administration bill for some time.

Senators are expressing satisfaction that a way has been found out of a legislative difficulty, by the special committee of the House deciding not to bring in the Administration bill as a separate measure. Some Senators have entertained the idea that as the Senate has recently dealt with water-power matters and officially expressed itself in the Shields bill, there would be little opportunity for substituting the Administration bill from the House for the Shields bill in the Senate. The plan now is for the House to amend the latter bill by incorporating the features of the Administration bill. The bill as so amended will then be submitted to conferees on the part of the House and Senate. Senator Shields will be manager of the conferees on the part of the Senate and Judge Sims, chairman of the House Special Committee, will be manager on the part of the House. It is authoritatively stated in Washington that Senator Shields has made up his mind to accept a number of the most important provisions of the Administration bill when they are tacked on to his bill as amendments, and there is a general disposition among other Senators to urge the measure to completion.

The measure must nevertheless go through a number of slow-moving processes before coming to be a law, as in all likelihood there will be debate on it in the House and in the Senate. It is said in Washington that if there is a disposition in the House to retard the passage of the bill unduly, a rule will be brought in by the Rules Committee, shutting off debate.

Brief additional hearings were held on the bill Thursday, Apr. 4, before the House Special Committee. As this is written in Washington, however, the committee feels that it has had laid before it practically all the facts upon which it needs to act.

Marking Packages for Express Shipment

The express companies have issued what is termed Supplement No. 5 to Official Express Classification No. 25. This refers to the marking on packages, bundles, etc., and it goes into effect May 1, 1918. Some of its requirements, which may be of interest to *Power* advertisers and readers, follow:

(a) Each package, bundle or loose piece in a shipment must be plainly, legibly and durably marked, showing the name of only one consignee, and of only one station, town or city and state to which destined.

(b) Shipments wrapped in paper, or packed in boxes, crates, barrels, corrugated paper or fiberboard containers must be marked with pen, brush, stencil, waterproof crayon, or by label securely attached with glue or equally good adhesive. Such shipments must not be accepted when marked only with tag except as provided below:

Shipments of iced goods, such as fish, oysters, etc., must be marked with brush, stencil or waterproof crayon, or with two tags securely tacked, one of which must be sunk in a groove in the box or case, or otherwise protected in such manner as to prevent becoming detached or defaced by contact with other articles or surfaces.

Containers which are customarily used several times for transportation of goods by express, such as bread boxes or dog kennels, which cannot be satisfactorily marked with brush, stencil, waterproof crayon or label, may be accepted when bearing two address tags securely attached to the package.

(c) Castings, machine parts, shafting, pipe, rods, bars, and other metal articles:

1. When boxed, barreled, crated or trussed, must be marked in compliance with paragraph *(b)*.

2. When not boxed, barreled, crated or trussed, and there is sufficient smooth surface for the purpose, the address must be plainly marked on the article with durable paint. Such shipments must not be accepted unless marks are thoroughly dry.

3. When not boxed, barreled, crated or trussed, or when not possible to mark as provided in preceding paragraph, shipments must be marked with not less than two wooden, leather, metal, cloth, rope stock or sulphite fiber-tag-board tags. Rope stock or sulphite fiber-tagboard tags must test not less than 14 point, 50 per cent. rope, have reinforced metal eyelets and cord must be attached by wire not less than 23 gage, or strong tarred cord. Tags must be attached wherever possible to unexposed parts of the article in order that they may not become detached in handling.

4. Rods, shafting, bars, iron-bed slides, automobile springs and other articles of like character marked with tags as provided in paragraph 3 must have the tags securely wired to the article, and in addition, a concealed tag bearing the same address, must be bound to the article with burlap covering, the latter securely wired at each end.

5. When metal articles are shipped in sacks, the address must be shown on tag conforming to the specifications in paragraph 3, attached either by wire or strong cord, and an additional tag bearing the same address must be inclosed in the sack.

Except when in carloads, each package or article in a lot shipment must be marked in compliance with these requirements.

Shipments not marked in accordance with the foregoing requirements, or as noted under individual items of the Classification, must be refused.

Petroleum in Britain

Lord Cowdray has addressed a letter to the press which requires the most careful consideration, both of the government and the public. It appears that he has offered on behalf of his firm to (1) place at the government's disposal the services of his technical staff for the duration of the war, for the purpose of investigating and exploiting oil fields in Great Britain, entirely free of cost; (2) to survey, drill and exploit at their own entire cost, subject to certain areas being reserved to the firm as licensees, who will spend at least £500,000 ($2,433,250) on the work. Thus the nation would incur no expenses, but would stand to gain both directly and indirectly. The point that requires most immediate attention is the statement that legislation is required; otherwise if the government proceeds under the Defense of the Realm Act, all discoveries made and work done would revert to the landowner after the war. That should not be. If petroleum exists in these islands in any quantity, it should be made national property. — *The Engineer.*

Production of Fuel Briquets

The output of fuel briquets in the United States in 1917 was 406,856 net tons, valued at $2,233,888, an increase over 1916 of 111,701 tons, or 38 per cent. in quantity, and of $788,226, or 55 per cent. in value, again breaking the record of the previous year.

According to C. E. Lesher, of the United States Geological Survey, Department of the Interior, the demand for fuel in 1917 was so strong throughout the whole year that there was no lack of market to limit the production of the briquet manufacturers. Despite the increased cost of binders and of manufacturing, most of the plants operated to full capacity and reported a prosperous year.

Obituary

Merrick M. Childs, for 22 years manager and superintendent of the Metcalf Building, Providence, R. I., died at his home at Edgewood on Mar. 31, after an illness of three weeks. His health had been poor for about two years. He was treasurer of the National Association of Stationary Engineers, No. 1 for 17 years, and previous to that had been president for three terms. He was a director of the Nichols Manufacturing Co. and also a Civil War veteran. He was born in Woodstock, Conn. He is survived by his widow and one daughter.

Personals

H. O. Savage has been elected vice president of the Locomotive Pulverized Fuel Co. of New York. He will also continue as vice president of the American Arch Co.

George M. Keenan, formerly test engineer of the Union Electric Co., St. Louis, Mo., is now chief engineer of the Little Rock Railway and Electric Co., Little Rock, Ark.

Henry A. Stringfellow has resigned from the Epping-Carpenter Pump Co., Pittsburgh, Penn., to accept the position of first assistant engineer with R. Winthrop Pratt, consulting engineer, on the design of the new filtration plant for the City of Detroit, Mich.

Engineering Affairs

The American Association of Engineers will hold its fourth annual convention in Chicago, May 14.

The Southwestern Electrical and Gas Association will hold its annual convention at Galveston, Tex., Apr. 15-16.

The Southwestern Society of Engineers wil hold its annual convention at Douglas, Bisbee and Tuscon, Ariz. Apr. 18-20.

The American Society of Heating and Ventilating Engineers will hold a meeting on the evening of Apr. 15, which will be devoted to "Fuel Conservation."

American Association of Engineers—Garrett P. Serviss, the prominent scientist and author, will address the New York Chapter at its next meeting on Wednesday, Apr. 10, at the Hotel McAlpin, at 8 p.m. His subject will be, "The Glory of the Engineer."

The American Institute of Electrical Engineers will hold a meeting on the evening of Apr. 12. The following papers will be presented: "A Physical Conception of the Operation of the Single-Phase Induction Motor," by B. G. Lamme; "No-Load Conditions of Single-Phase Induction Motors and Phase Converters,". by R. E. Hellmund.

Miscellaneous News

The Northwestern Electric Co. of Portland, Ore., has started the construction of a $1,500,000 additional power plant in this city which will have a capacity of 10,000 kw. or 13,400 hp., with an ultimate development of 40,000 hp.

The City Officials of Seattle, Wash., have decided to make a thorough investigation of all power sites offered recently before awarding the contract for the construction of a new plant. The opinion seems to favor the acceptance of the bid of Grant Smith & Co. for the construction of a plant to cost $2,100,000.

The Northern Idaho and Montana Power Co., Kalispell, Mont., has been sold at public auction for $563,166 to Robert J. Graf, representing the stockholders of the company. His bid was the only one received and was made for him by John L. Roemer, a Chicago attorney. The power company became insolvent some time ago and was ordered sold at auction. The Continental and Commercial Trust and Savings Bank, of Chicago, is the trustee for the bondholders, which has held the deed of trust in order to secure its issue of about $4,000,000 in bonds.

The Nevada-California Power Co. is contemplating one of the longest transmission lines in the country. The company has its headquarters at Riverside, Calif., and has been working out details of its scheme with a view to saving power to railroad companies that have been engaged in hauling fuel to the Nevada Consolidated Companies' plant at Ely, Nev. The 24-hour shift of the company has an equivalent of 20,000 hp., and this could be used to good advantage for a saving of fuel. The Nevada Consolidated now generates its own power with local steam plants, which call for an immense tonnage of fuel that is difficult to deliver in the present congested condition of traffic, and anything that would relieve the company from the uncertainty of getting power would be welcome, even though the cost would be in excess of the present showing. The copper company is mining by the steam-shovel method and concentrating the ores at the rate of 10,000 tons a day. The cost of the installation would be approximately $300,000 for the pole line alone. Before engaging in its construction or entering into a definite contract, the power company would have to secure the consent of the Government for a priority order of delivery for the material required in the construction, as it would be impossible to secure any considerable material without this arrangement. Should the deal become effective, the Nevada Consolidated would become the largest individual consumer of electric power in the West and the electric companies' service would extend over a distance of 300 miles from Inyo county almost to the Utah line.

Business Items

The H. W. Johns-Manville Co. announces the removal of its Memphis (Tenn. office to new quarters at 804-5 Exchange Building, Madison Ave. and Second Street.

Smith Serrel Co., Inc., 90 West St., New York City, are now manufacturing the Pintite rigid couplings for line shafting, which are made in shaft sizes from $\frac{11}{16}$-in. to 4-in. This coupling was described on page 229 of the Feb. 17, 1914, issue and was at that time manufactured by the Thomas Coupling Co., Warren, Penn.

The Hawes Foundry and Equipment Co., with a capitalization of $250,000, has just announced its acquisition of the Central Bronze Co., which concern will cooperate with its other plants in turning out a complete line of bronze valves and fittings. All its products will be marketed and distributed as in the past, through its principals, the John Wilfert Co., of New York, Brooklyn, St. Louis and Buenos Aires.

MacGovern & Co., of 114 Liberty St., New York City, well-known dealers in second-hand equipment, announce the opening of branch offices at Pittsburgh, Penn., and St. Louis, Mo. The office in Pittsburgh is located at 498 Union Arcade, and is under the direction of L. H. Tippins and W. L. Sprengle. The St. Louis office is at 315 North 12th St., and is under the direction of R. S. Fisher, district manager.

The Big California-Oregon Power Co. Dam at Copco, Calif., on the Klamath River has been completed and the reservoir which is formed has been filled. This, together with the construction of a similar dam lower down the river, will give the company a total of 103,000 hp. from this one source. The dam just completed is considered one of the great engineering feats of the country. It is 95 ft. across at the base and 500 ft. at the top. It develops 26,000 hp. and cost $1,500,000.

Trade Catalogs

"The Pump that Manistee Builds." The Maniste Iron Works, Manistee, Mich., Pp. 12; 9 x 6 in.; illustrated. This booklet illustrates the design and construction of the RO TURBO centrifugal pump, made by the Manistee Iron Works, in a most unusual way. Instead of the ordinary series of halftone views of the various features of the pump, the booklet contains a cleverly arranged series of pictures of each part. These are cut out and arranged one over the other so that in turning the leaves the reader sees the pump just as he would see an actual model being taken apart. Thus, turning the first page removes the bearing cap. Turning the next page removes the thrust cap and bearing bracket. Each page in turn shows the pump in a more disassembled condition until the last page shows just the holow pump casing. Not only is this booklet one of the most novel publications ever issued by a machinery house, but it makes the design and construction of the RO TURBO pump so clear that a copy should be in every engineer's library.

NEW CONSTRUCTION

Proposed Work

Mass., Cambridge—The Cambridge Electric Light Co. 46 Blackstone St., is receiving bids for the erection of a 1-story, 30 x 50 ft. addition to its power plant. Noted Jan. 22.

N. Y., Albany—State Dept. of Health will receive bids until May 8, for the installation of heating and illuminating systems in laboratory on New Scotland Ave. H. Biggs, Comr.

N. Y., Buffalo—The Demarest Heating Corporation, 21 The Terrace, has increased its capital stock from $10,000 to $50,000; the proceeds will be used to make alterations and build additions.

N. Y., Buffalo—The Frontier Water and Steam Supply Co., 667 Main St., has increased its capital stock from $40,000 to $150,000; the proceeds will be used to make alterations and build additions.

N. Y., Buffalo—The Lackawanna Steel Co. Hamburg Turnpike, is having plans prepared for the erection of a 1-story, 100 x 190 ft. central turbo generator power plant. Estimated cost, $200,000.

N. Y., Buffalo—The National Aniline and Chemical Co., Abbott Rd., plans to build a power house in connection with its plant. Estimated cost, $8500.

N. Y., Buffalo—The Power Efficiency Corporation, 102 Clinton St., has plans under consideration for additions and improvements to its plant.

N. Y., Jamestown—The Crescent Tool Co., 202 Harrison St., is having plans prepared for a power station to be erected at its plant. Noted Feb. 26.

N. Y., Niagara Falls—The State Reservation Commission is having plans prepared by F. N. Williams State Engr., Capitol, Albany, for a power plant to be erected on Goats Island. Estimated cost, $3,000,000.

N. J., Bridgeton—City has plans under consideration for the installation of an electric lighting plant.

N. J., Newark—Maas & Walstein, Inc., Ave. R., has had plans prepared for the erection of an addition to its power plant and alterations to its boiler room. Estimated cost, $12,000.

N. J., Trenton—City is considering plans for a hydro electric plant to be erected on the Sanhican Creek. J. R. Fell, Jr., City Engr.

N. J. Trenton—J. E. Thropp Sons Co., Lewis St., will receive bids until Apr. 19, for the erection of an iron plant to include a power house, foundry, etc. Estimated cost, $100,000. J. O. Hunt, 114 North Montgomery St., Engr.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., will soon award the contract for furnishing and installing at Navy Yard, here, exciters switchboards, cell structures, cell equipment, wiring transformers, etc.

Penn., Portersville—The Fox Coal Co., Brannan, near here, has had plans prepared by C. D. Hall, Engr., Jenkins Arcade, Pittsburgh, for the erection of a power house at its plant.

Md., Baltimore—The Baltimore Manufacturing Co., Monument and Constitution St., is having plans prepared for the erection of a new power station on Central Ave. and Bank St.

Va., Norfolk—The Bureau of Yards and Docks, Navy Dept., Wash., will soon award the contract for furnishing and installing at Navy Yard, here, exciters, switchboards, cell structures, cell equipment, wiring, transformers, etc.

Ga., Valdosta—The Ocean Pond Club House plans to install an electric lighting plant to supply light to the house and grounds.

Ala., Chickasaw—The Chickasaw Shipbuilding Co. plans to build an electric generating plant to cost $750,000 in connection with its shipbuilding plant now under way at Mobile.

Tenn., Columbia—M. R. Sterns, Nashville, and associates, plans to organize a company with $200,000 capital stock, to build and operate an electric generating plant on the Duck River, near here.

Ky., Somerset—The Southern Machinery Exchange is in the market for a 150 kw., direct current, 250 volt belted generator and engine, or direct connected set.

Ohio, Bedford—The Owen Tire and Rubber Co., 1900 Euclid Ave., Cleveland, will build a 1-story, 250 x 250 ft., reinforced, concrete, steel and brick factory and power house; also install a high pressure boiler, steam engine and dynamo. Estimated cost, $125,000.

Wis., Brodhead—The Brodhead Electric Light and Power Co. has had plans prepared by Power Eng. Co., Engrs., 512 Corn Exchange, Minneapolis, Minn., for the erection of a 2-story, 40 x 80 ft., brick and rein.-con. hydro electric plant. K. Guelson, Supt. Noted Mar. 19.

Wis., Superior—E. Kaner has acquired a site and plans to build a plant and will install electric cranes in same.

Minn., Crosby—City voted to issue $76,000 bonds for the installation of an electric-lighting plant.

Wyo., Manville—City plans to build an electric-lighting plant. Estimated cost, $30,000.

Ark., Buffalo—The Dixie Mining Co. will soon award the contract for the erection of an electric lighting and power plant. Address A. C. Barnhart, Wheat Bldg., Ft. Worth, Tex. Noted Apr. 2.

Ark., Delight—B. F. Ryon, Texarkana, has been granted a franchise to build an electric lighting plant here.

Ark., Diaz—The Wilmans Mercantile Co. is in the market for machinery including power plant equipment, crusher, etc.

Ark., Hominy—The Hominy Icc, Light and Power Co. is in the market for machinery including a 150 hp. gas engine, direct connected to a 100 kw., 3 phase, 2300 volt generator.

Ark., Rector—The King Mercantile Co. is in the market for equipment for its power plant and cotton gin. About $25,000. L. King, Pres.

Tex., Texas City—The Texas City Electric Light and Power Co. plans to build an electric power station; also install a 100 kw. turbo generator with convertor, for street railway service and an emergency unit. R. C. Trubex, Mgr.

Okla., Blackwell—City plans to install additional electric lighting equipment. Estimated cost, $82,500.

Okla., Ferguson—The Blaine County Salt Co. plans to install electrical equipment in its new salt plant.

N. M., Columbus—The Columbus Electric Light and Power Co. plans to build a power plant here. Estimated cost, $30,000. J. L. Greenwood, Pres.

Wash., Seattle—The Rothert Process Steel Co., 622 Harriman St., plans to install a 10 ton electric furnace.

Calif., Oakdale—The Sierra and San Francisco Power Co., 58 Sutter St., plans to rehabilitate its old hydro-electric plant at Knights Ferry. Estimated cost, $10,000. M. C. McKay, Supt.

Ont., Drummondsville—The Dominion Power and Transmission Co., Terminal Bldg., Hamilton, has had plans prepared for the erection of a hydro electric plant. New electrical equipment will be installed. E. R. Coleman, Gen. Mgr.

Ont., Oshawa—Bradley Bros. is in the market for a 5 hp., 220 volt, single phase, electric motor, 170 r.p.m.

Ont., Owen Sound—The Empire Stove & Furnace Co., Ltd., is in the market for three 15-20 and 25 hp., 60 cycle, 550 volt, 3 phase motors, either new or second hand.

Ont., Owen Sound—Keenan Bros., Ltd., is in the market for a 60-75 hp. engine.

Ont., Toronto—The Universal Products, Ltd., 43 Britain St., is in the market for one 5 hp. and one 10 hp., 230 volt, direct current, medium speed motor.

Ont., Toronto—E. Whiting, 122 King St., E., is in the market for an 18-30 hp. steam traction engine.

Que., East Broughton—The Quebes Asbestos Co. plans to spend $30,000 for a power plant.

CONTRACTS AWARDED

Mass., Boston—The Tilestone and Hollingsworth Co., 49 Federal St., is building a reinforced concrete transformer house. Electric motive power is being installed.

Mass., East Hampton—The Glendale Elastic Fabrics Co., 52 Union St., is building a 1-story, 65 x 75 ft. power plant and switchroom. Estimated cost, $10,000.

Mass., New Bedford—The New Bedford Textile Co., 247 Shawmut Ave., is building a 1-story, 25 x 40 ft. boiler plant. Estimated cost, $40,000.

Mass., Springfield—The Undertakers Supply Corporation, Stearns Bldg., has awarded the contract for the erection of a new 25 x 30 ft. power house, to Gour Bros., 20 Woodmont St.

R. I. Westerly—The Narragansett Electric Light Co., Providence, has awarded the contract for the erection of a 1-story, 30 x 72 ft. addition to the gas house of the Westerly Light and Power Co., to the Joslin Lena Co., 20 Mechanic St.

Conn., Hartford—The Pratt & Cady Co., Capitol Ave., has awarded the contract for a 1-story, 30 x 103 ft. concrete and brick boiler room to be erected at its foundry on Cushman St., to Porteus & Walker Co., 13 Forrest St. Estimated cost, $23,000.

N. Y., New Hampton—The Department of Corrections, Municipal Bldg., New York City, is building a power house at the reformatory here.

N. Y., Syracuse—The Swan & Finch Co., 416 Tracey St., has awarded the contract for the erection of an addition to its power house, to F. M. Kimmey, 1007 West Onondaga St.

Penn., Indian Creek—The Mountain Water Supply Co. has awarded the contract for the erection of a 1-story, 31 x 71 ft. power plant, to the Rust Eng. Co. Penna. Bldg., Philadelphia. Estimated cost, $35,000.

Penn., Philadelphia—The Fretz Co., Ontario and Brabant St., has awarded the contract for the construction of a new engine and boiler house, to H. E. Brocklehurst, 512 West Norris St. Estimated cost, $19,000.

Penn., Pittsburgh—The Arrott Estate, Arrott Bldg., has awarded the contract for a new power plant to be erected on Barker Pl. to replace the one recently destroyed by fire, to Rose & Fisher, 821 Penn Ave. Estimated cost, $15,000.

Penn., Pittsburgh—The South Pittsburgh Water Co., Carrick, has awarded the contract for the erection of a new 45 x 115 ft. power house, to the Walker & Curley Co., Trust Bldg. Estimated cost, $35,000.

Ala., Columbia—The Columbia Power Co. has awarded the contract for enlarging its plant at Omussee, to Tucker & Laxton, Inc. Charlotte, N. C. Estimated cost, $500,000.

Wyo., Wheatland—The town has awarded the contract for a 120 kw. generator directly connected and a new switchboard, to the Fairbanks-Morse Co. Noted Mar. 5.

B. C., Vancouver—The Wallace Shipbuilding Co. has awarded the contract for reconstructing the entire power system to the Mudy Rowland Co.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Apr. 4, 1918	Individual Apr. 4, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular Apr. 4, 1918	Individual Apr. 4, 1918
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	5.10@5.85
Barley	3.40@3.65	3.10@4.10
Rice	3.90@4.10	4.10@4.85
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania..	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	April 4, 1918	One Yr. Ago	April 4, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat ..	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes...	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes...	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties April 4, 1918	Mt. Olive & Staunton April 4, 1918	Standard Apr. 4 1918
6-in. lump	$2.65-2.80	$2.65-2.80	$2.65-2.80
2-in.-lump	2.65-2.80	2.65-2.80	2.65-2.80
Steam egg....	2.65-2.80	2.65-2.80	2.65-2.80
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut....	2.65-2.80	2.65-2.80	2.65-2.80
2-in. screen...	2.15-2.30	2.15-2.30	2.50-2.65
No. 5 washed .	2.15-2.30	2.15-2.30	2.50-2.65

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba.	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule

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Lost Opportunity

Contributed by H. D. Odell

THE chief engineer was an intelligent and industrious young man, a correspondence graduate. Although only 25 years old, he had already put in eleven years at the game, having entered the engineering field as an oiler in an electric-light plant. In two years he was promoted to the position of night engineer. Attentive to his work and courteous to all, he made friends and a great future was predicted for him. At the age of 25 years he had realized his ambition and was a full-fledged chief engineer in charge of a street-railway power plant. But there was one thing that had never been impressed on his mind and that was "'never to accept favors from drummers."

THE manager of this railway system was a clean-cut, intelligent person and a first-class judge of men in general. This power plant was one of a string of six owned by a syndicate, and the manager was so efficient that the syndicate appointed him general manager of all six plants with headquarters in a larger city. Of course he had to employ a man to take his place in the position he was going to give up. He thought the young chief would make good if given a trial, but he wanted to find out a few things before deciding. He walked into the power house the next evening and, not finding the chief, was told that he was at home and decided to call on him there. He was invited in and found the chief taking down short-hand from his wife's dictation. He expressed his surprise, and the chief told him that he had been studying office work by correspondence for over a year. The manager was so well pleased that he almost told the chief of his intended promotion, but his better judgment prevailed and he decided to try him on honesty first. So, after talking about several proposed changes to be made at the plant, he left. Next day the manager called an oil drummer by 'phone and asked him to visit the chief and try to sell him some oil. The drummer did so, but the chief told him that he only made requisition to the manager, who acted as purchasing agent. The drummer said that he was anxious to place his oil at the plant and that if the chief would use his influence he would divide his commission with him. As he left he shoved a five-dollar bill into the chief's shirt pocket, the latter objecting rather weakly.

The manager visited the power house next evening and after talking with the chief for a while, asked him how his oil supply was and if he would need any soon. The chief stammered and said that he had plenty. The manager left, looking sad.

SEVERAL days later the drummer appeared again and told the chief that the chance he had waited for so long had come and he wanted to get his oil placed in the plant and would pay the chief well. He then said that the manager was going to be promoted and that a new man was to take his place, and when the change was made he expected him to purchase his oil. It would be easy, he said, as the new manager would not be familiar with the run of things for several weeks and the chief could make the change from one oil to the other without any danger and make some velvet besides. When he left he gave the chief $20 and did not have to push it into his pocket.

NOT knowing that he had been selected for the manager's position, the chief fell for the whole plan and upon reaching home told his wife that his influence was beginning to be recognized and then told her the whole story. Her woman's intuition almost saved him, for she begged him to take the money to the manager and order the drummer to keep away from the plant. She told him that the manager might promote him and wanted to know why he had been studying office work evenings for the past year if he did not expect to advance by the knowledge he gained. The chief maintained that the manager had nothing for him or he would have spoken to him before about the change.

The manager appeared at the plant again the next day to give the chief a chance to redeem himself, but the latter would not talk much, and as he felt guilty, he was glad when the manager had gone.

The manager left, a new man took his place and the oil deal was made two weeks later. The first of the next month when the general manager made his visit to the city, he called on the chief and told him he had heard of his little deal in oil, but that he had not entirely lost faith in him and was going to give him a chance to be honest. Then he told the humiliated chief of the opportunity he had lost for advancement.

Spontaneous Ignition of Bituminous Coal

BY J. F. SPRINGER

The author explains how the spontaneous ignition of bituminous coal occurs; cites the results of experiments made to determine conditions favorable and unfavorable to self-firing; gives tests by which to find out whether a certain coal is likely to ignite spontaneously; and points out methods of storing coal to prevent such action.

BITUMINOUS coal will often take fire without the application of a flame. This action is called spontaneous ignition or, more commonly, spontaneous combustion. In times past it was largely a mystery, and even at the present day it is not thoroughly understood in all its details; however, scientific men have learned enough about its causes to remove the cloak of mystery.

FIG. 1. CONCRETE COAL-STORAGE PIT OF THE OMAHA ELECTRIC LIGHT AND POWER CO.

Spontaneous ignition is believed to occur as follows: Bituminous coal exposed to the atmosphere absorbs oxygen slowly, and as a consequence of the oxidation, the temperature rises—slowly, perhaps, but nevertheless the coal gets warmer. Now, the higher the temperature of the coal the more rapidly will oxygen be absorbed from the air, and the more rapid the absorption of oxygen the faster will the temperature increase. Thus, each action accelerates the other until the temperature eventually reaches the point at which the coal will ignite, and spontaneous combustion ensues.

No external application of heat is necessary, though it will doubtless hasten spontaneous ignition. External heating—not necessarily at a high temperature, either—may start spontaneous combustion. For example, coal stored against a furnace wall or over a steam pipe may ultimately take fire spontaneously, although it would have remained safe from such eventuality if the furnace wall or the steam pipe had been absent. It is possible that, under favorable circumstances, coal that is merely warm when stored may develop spontaneous combustion. In the Cape Breton mining region in Nova Scotia the coal piled in heaps on the surface in the winter does not develop spontaneous combustion; but the very same coal stored in Montreal in the summertime in piles of less height is subject to spontaneous firing. It would seem as though the very moderate temperature of the coal due to the summer weather is sufficient to start spontaneous combustion.

Doubtless some coals are much more subject to self-firing than others, so that the conditions which result in no harm in one case will make all kinds of trouble in another. Anthracite seems to be proof against spontaneous combustion; it is bituminous coal that causes difficulty, and some grades give more trouble than others under the conditions of storage.

A very simple test may be applied to determine whether a coal is likely to ignite spontaneously. If it results unfavorably, great care should be taken in storing that particular coal. If the test results are only moderately favorable, caution should still be exercised. One form of test is as follows: Take a convenient quantity of the coal and weigh it pretty accurately. Heat the sample to 250 deg. F., hold it at that temperature for three hours, and then weigh it. If the weight has gone up 2 per cent. or more, the coal is a dangerous one, from the point of view of spontaneous combustion. The sample must be dry coal, the drying being done at about 100 deg. F. During the test a temperature of 250 deg. could be maintained by using a steam coil containing steam at a pressure of 15 lb. per sq.in., gage. Another simple form of test is as follows: Shake one grain of finely pulverized coal for five minutes with 20 c.c. (1.2 cu.in.) of a half-normal solution of bromine. Bromine has a bad smell. If the sample, at the end of the five minutes, has absorbed the bromine and destroyed the smell, then the coal is to be regarded as a dangerous one to put in storage.

The depth of a pile seems to have a good deal to do with the development of spontaneous combustion, according to experiments made in France some years ago. A pile of slack coal was constructed in such a way that its height or depth varied from nothing at all up to 20 ft. The length was 130 ft., and the width at the top was about 3 ft. This pile was under observation for some three months, and every day tests were made at points in its length, to determine temperature conditions down in the pile. The points tested varied in respect to their distance from the bottom; the deeper the pile the greater this distance. Disregarding the low end of the pile, the temperature rose pretty steadily from the beginning to the end of the three-month period. The temperature never got higher than about 160 deg. F. between the low end of the pile and a depth of about 13 ft. From a depth of 13 ft., the temperatures went up until at the deep end of the pile spontaneous combustion took place.

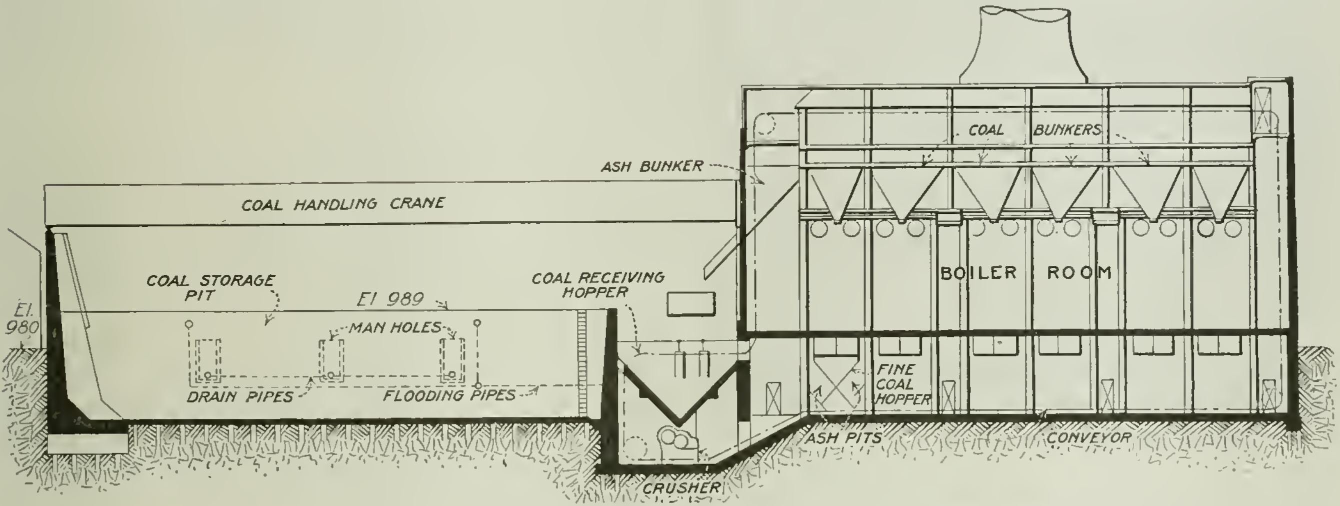

FIG. 2. SECTIONAL VIEW OF STORAGE PIT, RECEIVING HOPPERS, AND PLANT

There is reason to believe that for each and every coal there is a certain safe depth of pile which should not be exceeded. A 10-ft. pile is very likely safe for most bituminous coals, provided other conditions are not unfavorable; but 20 to 25 ft. is probably more or less dangerous for most coals. The New York Edison Co. has a big storage yard at Shadyside, N. J., where coal is stored in long piles which reach heights up to about 35 ft., and spontaneous combustion gives trouble at this yard. In fact, it is probable that most consumers who pile coal to heights exceeding 20 ft. have more or less trouble.

The oxygen absorbed by the coal is taken from the air in the spaces between the lumps, but it has been pretty well established that the amount of oxygen contained in these spaces is too little to account for the total absorption from the moment of storage up to the moment when the coal takes fire. If this is really the case, then there must be a circulation of air into and out of a coal pile. It has been estimated—for a particular case—that an entire change of air takes place once every 9½ hours, which would mean a very slow movement of air. An experiment with a coal pile having a cover with openings that could be closed showed that the temperature rose and fell as holes were opened and closed, respectively. That is to say, when the air supply was cut off, the coal cooled; and when air was admitted, the coal heated. This seems to indicate that if coal could be stored in an air-tight chamber, spontaneous combustion would not develop.

Fine coal is especially susceptible to self-firing, probably because there is much more surface exposed to the air in a ton of fine coal than in a ton of coarse. Wherever air touches the surface of a piece of coal, there is opportunity for the coal to absorb oxygen; so, the larger the surface, the greater the absorption of oxygen and the higher the rise of temperature. It is therefore disadvantageous to have a part of the coal in the form of dust or very small pieces. Such fine coal will naturally sift toward the bottom of the pile, which is a bad position; for it has already been pointed out that deep piles heat up more rapidly than shallow ones.

The circulation of air through coal appears to have a double tendency. First, the circulation continually supplies oxygen, increasing the rate of absorption and consequently the temperature; that is to say, the circulating air tends to promote spontaneous combustion. Second, the circulation of air tends to cool the coal and so operates to retard spontaneous combustion. As these tendencies are opposed, it is necessary to know which will have the upper hand, and that introduces a serious element of doubt. The safe thing to do is to put no dependence upon air made to circulate through a coal pile. It may bring trouble, instead of warding it off.

Another matter that is somewhat obscured in doubt is the effect of storing wet coal. Those who have made inquiries or who have had experience of their own do not seem to be agreed. About a score of years ago in Australia, an experiment was made to obtain information on this matter. Each of two similar bins, placed side by side, was charged with 245½ tons of the same grade of small coal. There was a roof over the bins, but surface ventilation was supplied, and the sides of the bins were of boards with the cracks left unstopped.

In the one bin, the coal was put in dry; but during the loading of the other a stream of water was played on the coal, which was made thoroughly wet, as was indicated by the leakage of water from the bin. Temperature observations were made from day to day in both bins. The temperature of the interior of the dry coal rose steadily until in about sixty days it reached 392 deg. F. in the central part of the coal. The experiment was then halted for fear of actual firing. The coal that was stored wet also increased in temperature until a maximum of 138 deg. F. was reached, after which time the temperature fell.

Paymaster G. R. Crapo of the United States Navy, with an experience gained in a subtropical climate, says that he has handled coal both wet and dry and has discharged vessels in a downpour of rain. He says that fires have occurred with coal stored in both ways, but that less trouble has been experienced with coal stored wet. But this is not the end of the story. A British investigation, by J. I. Graham, resulted in the following conclusion: "At temperatures below 122 deg. F., coal dust, when moist, absorbs oxygen at a rate approximately half as great again as dry dust." This means that under such conditions spontaneous combustion would be markedly promoted. J. Ashworth, lately of Vancouver, B. C., reached the conclusion, presumably from observation and information, that moisture had to be considered and that no gob fire in a mine would take place if the mine were dry and particularly if the air were dry. In years gone by, he was connected with a colliery where the gob heated up and where the coal when stacked above ground was subject to spontaneous firing. He notes that this self-firing "generally occurred soon after the first heavy shower of rain." What is to be concluded in this matter?

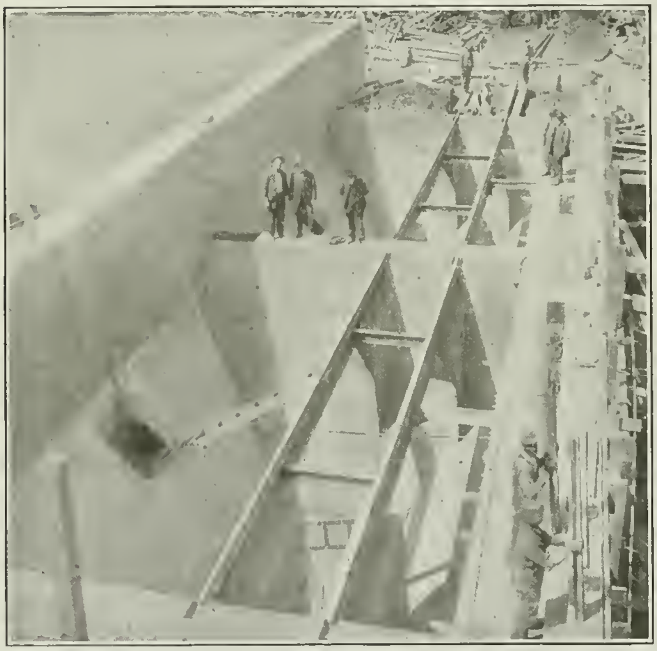

FIG. 3. RECEIVING HOPPERS FOR COAL

An investigation of Illinois coals seems to have favored, for those coals at least, the idea that wet coal is dangerous. "Any coal with conditions favorable to oxidation will be facilitated in that action by moisture. Without exception, in all the series of tests, the wetting of the coal increased the activity, as shown by the ultimate temperature."

The truth of the matter probably is that a little water will promote spontaneous combustion, but that a great deal will check it. But how much is "a great deal"? Is a generous sprinkling, as in the Australian experiment, sufficient? Or must there be complete submergence in a body of water? There seems to be no recorded case of self-firing originating with a coal that was fully submerged in water; but if the coal is merely damp or lightly sprinkled with water, it is probably in a dangerous condition. Old coal mixed with coal freshly mined is understood to be a dangerous combination.

There may exist an impression that spontaneous combustion seldom occurs. In contradiction of this idea, it is on record, according to the officer in charge of the coaling plant, that at the United States Naval Station at Key West, Fla., sixteen cases of spontaneous combustion occurred in a period of less than 100 days. This was during the winter of 1914-15 at this subtropical location. The Canadian Pacific Railway's big storage yard at Montreal has been productive of repeated trouble from spontaneous combustion. The Chicago & Alton R.R. some years ago had a coal-storage pile 10 ft. high, containing a considerable percentage of slack. Notwithstanding the moderate depth, this pile took fire in several places.

Fires due to spontaneous ignition apparently do not occur on the surface; they occur down in the coal. A lighted match or a cigar stub could not very well account for a deep-seated fire. Spontaneous combustion is a real danger in connection with coal storage and can no longer be doubted or ignored. The thing to do is to provide against its occurrence.

There is at least one certain and sure method—complete submergence of the coal in water. Such submergence operates in two ways. In the first place, it cuts off the oxygen supply, which is most important. As the coal cannot get oxygen, there will be no absorption of this gas and no consequent heating. In the second place, the water is sufficient in amount to keep the temperature fairly uniform. There can be no spontaneous combustion unless the temperature rises to the point at which coal takes fire, known as the ignition point.

Complete submergence is neither unheard of nor unused. The United States Navy is using submergence for large quantities of coal at the coaling stations at the Atlantic and Pacific ends of the Panama Canal. Depressed storage floors are provided at both points, and the arrangements are such that from 20 to 30 ft. of t bases of the coal piles on these floors is submerged salt water.

The Underground Railways of London have an electric generating station at Lot's Road. Here a tank for totally submerging coal in quantities up to 15,000 tons has been constructed and put in operation. The tank is of steel and is operated by means of their existing coal-handling equipment. The company has dry storage in addition.

An interesting example of a submerged-storage pit for bituminous coal is that of the Omaha (Neb.) Electric Light and Power Co., in which 6000 tons can be stored under water. Fig. 1 is a general view of the storage pit filled with coal, showing also the crane by which the coal is handled. Between the pit and the power house are two receiving hoppers over which runs the railway siding. A longitudinal section of the plant and pit is shown in Fig. 2. The pit is built of concrete, with walls 22 ft. high on three sides. On the fourth side the wall is 16⅝ ft. higher. This high wall parallels the west side of the power house and not only forms one of the sides of the pit, but also serves as a fire protection for the near-by plant of the Omaha Ice Co. and supports one rail of the crane runway. The other rail is carried on a girder along the side of the power house.

The two receiving hoppers, shown in Fig. 3, are of reinforced concrete, and each has a capacity of 50 tons. The function of the receiving hoppers is to receive coal that is to be consumed at once. As the railway track is directly overhead, it is only necessary to spot the cars at the proper points and make delivery by gravity, with or without the assistance of men. Coal going into storage is taken from the cars by a grab bucket on the crane. As the crane spans both track and pit, the coal may be readily delivered at any desired point. The span of the crane is 143¼ ft. from center to center of wheels. The grab bucket has a capacity of 1½ cu.yd., and the lifting power of the crane is 5 tons. This handling device is guaranteed to deliver 50 tons of coal per hour from the car to the center of the pit.

WALLS AND FLOOR REST ON PILES

The site of the pit is underlaid by quicksand, and so the walls and floor are carried by piles. Apparently all the floor piles, and possibly the wall piles also, reach down to rock and accordingly act more as columns than as piles. The pile heads terminate just beneath the floor, and each is surrounded by a square cap of concrete 2½ ft. on a side and 1 ft. thick. In estimating the loads, the engineers placed the full load on the piles and none on the soil between the piles. There is a certain amount of reinforcement in the floor slab. At the same time it is not a part of the design that the floor shall withstand an unbalanced upward pressure of water beneath it. There is such a pressure, especially when the river is in flood, but the downward pressure of the water and coal in the pit operates against it.

A recent pit for submerged storage is the one built for the Duquesne Light Co. on Brunots Island at Pittsburgh[1]. This pit is 150 by 800 ft. in plan and 25 ft. deep. The bottom is horizontal, but the sides slope at an angle of 45 degrees.

A blanket of carbon-dioxide gas would probably be quite as effective as submergence in water for preventing spontaneous ignition. Such a blanket might be relied upon to remain in the tank because of the fact that its specific gravity is greater than that of air; but it might be necessary to extend the sides of the tank a few feet upward to prevent dissipation of the gas by passing currents and the like.

The things to be done when spontaneous combustion occurs are to dig out the fire and either burn the affected coal at once or remove it to a safe place. Flooding with water is not advisable; for the coal over the fire may coke, and form a dome-like shield capable of affording a good deal of protection against water. At Shadyside spontaneous combustion is dealt with by digging out the fire and sending the affected coal to the power station.

Power-Plant Measuring Instruments

By H. TAYLOR

Plants of, say, 150 hp. or less are as a rule the ones where the absence of measuring instruments is most noticeable. Picture, if you will, such a plant consisting of one 150-hp. horizontal return-tubular boiler operating under forced draft, one pump feeding through a closed feed-water heater, and one injector for emergency use; one 100-hp. automatic cutoff, high-speed engine belted to a lineshaft and one little air compressor tucked away in a corner where no one can get at it, trying its best to do the work of a 50 per cent. larger machine.

The tools usually supplied to such a plant consist of the following: The remains of a No. 7 scoop shovel; one fire hoe with the blade badly burned and loose on the handle; one garden hoe with handle split, to be used for cleaning the ashpit; one iron body wheelbarrow with a large hole eaten through the bottom and one leg loose; a few broken wrenches, a hammer and an old tomato can to fill the oil cups with. The engineer must be on duty at 6:30 a.m. in order to have power on at 7 a.m. He must wheel his coal about fifty feet to the boiler room, do his own firing, including cleaning fires from stationary grates twice during the ten-hour run, and then wheel away the ashes in all kinds of weather. He is responsible for and must look after the boiler and engine plant throughout the entire day and occasionally repair a steam line or splice a broken wire in the mill.

This type of plant is more common than some of us believe, perhaps. Suppose this is the type of plant I am about to take charge of. I get after the manager as follows: "Mr. Manager, I have come to ask your coöperation to the extent of purchasing the necessary implements and instruments that I may conserve fuel, oil and other supplies, thus aiding the Government and benefiting yourself—first of all, a set of good tools, a list of which I submit herewith, that I may be able to do my work quicker and better, thereby giving me more time to study the peculiar needs of the plant. Next, I will need a thermometer to put on the feed line to the boiler—the cost is trifling compared with its value—a boiler-room scales and a water meter, that I may be able to weigh the coal and measure the water to determine whether I am getting a reasonable water evaporation per pound of coal. I would then suggest a gas-analysis instrument to find out whether we are getting the benefit of the greatest number of heat units possible. By the aid of these tools and instruments I can get the boiler plant working more efficiently and save many pounds of coal. For the engine room I will need a few suitable oil cans to save gallons of oil which today costs 'real money.' After making steam economically, we should not fail to use it economically, therefore I will ask you to purchase a good steam-engine indicator that I may make sure the engine valves are set properly and not wasting steam.

"With the aid of these instruments we can tell from day to day just what our power costs, and I feel certain we can reduce that cost, thereby conserving coal and saving money for the company. Now, Mr. Manager, just one more suggestion. If you will allow me access to the vouchers pertaining to my department I will be able to prepare a tabulated cost sheet of the whole power plant."

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[1] See *Power*, page 650, Nov. 13, 1917.

Underground Steam Mains

BY CHARLES L. HUBBARD

This article treats of tunnel and conduit construction. Various types of conduits selected from those in common use are described. Wood conduits are still extensively used where it is desired to avoid the expense of concrete and tile. Insulation of piping.

ONE of the most important details connected with underground steam mains is the form and construction of the conduit. This serves the purpose of protecting the pipe from moisture and also forms a part of the insulation for reducing heat loss. In some cases, as with wooden conduits, both of these offices are combined to a large extent in the same casing, while with those of masonry the walls of the conduit only serve as a protection to the special insulation which surrounds the pipe, tile or concrete in itself offering a comparatively small resistance to the transmission of heat. The forms of construction shown have been selected from those in common use, with the idea of illustrating different types. Some of them are patented, while others have come into general use through the experience of various engineers.

VARIOUS KINDS OF WOODEN CONDUITS

Wooden conduits, the oldest type, are still extensively used where it is desired to avoid the expense of concrete or tile. With some of these the wooden casing forms both protection and the only insulation, while in others an additional insulating filling is placed around the pipe inside the conduit. The life of a wooden conduit depends largely upon the quality of the wood employed and the nature of the soil in which it is laid, whether wet or dry. A typical conduit or casing of this kind is shown in Fig. 1. The main body in this case is composed of a thick wooden wall lined with bright tin and protected on the outer surface by a coating of waterproof asphaltum cement. Solid turned logs are employed for pipe sizes up to 6 in.; larger sizes are built up of staves, put together with mortise-and-tenon joints, coated with a creosote preservative and strengthened with heavy galvanized wire. The thickness of shell varies from two to four inches, according to requirements. The sections are made in lengths of six to eight feet, cylindrical in form, with space inside for rollers and supports. Wood casings of this type have been known to give thirty years of service. Fig. 2 is a section of a conduit of this kind, showing its make-up and method of drainage.

Porous-tile drain pipes are laid below and at either side of the conduit, with a layer of crushed stone between to prevent surface or ground water from settling around the casing. This is an important detail of conduit work, especially where wood is used, as the length of service depends largely upon the degree of dryness which is maintained. Another wooden conduit is shown in Fig. 3, and consists of a tin lining outside of which are layers of asbestos, wood, corrugated paper and, finally, an outer casing of wood staves coated with asphaltum. This form has the advantage of being removable for repairs to the pipe.

A simple form of conduit, often used around railroad yards and industrial plants where the pipes are carried a short distance below the surface, is shown in Fig. 4. The box is of rough lumber, usually about two inches thick, and is set over broken stone with a tile drain below. Any water that finds its way into the conduit is drained off through holes bored in the bottom of the box at frequent intervals. The pipes are supported upon rollers strung on a stay-bolt, also serving to strengthen the box. Stiffening pieces are nailed to the sides and bottom of the box to give it additional support. The life of a wooden conduit of this type in fairly dry soil with the trenches well drained is estimated at 16 to 30 years. One trouble experienced with wooden conduits comes from the great difference in temperature to which they are exposed during the heating and nonheating season. In some cases they shrink or swell, causing serious damage, and sometimes, to avoid this, it has been considered more economical to keep steam on the mains all summer, shutting off the branches to the various buildings just inside the basement walls. The tile underdraining already mentioned appears to be necessary to long life as instances are common where conduits so protected have been found in good condition after 25 or 30 years, while those without underdraining have had to be renewed in seven to ten years.

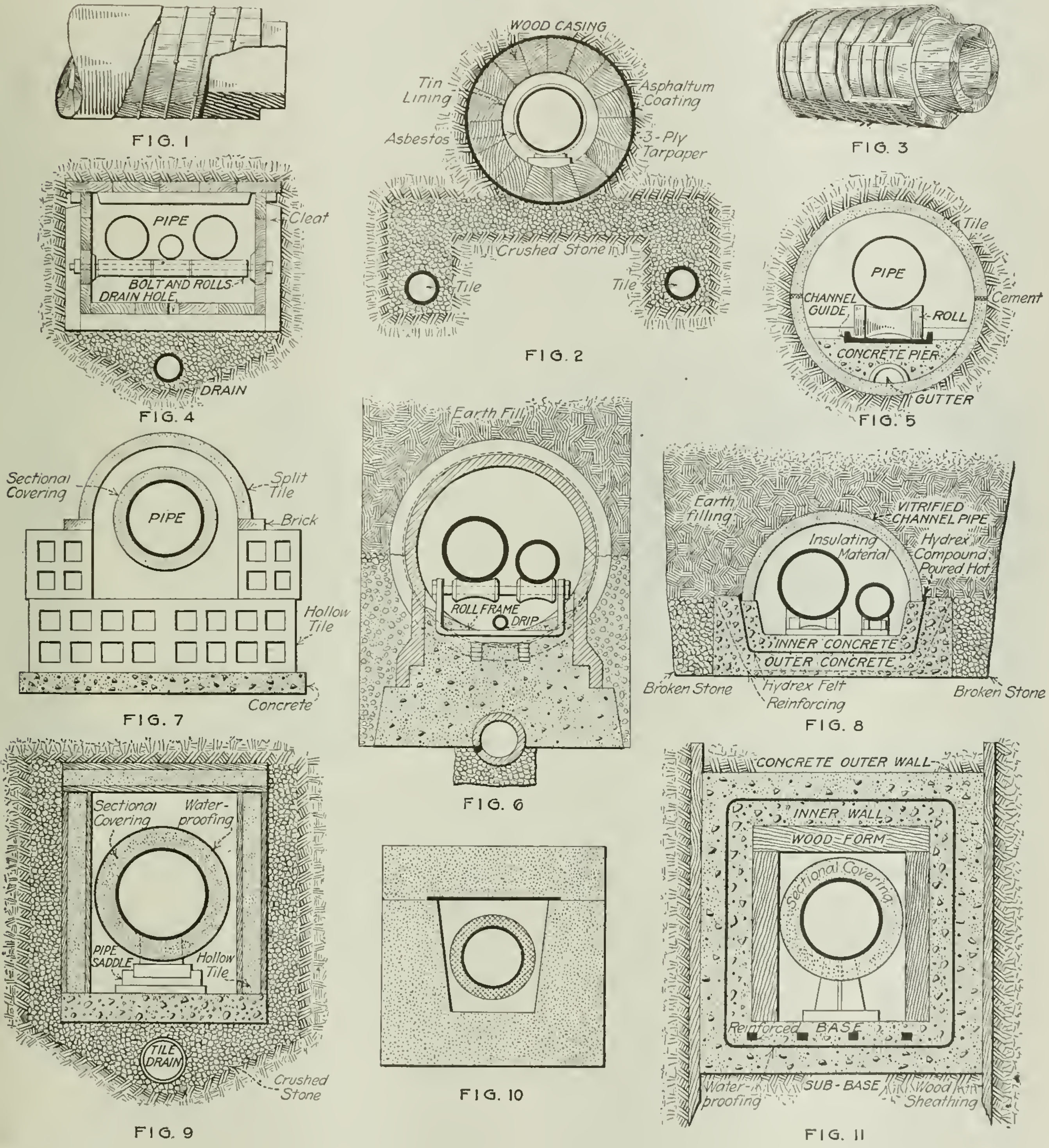
The objectionable points mentioned in connection with wooden conduits have led to the adoption of materials that are not affected by heat or moisture, among which are brick glazed sewer piping, hollow tile blocks, concrete and combinations of these. A well-constructed conduit of masonry is practically indestructible so far as general deterioration is concerned, but is susceptible to the action of frost, the bursting of pipes, etc., which limits its useful life to that of the pipes which it contains unless it be of such form that the top may be removed without damage to the lower half.

GLAZD-TILE CONDUITS

A common form of glazed-tile conduit is illustrated in section in Fig. 5. The lengths are made with longitudinal grooves, which allow of their being split in halves with considerable accuracy after being burned. The lower half is first laid in the trench, after which the pipe is put in place supported upon iron cradles or rollers and the space around it filled with insulating material. The cover, or upper half, is then put in position, the space around the pipe packed with insulating material, completely filling the conduit, and the joints then made tight with portland cement. One difficulty experienced with tile conduits is in supporting the pipe, as bolts cannot be used to hold the saddle in place. A simple device for a single pipe is shown in Fig. 5 and consists of filling in the bottom of a section of the conduit with concrete forming a pier 10 or 12 in. in length, in the top of which is set a piece of channel iron, forming a guide for the roller supporting the pipe. The ends of the pier are raised sufficiently to prevent the roller from falling out of place, and a gutter beneath the pier allows any water in the bottom of the conduit to drain away. When there are two or three pipes to be supported, a saddle or frame carrying the required number of rollers may be built into the concrete base in place of the channel-iron described.

A patented split tile conduit especially adapted to extensive systems of piping is illustrated in Fig. 6. The principal feature is the method of supporting the pipe rollers and anchors by using a tee in the conduit line with the side outlet turned down and built into a heavy concrete base. The pipe support or anchor is embedded in this, as indicated in the illustration. Drainage around the conduit is secured by gravel filling, crushed stone and a tile underdrain.

A combination type of conduit used by one of the largest distributers of steam in their latest construction, shown in Fig. 7, consists of a concrete base upon which is laid a flooring and side walls of hollow tiling carried up to the center line of the pipe and on top a line of brick and over the top a half section of glazed sewer pipe. The joints between the tile in the side walls and bottom are left open to drain off any water that may find its way into the conduit. To prevent a circulation of air from tile to tile in a longitudinal



FIGS. 1 TO 11. VARIOUS TYPES OF UNDERGROUND PIPE-LAYING AND CONDUIT CONSTRUCTION

direction, bricks are set up on edge between the sections, forming dead-air spaces which add to the insulating effect. The steam pipe is covered with sectional covering, and the space between it and the conduit walls is packed with mineral wool.

A patented conduit of special construction particularly adapted to wet locations is shown in Fig. 8. The lower half, which is of concrete, is first constructed and the pipes are laid, after which the tile cover is put on and made tight by a cement dam at the sides and a special waterproofing poured, while hot, into the joints. The conduit shown in Fig. 9 is similar to Fig. 7, except that the sides and top are of hollow tile laid crosswise on a concrete base; this arrangement of the tiling limits the length of the air spaces and prevents air circulation. The entire trench, except the top, is lined with crushed stone, and a porous-tile drain is laid under the center.

One of the simplest forms of continuous concrete conduit is shown in section in Fig. 10. When the trench is dug, a mold is made of boards with a core to form the slot at the center. The concrete is then filled in, forming the bottom and side walls. After this has set for about twelve hours, the core is removed and the pipe may be laid, a strip of sheet iron placed over the slot and the covering layer of concrete filled in. If the ground is likely to hold water long after rain, it is well to coat the sides and top of the conduit with hot coal tar.

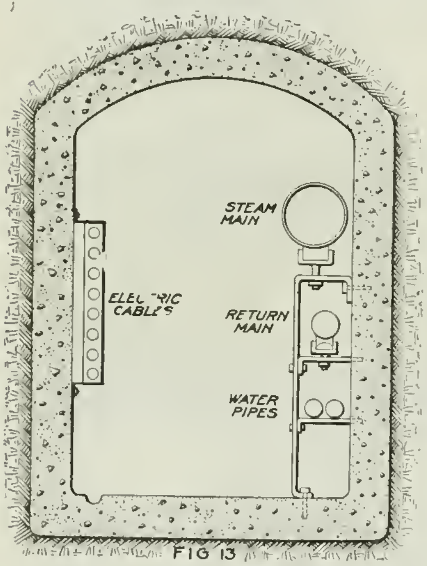


FIG 13

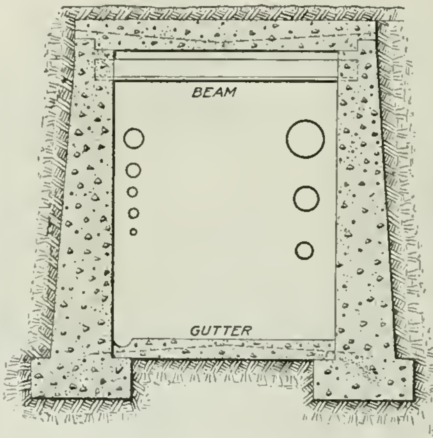


FIG 12

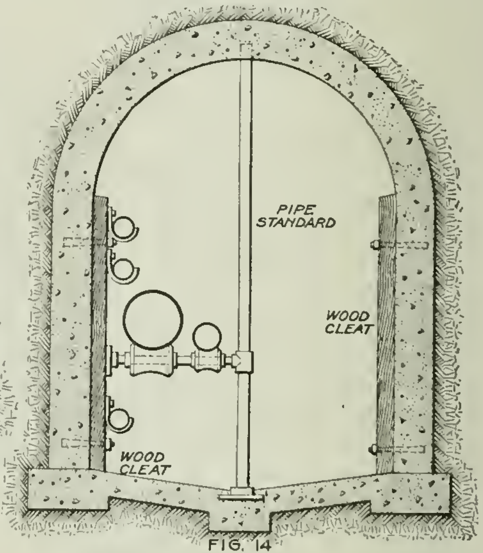


FIG. 14

FIGS. 12 TO 14. TUNNEL DESIGN AND MEANS OF SUPPORTING PIPES AND CABLES

There is no item of greater importance concerning underground heating mains than the protection of the piping from outside moisture. The presence of water in the conduit, especially if it reaches the piping, greatly increases both the heat loss and the deterioration of pipe and insulation, therefore conduits should be thoroughly underdrained with tile laid in coarse gravel or crushed stone, special care being taken to provide a free outlet for the drains to keep the trenches clear of water.

The National District Heating Association has recently made an investigation of different methods of underground conduit construction with special reference to waterproofing and has submitted the type shown in Fig. 11 as one of the best "home-made" arrangements when material and the degree of skill required in its construction are taken into account. In laying this conduit wooden sheathing is driven along the sides of the trench to a distance of at least a foot below the sub-base. Seepage water is kept out by means of pumps and the sub-base and outer walls poured nearly to the top, an inner form of course being used. When this outer shell has set, the inner faces, sides and bottom are brushed with hot asphaltum, a layer of felt or burlap is pressed against it and the surface again brushed with hot asphaltum as before. From four to six layers of this material are used, taking care to give it a good lap, each being joined to the previous one by brushing it over with hot asphaltum. The strips of felt or burlap are run at right angles to the line of the trench and the ends carried well above the sides of the preliminary outside walls and folded back, awaiting completion of the top, or cover. Next, the inner reinforced base is poured, the pipe installed and insulated either by a sectional covering or by packing it in some suitable insulating material. The wooden form for supporting the inner walls and top are left in place, serving as additional insulation. After the inner walls and top are poured, the felt is folded over the top, layer by layer, each being brushed with hot asphaltum as previously described. Last of all the outer or preliminary side walls of concrete are carried up and over to make a complete envelope. Although no under-drain is shown, it is always advisable to provide one if it is possible to secure an outlet at such a grade as to drain away the surface water from around the conduit.

Tunnels have the advantage of accessibility to the piping, but their excessive cost as compared with conduits limits their use to special cases. They are most frequently employed in connecting buildings of an industrial plant where a considerable number of pipes and electric cables are to be put in. Tunnels were formerly constructed of brick, but reinforced concrete is now employed almost exclusively. One form is illustrated in Fig. 12, having a reinforced floor and roof and monolithic side walls. The roof slabs are made in sections and cemented to the walls and are therefore removable. The I-beams just below the roof, for attaching pipe hangers, are spaced 10 or 12 ft. apart. They may, however, be buried in the roof slabs with only the lower flange projecting. Pipes run in tunnels should be carried close to the walls so as to allow a free passage, either at one side or in the center. Fig. 13 shows a tunnel having an arched top and made of solid concrete. Special attention is called to the construction of the rack for carrying the pipe chairs, designed so that sections of the top pipe may be removed directly, while those below must be slid out from behind the front support of the rack, which is not objectionable in the case of small or medium-sized piping. Another method of supporting pipes and cables is shown in Fig. 14, in which pipe standards are erected at the center of the tunnel and cleats are bolted to the wall opposite the standards. Heavy piping is carried on horizontal supports attached to the standards and cleats, while small pipes, cables, etc., may be carried on hooks or other devices fastened directly to the cleats. Special care must be taken in the insulation of tunnel piping and the ends of the tunnel should be tightly closed to prevent any circulation of air which would tend to increase the radiation losses.

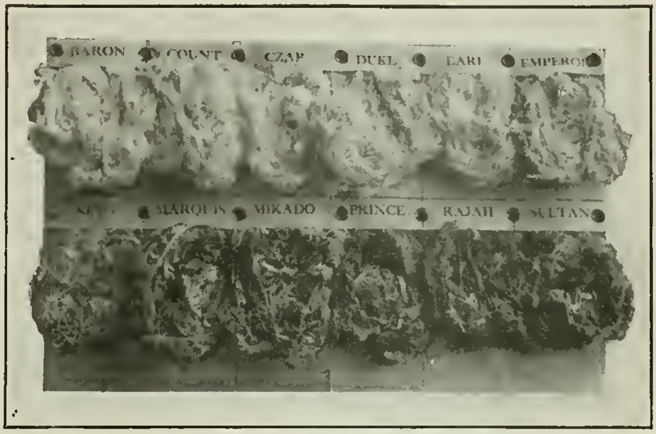
When considering the insulation of a pipe, the entire covering, including the conduit, must be taken into account. Where pipes are carefully packed with suitable nonconducting material and incased in tile or concrete, the efficiency will be somewhat more than for sectional covering, owing to its greater thickness. Conduits of this kind are usually made of such size that the thickness of the insulation shall not in any case be less than three inches, which should bring the efficiency of the entire conduit up to 90 or 95 per cent. The insulating material for this purpose should be especially adapted to conduit work, such as granulated cork, fossil earth, asbestos fiber and ground sponge. Mineral wool may be used when the pipe is protected with some form of sectional covering to prevent the corrosive action of the mineral wool. In the case of brick and concrete tunnels the pipes should be covered with some form of sectional covering that has the property of resisting dampness as well as preventing the loss of heat, for tunnels may be dry in winter, when heat is on, but during the summer, when steam is shut off, moisture is likely to gather. The best grades of sectional covering have an efficiency of 75 to 85 per cent., which refers only to the covering on the pipe and not to the conduit as a whole. The insulating effect of the tunnel will depend largely upon the tightness of the manhole covers and the pipe openings into various buildings. If there is a perceptible circulation of air through the tunnel, the insulating effect of the walls will be neutralized, based on the principle that a dead-air space around the pipes is important in reducing radiation losses. Similarly, in tunnel construction, the circulation of air through it should be kept at a minimum.

"Royal" Family of Waste

What is cotton waste? "The answer to that is simple," say some, yes, probably most engineers. "Cotton waste is the yarn remnants from cotton mills, and we use it to wipe up power-plant machinery. Waste is waste, but what is the idea of the question?"

Waste is not waste; there is as much difference in the grades of cotton waste as there is in shoe leather. As a matter of fact there are many grades of cotton waste, and that which is suitable for one kind of work is not good for another. A good waste should be standardized as to quality, and that is what the Royal Manufacturing Co., Rahway, N. J., has done in the production of twelve grades of cotton waste. Six of these grades are white and six are colored. The illustration shows the sampling catalog on which are mounted a sample of each of the twelve standard grades manufactured by this company. The upper row represents the white and the lower the colored grades.

When an engineer receives this sample card he orders a 100-lb. bale of, say, Duke. Some time later he orders a second bale of the same grade, and it will be the same in quality as the first order because each grade of waste is made from the same prescribed grades of materials which are procured from cotton mills that manufacture a certain grade of cotton or yarn cloth.



SAMPLE CARD OF ROYAL WASTE

A high-grade waste will not leave lint on a machine after wiping it, and it will have the maximum capacity for absorbing oil. A poor grade will possess just the opposite quality. In order to know how to intelligently purchase waste an engineer must know to what use it is to be put and he must also be somewhat acquainted with the grade of waste that is made by the manufacturer of whom the purchase is made.

Some prefer clean white waste, which, of course, is made from white raw material; others favor the use of colored waste, which is made from yarns which have been dyed in various colors. One reason for the preference for white waste is that after it has been soiled the user is more likely to open it up, bringing the clean portion to the outside, thereby using all clean portions before throwing it away as too dirty to use. Colored waste has a soiled appearance to begin with and is likely to be thrown away before it has been thoroughly used; therefore, when purchasing waste a consideration of the type of men who will use it is of importance.

Referring to the illustration, the grade designated as Baron is a fine, long-fibered, high-grade waste suitable for polishing varnished surfaces, etc., and is not recommended for general use. Grades Count and Czar are high-grade wiping wastes and Duke and Earl are for general-utility work and fit the pocketbook as well as the requirements of the purchaser. Emperor grade, although it can be used for wiping purposes, is really not suitable for such work, because it does not give the service, being coarse in texture and is somewhat dirty to begin with. It is usually employed by oil companies for mopping up oil.

The best grade of colored waste, King, is equal in quality to Czar and Duke grades of white waste, at the same price. King and Marquis are for general wiping and are used largely by railroads, as well as in power plants. Mikado and Prince are for general-utility work and Rajah is for rough work such as putting into the journal boxes of railroad rolling stock. Sultan is in the same class as the white Emperor, both being of a low order of the Royal family, being fit only for dirty work. Sultan is for use in foundries for protecting the hands of the workmen when handling the ladles of molten metals, etc., and for starting fires.

Having determined on the grade of waste wanted, the engineer is also interested in knowing how much will be delivered with an order for a 100-lb. bale. That is, how many pounds of burlap, paper and iron hoops is to be paid for at the price of waste. Here is what he receives in the Royal brand of, say, a 100-lb. bale: First, 94 lb. of waste, it does not matter what grade, is weighed in a basket. The burlap wrapper paper and iron hoops are also weighed, the total for each bale being just 6 lb. After the waste has been pressed in a bale, it is again weighed and if there is a gain or loss in weight enough is taken from or added to the bale to bring the total weight up to 100 lb. Therefore the tare on every 100-lb. bale of waste in just 6 lb., no more and no less.

This waste is put up in bales of 25, 50, 100, 250 and 500 lb., but in each case the tare is 6 per cent of the total weight. With this standardization of the bale the engineer knows just how much useless material he is getting with his waste; in some instances with certain dealers the tare runs as high as 14 per cent. of the total weight of the bale.

All raw waste material of the Royal brand is hand-picked and screened; the yarn that goes to make up the grade of finished waste is thoroughly mixed by hand, and the mixture is machined twice to give uniformity of texture. This applies to all grades except the lowest grade of colored waste.

Mono-Rail Hoist Handling Ashes

A few years ago, in most cases ash-handling machinery was "conspicuous by its absence" and the ashes were almost allowed to take care of themselves, so that designing machinery to handle them in old boiler houses is an undertaking that must be viewed from a number of different angles. The device adopted must save labor; its first cost and maintenance must be low, and it should never entail a lot of changes in the old building, with the consequent expense. A mono-rail electric hoist with a bottom-dumping bucket lends itself readily to such installation, especially where the ashes are pulled out on the boiler-room floor. The illustrations show a Link-Belt Mono-Rail Hoist of this type that is giving excellent results in the plant of the Philadelphia Paper Co.

This machine runs on the lower flange of an I-beam track and is operated by a man riding in a trailer cage, who controls the raising or lowering of the bucket as well as the travel of the hoist. The track runs through the boiler house and continues on out over a railroad car on the siding. Laborers fill the bucket, and the operator then hoists it and runs it out over the car, and dumps it by the motion of a lever in the cage. The current required is very small, and the saving in time and labor by this method compared with that of wheeling the ashes is notable. In this instance the superintendent designed his own track supports. It is evident that while he did the work quite cheaply, he made a thoroughly good job of it. About thirty tons of ashes are handled daily, pulled out every six hours. Two men do the work of shoveling into the bucket, and at times one of them gets into the cage and runs it out over the car; at other times, to hurry the work, an additional man operates the hoist, remaining in the cage. The bucket holds 1½ cu.yd. and is handled by a two-ton hoist. The machine is very compact and requires little headroom, and all the gears are entirely inclosed in housings and operate in oil.

TYPICAL USE OF MONO-RAIL HOIST

In places where an overhead coal bin cannot be installed for lack of space, it may then be practicable to use the same mono-rail system to handle the coal as well as the ashes, using either the bottom-dumping or a tipping bucket to discharge coal into the stoker hopper as the case may require, or, sometimes better even, a bucket with a small chute and undercut gate is often used. This problem of handling ashes mechanically is daily becoming more urgent, as many plants are now running twenty-four hours a day where two years ago they were running only ten; hence they have over twice the ashes to handle, with labor scarce. Many plants have stokers and forced-draft systems put in to increase their capacity, without providing for the handling of the ashes.

Some Old Firebox Boilers

By R. E. McNamara

The illustration, Fig. 1, represents one of two firebox type of boilers recently removed from one of the power houses of the Calumet & Hecla Copper Co., Calumet, Mich., the combination of size, age, design and serviceable condition being so unusual as to merit a few words of description.

These boilers are 84 in. diameter, 34 ft. 9¾ in. long and have 52 sq.ft. of grate surface, two 6-in. safety valves and double firebox. Being about forty years of age, they have been discontinued from service, although a test strip cut from one of the shells showed practically no diminution on tensile strength or elongation.

One of the unusual features is the quintuple-riveted butt joint and the rigid head bracing; even in the modern boiler nothing is found, as a rule, above the quadruple butt joint with 94 per cent. efficiency; and when it is considered that this boiler was built in 1878, not only was it a leviathan for its time, but it represents engineering and boiler-making practice which, to say the least, is by no means universal even at the present day. The firebox or furnace of one of these boilers partly demolished is shown in Fig 2.

In explanation of the apparent longevity of these boilers, it might be noted that one of the contributory factors is the remarkable purity of the Lake Superior water and the close attention in care, washing and repairs that the boilers have received since their installation.

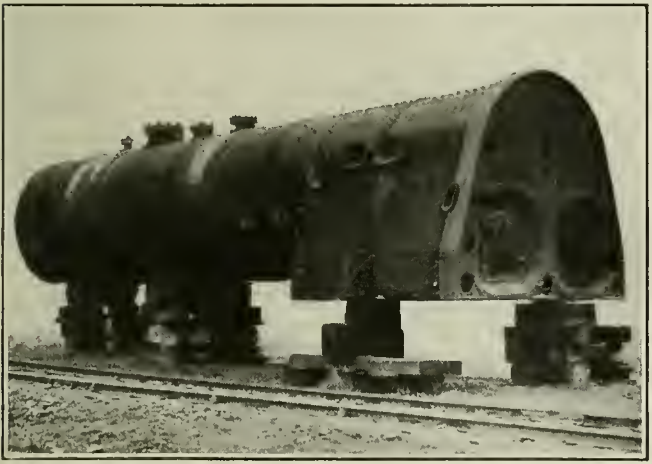


FIG. 1. FIREBOX BOILER REMOVED AFTER 40 YEARS OF SERVICE

Other similar boilers are still in use, but they are limited to comparatively low pressure; that is, around 100 lb. Other and later types in the same power house are of similar design, but are somewhat larger and are allowed 170 lb. pressure.

[Since receiving the foregoing we have obtained some additional information from F. W. Dean, mechanical engineer, formerly of Boston, Mass., and now with the Emergency Fleet Corporation in Washington. In speaking of this type of boiler, Mr. Dean expresses the opinion that the first ones of 90 in. diameter were designed in 1882 or 1883. Mr. Dean made the first drawings of the 90-in. boilers which were designed by E. D. Leavitt at his office in Cambridge, Mass., and were built by Edward Kendale & Sons of that place. The steel was acid openhearth and was rolled by the Nashua Iron and Steel Co., of Nashua, N. H. The nozzles were of steel plate rolled up and flanged, and with thick plates riveted to the flanges.—Editor.]

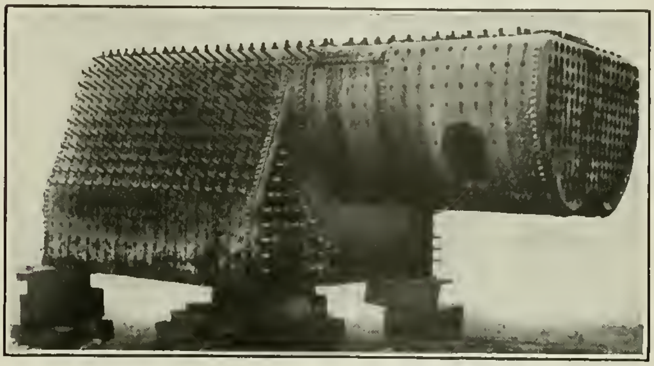


FIG. 2. SHOWING STAY-BOLTS AND TUBE SPACING

Steam-Carrying Capacity of Pipes

Several readers have written, suggesting that it would be of interest to know what formula was used by Mr. Thies in computing and laying out the charts for the carrying capacity of pipes, in the issue of Dec. 18, 1917, pages 825 and 826. Following is Mr. Thies' reply:

These charts were made after a careful study of an article on "Flow of Superheated Steam in Pipes," by E. H. Foster before the A. S. M. E. in May, 1917 (Volume 29 of the Transactions). These charts are good only for short runs of pipes such as mains and branches in power plants and are not figured on a basis of pressure drop. The formula is:

$$A = \frac{2.4PC}{V}$$

in which

A = Area of pipe in square inches;
P = Pounds of steam passing per hour;
C = Cubic feet of steam per pound;
V = Velocity in feet per minute;
2.4 = Constant.

The Continental heat unit, or calorie, is the quantity of heat required to raise the temperature of one kilogram of water one deg. C., and as 1 kg. is equal to 2.205 lb. and 1 deg. C. is equal to 1.8 deg. F., it is obvious that one calorie measures the same quantity of heat as does 3.969 B.t.u. This is shown by multiplying 1.8 by 2.205. It is usual when translating from the English and American standard to the Continental or metric standard of heat measure to call 1 calorie equal to 3.97 B.t.u.

A ready means of remedying leaks in engine casings is by filling cracks with litharge and glycerin.

Parallel Operation of Direct-Current Generators

By T. F. BARTON

The elements that must be considered when operating direct-current generators in parallel are discussed, and the adjustments that may be made to obtain the proper characteristics are pointed out.

ELECTRICAL generators are considered as operating perfectly in parallel when the load divides among the several units according to their rating, this proper division of the load holding as the load varies over the entire operating range of the machine. Parallel operation is considered satisfactory when this perfect condition is approximated within a small percentage.

For successful parallel operation machines must have approximately the same voltage characteristics. It is therefore impossible to operate shunt- and compound-wound generators in parallel or compound machines of greatly different characteristics, although the equalizer used with such machines tends to give each the same effective compounding.

The simplest case of parallel operation in so far as connections and electrical characteristics are involved. is found in the shunt-wound noncommutating-pole type machine, Fig. 4. If two shunt-wound machines are connected together at no load, and no change is made in their field rheostats, then the voltage of both machines will decrease with increase of load, and the two machines will divide the load as determined by their voltage regulation.

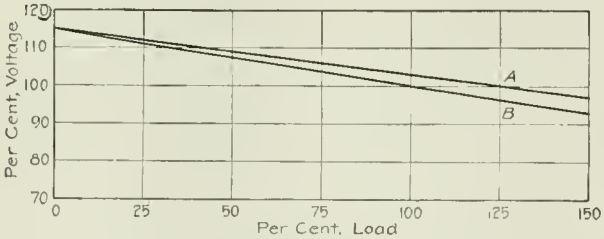


FIG. 1. REGULATION CURVES OF TWO SHUNT-WOUND, DIRECT-CURRENT GENERATORS

As an example, consider two 200-kw. generators operating in parallel, having voltage regulations as shown by the curves *A* and *B* in Fig. 1. A total load of 450 kw. will divide as indicated, 200 kw. on generator *B* and 250 kw. on *A*.

There are three adjustments that can be made to change the regulation of shunt-wound generators:

a. The demagnetizing effect of the armature current on the field poles is proportional to the amount of brush shift. The greater the brush shift, therefore, the broader the regulation. Commutation primarily determines the brush position, and it is unwise to sacrifice commutation for regulation.

b. Increasing the air gap improves regulation, while decreasing it has the opposite effect. Most machines are arranged with shims back of the polepieces, and these may be removed or added to, depending on the results desired. Mechanical dimensions determine the minimum air gap, and field copper the maximum. It should be remembered, however, that the design of a machine determines the proper air gap, and any change from this value may result in some slight disadvantage, but usually not sufficient to affect the operation of the machine in any way except regulation.

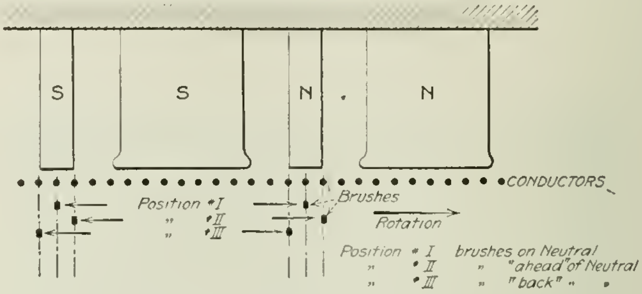


FIG. 2. DIFFERENT BRUSH POSITIONS IN REFERENCE TO THE COMMUTATING POLES

c. A change in speed also affects voltage regulation. Speed changes are to be used only within narrow limits. Better regulation is obtained by lowering the speed or improving speed regulation, or by a combination of the two.

Commutating-pole machines require very careful adjustments if the best results are to be obtained. Connections are shown for a shunt-wound commutating-pole type machine in Fig. 5.

At brush position No. 1 in Fig. 2, the effect of the commutating field is normal with regard to regulation. With the brushes in position No. 2 or 3, a part of the commutating-field flux is not effective for commutation, but combines with the flux of the main pole, subtracting from it with forward and adding to it with backward brush shift.

The voltage generated by a direct-current machine is the sum of the voltages of all coils connected to the commutator bars between positive and negative brush studs. If the brushes were shifted 90 electrical degrees from the neutral position, no voltage would exist between positive and negative studs. Similarly, if the brushes were shifted a few degrees as in position No. 2, Fig. 2, in this position some of the conductors connected to commutator bars between the studs would cut the flux from the commutating field; and since this flux is proportional to the load, the voltage characteristic with forward brush shift is similar to that of a differen-

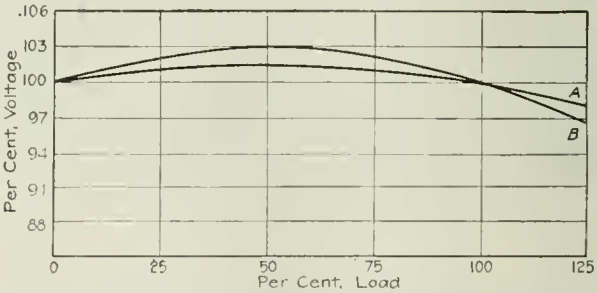


FIG. 3. REGULATION CURVES OF TWO COMPOUND-WOUND, DIRECT-CURRENT GENERATORS

tially wound generator. Backward brush shift is a compounding effect. Brush position and commutating-field strength are definitely related, a backward of neutral position requiring a stronger, and ahead of the neutral a weaker flux. If the brush position is changed, the strength of the commutating machine should usually be changed. This, however, depends on the correctness of the original adjustment. The effect of air gaps, speed and speed regulation, are the same as in the noncommutating-pole type.

An equalizer is used in connection with shunt-wound commutating-pole machines in some instances. Such an arrangement becomes necessary only where the voltage regulation is made very close owing to the compounding effect of the commutating field. The equalizer functions here as in compound-wound machines. An equalizer is undesirable on shunt-wound, commutating-pole machines, since for the equalizer to function, the commutating-pole field strength is necessarily changed from its correct value.

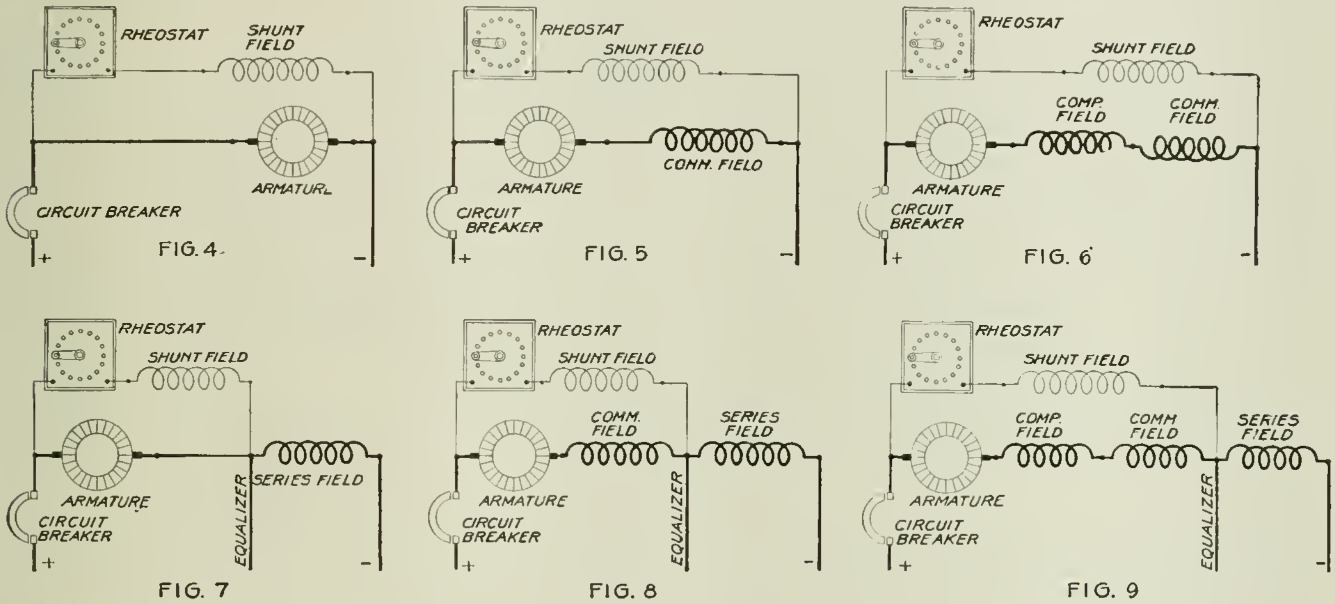


FIG. 4 FIG. 5 FIG. 6 FIG. 7 FIG. 8 FIG. 9

FIGS. 4 TO 9. DIAGRAMMATIC CONNECTIONS FOR VARIOUS TYPES OF GENERATORS

The shunt-wound, compensated, commutating-pole generator is very similar to the commutating-pole type except that, instead of neutralizing the armature reaction only under the commutating pole, it is more or less entirely neutralized by the compensating windings, depending on the amount of compensation. The connection for this type of machine is given diagrammatically in Fig. 6. The effects of brush position, strength of field, etc., are the same as in the commutating-pole type.

To obtain stability in parallel operation of compound-wound noncommutating-pole generators, they must be connected together at points where a drooping-voltage characteristic results with increase of load. The equalizer connection, if made on the armature side of the compound-field winding, will accomplish this result (see Fig. 7).

The compound-field windings with their connecting line cables of all machines in parallel are in multiples between the equalizer and the bus, and it is therefore important that the resistance of these circuits be inversely proportional to the rating of the machines. Resistance is often connected in the line cables for obtaining a proper balance. Resistance should never be connected in the equalizer cable. If the resistances of the field circuit are not properly balanced, the machine with the low-resistance field circuit will take more than its proportion of the load.

The compounding curves of generators vary greatly, and except for the correcting effect of the equalizer, generators with voltage characteristics as shown in Fig. 3 would not divide a load properly between them at any point except zero and 100 per cent. The amount of compounding above a given no-load voltage may be varied by changing the strength of the compound winding, raising or lowering the speed, changing the speed regulation, shifting the brushes, or changing the air gap.

Connections for a compound-wound commutating-pole generator is given in Fig. 8 and the connection for a compound-wound commutating-pole compensated machine is given in Fig. 9. In adjusting these types for parallel operation, the fact that the series field does not necessarily produce all the compounding should be kept in mind. The actual compounding depends on the strength of the compound field, the brush position and the strength of the commutating field. Parallel operation is sometimes difficult even though the voltage characteristic of each generator is approximately the same. The real difficulty lies in the fact that while each machine has the same regulation at the line terminals, each does not have the same regulation at the point of equalization, and the machines may compound entirely from the action of the compound field, while another may compound but slightly from this source, but from the commutating field and brush position. The equalizer cannot be very effective in such cases, since all equalizing must be done by current changes in the compounding-field winding, and if any such field has little or no effect on the compounding, it follows that the equalizer has little effect on the division of load among the machines. The equalizer cable of any machine should be designed to carry not less than 50 per cent. full-load current.

Operating Cost, Tamarack Mills Power Plant

Analyses of cost of operation of the Jenckes Spinning Co. and the Tamarack Mills power plant.

IN *POWER* for Mar. 26 appeared an article setting forth the chief features of the new Tamarack Mills power plant, Pawtucket, R. I. This plant and that of the Jenckes Spinning Co. near-by are two of the most interesting in New England, particularly in the textile industry. At the time the article referred to was written, operating-cost figures were not available; but they are given in the following. As pointed out in the article, both the Tamarack plant and that of the Jenckes Spinning Co. burn fuel oil exclusively in B. & W. water-tube boilers. The former is a high-pressure turbine plant, the latter a reciprocating-engine mixed-pressure turbine plant; both use atmospheric cooling towers for cooling the condensing water.

This is a good time to call the reader's attention to an error in the price of oil for the Tamarack plant. as stated in the article in *Power* for Mar. 26. It was given as 92c. per bbl. of 42 gal. The price paid is $1.15 instead; 92c. per bbl. is the old contract price made about two years ago for the Jenckes Spinning Co.'s plant.

There follows a brief analysis of the cost per kilowatt-hour of generating power in the Jenckes Spinning Co.'s power station and in the Tamarack No. 2 power station. The figures given are actual operating expenses incurred during one week's continuous run. The matter of oil, repairs, supplies, etc., was estimated and then verified by reference to the accountant's books, so that the total over-all cost per kilowatt-hour includes every expense that can rightfully be charged against the operating expenses.

With particular reference to the fixed charges on these two power stations, it is believed that the following figures will serve as an accurate criterion in estimating the gross costs of power delivered to the switchboard. The percentages given are those that are normally used in plants of the capacity, and containing like generating equipment.

Fixed annual charges: Interest, $0.06000; depreciation (annuity basis), $0.03344; taxes (¾ of total cost at 1½ per cent.), $0.01125; insurance, $0.01000; total fixed charges, $0.11469.

The item of depreciation given as 3.344 per cent. is figured on the annuity basis, which is the common practice in plants of this nature. The percentage of the total costs of the plants must be set aside at the beginning of each year, for a period of 17 years (the estimated average life of the complete plants), the same assumed to earn interest during the whole period at the rate of 6 per cent. compounded.

Using the figures given of 11.46 per cent. as the average annual fixed charge on the two plants, the gross cost of power delivered at the switchboards, per kilowatt-hour is as follows: Jenckes Spinning Co., $0.00806; Tamarack No. 2, $0.00782.

Note that there is a difference in the gross cost per kilowatt-hour in favor of the Tamarack plant of $0.00024. This decrease is due to the fact that the items of repairs, supplies, lubricating oil and labor cost 27 per cent. less in the Tamarack plant than in the Jenckes Spinning plant. If, on the contrary, the costs on the two plants were identical, the total net cost per kilowatt-hour in the Jenckes Spinning plant would be somewhat less than in the Tamarack plant, due to the fact that fuel oil costs approximately 28 per cent. less in the Jenckes Spinning Co.'s plant than in the Tamarack plant.

ECONOMY CALCULATIONS OF THE JENCKES SPINNING CO.'S POWER PLANT FOR WEEK ENDING FEB. 23, 1918:

The engine room of this plant contains the following equipment:
One Harris simple engine, 30¾ x 60-in., 66 r.p.m.
One Harris simple engine, 24 5/16 x 48 in., 76 r.p.m.
One 1,000-kw. mixed-pressure turbine, taking exhaust from engines and auxiliaries, in excess of amount required to heat feed water.
One 300-kw. noncondensing turbine, the exhaust steam from which is used for heating feed water and operating 1,000-kw. unit.
One 390-hp. synchronous motor belted to the engines and connected in parallel with the turbines, this motor being allowed to float on the line, sometimes operating as a generator and again as a motor.

	A. Total Quantities:	
1.	Kind of fuel	Mexican fuel oil
2.	Total oil used at 147 deg. F., bbl	1657 3
3.	Total oil used at 147 deg. F., gal	69,606. 6
4.	Weight of one gallon oil as fired, lb	7. 7
5.	Total weight of oil, lb	535,970. 8
6.	Total water feed to boilers, gal	710,600
7.	Total weight of water, lb	5,921,667
8.	Total water evaporated, corrected for quality of steam (0.985 estimated), lb	5,840,000
	B. Economy:	
1.	Water fed per pound of oil as fired, lb	11. 10
2.	Water evaporated per pound of dry oil (estimated), lb	11. 14
	C. Cost of Evaporation:	
1.	Cost of oil per barrel of 42 gal., cents	0. 90
2.	Weight of gallon of oil at 60 deg., lb	8. 02
3.	Cost of oil per pound, delivered to tanks, cents	0. 267
4.	Cost of oil per one thousand pounds of water evaporated, cents	24 05
5.	Cost of 1,000 lb. of water (8c. per 1,000 gal.), cents	0 96
	D. Chargeable to Power:	
1.	Fuel oil (estimated), bbl	1,325. 9
2.	Total cost fuel oil, dollars	1,193. 31
3.	Water purchased, gal	568 48
4.	Total cost water, dollars	45 48
5.	Labor, dollars	193. 00
6.	Oil, dollars	10. 00
7.	Repairs, dollars	72 12
8.	Supplies, dollars	7 80
	E. Chargeable to Heating:	
1.	Fuel oil (estimated), bbl	331 4
2.	Total cost fuel oil, dollars	298 26
3.	Water purchased (estimated), gal	142. 12
4.	Total cost water (8c. per 1,000 gal.)	11. 37
5.	Labor all charged to power	
6.	Repairs (estimated), dollars	25. 00
7.	Total weekly heating costs, dollars	334. 37
	F. Power-Plant Details:	
1	Total average output for 54 hours (nights), hp	2,436 7
2.	Total average output for 54 hours (days), hp	2,829 0
3.	Total grand average (54 hours), hp	5,265 7
4	*Total kw.-hr. generated	213,800
5.	Load factor of plant, per cent	64 2
6.	Pounds of steam per kw.-hr	21 8
7.	Pounds of oil per kw.-hr	2. 09
8.	B.t.u. per pound of oil (estimated)	18,400
9	Over-all efficiency of plant, per cent	8 9
	G. Unit Costs of Power per Kilowatt-Hour, Dollars:	
1	Fuel oil	0. 005600
2.	Water	0. 000230
3	Labor	0. 000965
4	Oil	0. 000047
5.	Repairs	0 000338
6.	Supplies	0 0000365
	Total cost per kilowatt-hour	0. 0072165

NOTE.—No allowance made for overhead charges which should be added to "G" to give gross costs.

* The figure of 213,800 kw.-hr. is the net power output after deductions for excitation and other auxiliaries.

ECONOMY CALCULATIONS OF THE TAMARACK CO.'S NO. 2 POWER PLANT FOR WEEK ENDING MAR. 2, 1918

The engine room of this plant contains the following equipment:
One 2,500-kw. bleeder-type turbine.

	A. Total Quantities:	
1.	Kind of fuel	Mexican fuel oil
2.	Total oil used at 149 deg. F., bbl	1,227 8
3.	Total oil used at 149 deg. F., gal	51,567. 6
4.	Weight of one gal. of oil as fired (estimated), lb	7. 7
5.	Total weight of oil, lb	397,070 5
6.	Total weight fed to boilers, gal	594,510
7.	Total weight of water, lb	4,954,250
8.	Total water evaporated, corrected for quality of steam 0.985 (estimated), lb	4,870,000

B. Economy:	
1. Water fed per pound of oil as fired, lb.	12.05
2. Water evaporated per pound of dry oil (estimated), lb.	12.54
C. Cost of Evaporation:	
1. Cost of oil per barrel of 42 gal., dollars	1.15
2. Weight of gal. of oil at 60 deg. F. (estimated), lb	8.02
3. Cost of oil per pound, delivered to tanks, cents	0.342
4. Cost of oil per 1,000 lb. of water evaporated, cents	27.4
5. Cost of 1,000 lb. of water (8c. per 1,000 gal.), cents	0.96
D. Chargeable to Power:	
1. Fuel oil (estimated), bbl	1,050
2. Total cost fuel oil, dollars	1,207.50
3. Water purchased, gal	510,000
4. Total cost water (8c. per 1,000 gal.), dollars	40.80
5. Labor, dollars	153.00
6. Oil, dollars	5.00
7. Repairs (estimated), dollars	50.00
8. Supplies, dollars	6.00
E. Chargeable to Heating:	
1. Fuel oil (estimated), bbl	177.8
2. Total cost fuel oil, dollars	204.47
3. Water purchased (estimated), gal	84,510
4. Total cost water (8c. per 1,000 gal.), dollars	6.76
5. Labor (all charged against power)	
6. Repairs (estimated), dollars	15.00
7. Total weekly heating costs, dollars	226.23
F. Power-Plant Details:	
1. *Total kw.-hr. generated	208,100
2. Load factor of plant, per cent	49.5
3. Pounds of steam per kw.-hr.	20.4
4. Pounds oil per kw.-hr.	1.69
5. B.t.u. per pound oil (estimated)	18,400
6. Over-all efficiency of plant, per cent	10.9
G. Unit Costs of Power per Kilowatt-Hour, Dollars:	
1. Fuel oil	0.005790
2. Water	0.000196
3. Labor	0.000736
4. Oil	0.000024
5. Repairs	0.000240
6. Supplies	0.000029
Total cost per kilowatt-hour	0.007015

NOTE.—No allowance made for overhead charges, such as interest, insurance, depreciation, etc., which should be added to "G" to give gross costs.

* F-1: The figure of 208,100 kw.-hr. is the net power output, after deductions for excitation and other auxiliaries.

The foregoing data were obtained through the courtesy of Charles E. Teft, chief engineer of both plants and of Robert L. Brunet, Public Service Engineer for the city of Providence, R. I., who is consulting engineer for the Jenckes Spinning Co.

Electric Current Without Cost During Heating Season

An instance of the saving to be realized by generating the necessary current in a building where heat is maintained is found in the New Weston Hotel on the northeast corner of Madison Ave. and 49th St., New York City. Although the generator has been in operation only a short time, the showing at present is that the electric current used for light and elevator service is a cost-free byproduct and will continue so during the heating season at least. Mr. Clayton, the lessee of the building and proprietor of the hotel, feels that with his modern kitchen equipment he will be able to utilize a large percentage, if not all, of the exhaust steam in summer also, because of the diminished use of current for lighting during that period. The new unit is a high-speed self-contained American Ball 50-kw. three-wire direct-current set with an automatic oiling system, so that operating attention is reduced to a minimum. Another unit of the same type but only about 25 kw. capacity will be put in as soon as the manufacturers can deliver it. This small unit will be able to supply the current during the periods of least demand—during the day and the late part of the night. The chief engineer, James Daugherty, is enthusiastic over the showing already made and expects to do still better when the new set is in, which will permit better manipulation or handling of the load.

The building has a frontage of 79½ ft. on Madison Ave. and 85 ft. on 49th St., is 12 stories high and contains 176 guest rooms besides the commodious dining rooms and offices—roughly, 7000 sq.ft. of floor space. It is of modern fireproof brick and steel construction, so that heating it is not difficult, and by the use of high-efficiency lamps the current consumed is comparatively small, making an ideal combination for a private plant, especially since the services of an engineer are essential and no additional help is required whether the generating units are in use or not. Complete operating costs for a year, when available, will furnish material for comparison with past performance when no current was generated.

Notwithstanding the extremely cold weather and the poor quality of the coal he is able to procure, Mr. Clayton's daily reports show no increased coal consumption, while generating all the electric current used about the hotel for illumination and elevator service, over that used when only the heating was being done, so that the electricity generated can be considered as a byproduct.

The calculation regarding the capital invested and the return from it, is interesting. Placing the cost of the first unit at, say, $2500 (which seems ample considering the fact that there was practically no cost for the foundation, switchboard, etc.), and the annual reduction in the cost of service at $620, the difference between $1100, the approximate total cost per year for the street service and the partial street service still retained at a cost of $480 per year, or $40 per month for the minimum. Six per cent. of $2500 = $150 interest to be deducted from $620, leaving $470 to be deducted from $2500 = $2030 remaining at the end of the first year. Continuing the calculation for succeeding years, it would show $1532 at the end of the second, $1004 at the end of the third and $444 at the end of the fourth, so that by the end of the fifth year this unit would have paid for itself.

Taking again the case of the smaller (second) unit, this should not cost more than $1500 and by means of it the street service could be dispensed with, saving $480 per year. Six per cent. of $1500 = $90, which, subtracted from $480, leaves $390 to be deducted from the first cost at the end of the first year, leaving $1110. There would remain $697 at the end of the second year, $259 at the end of the third, and by the end of the fourth year this unit would be paid for by its own output.

Therefore, allowing liberally for insurance, extra taxes, repairs, lubricants and a proportionate fuel charge for that part of the year when the exhaust steam is not all used, the period required for the installation to pay for itself is not extended more than a year or two at most. Or, extending the period of the transaction to 20 years and allowing for a total depreciation in that time, 5 per cent. of the $4000 investment, or $200, would have to be deducted annually from the net saving shown after overhead is taken care of. Then $4000 at 6 per cent. interest and say 1 per cent. for extra taxes and insurance, 7 per cent. in all, from $1100 is ($4000 at 7 per cent. = $280 + $200 refund on principal) $480, leaving $620 net per year. Even setting aside $120 per year for "incidentals" leaves a $500 saving, or 12½ per cent. clear on the original investment.

Low-Pressure Turbines for Lineshaft Drive

By R. J. HORNE

Geared low-pressure steam turbine used to drive a lineshaft in a paper mill resulted in obtaining 600 hp. without any cost for steam and made it possible to operate the plant with eight boilers in service where before the installation of the turbine thirteen boilers were required.

MANY a mill owner whose plant is driven by lineshafts finds, when he seeks to add power supply, that the simplest solution—electric-motor drive supplied from existing power lines—is not available. Often, however, there is sufficient boiler capacity in the plant to do the work if it is effectively applied. Particularly where the lineshaft drives only a small number of machines, an ingenious solution of the problem is to install a turbine, with reduction gearing.

In a western Pennsylvania paper mill there is a unique lineshaft drive consisting of a Westinghouse low-pressure turbine and double-reduction gear, Fig. 1. There are two mainline shafts to which the machines are belted. To one lineshaft are belted two cutters, ten beaters and one jordan; and identical equipment, with the exception of the cutters, is belted to the other shaft. Under ordinary running conditions only seven of the ten beaters on each shaft are in operation at one time, and these, with one jordan, require about 600 hp. The rag cutters take 20 hp. each.

Originally, these two lineshafts were each driven by a noncondensing reciprocating engine. However, one of these engines was wrecked, and it became necessary to obtain some form of drive to replace it.

It is interesting to note the considerations entering into the final selection of the new drive. These conditions were somewhat as follows: Two 100-hp. noncondensing engines turned the rolls and gave practically all the exhaust steam necessary for feed-water heating, so that all the exhaust steam from the 700-hp. noncondensing Corliss engine driving one of the lineshafts would have to be discharged to the atmosphere unless some means were provided for abstracting the energy still available in it. A low-pressure turbine was, without a doubt, the logical prime mover, but it would have been of little use, on account of its high speed, without suitable reduction gearing.

Other types of drive were considered, but each had inherent characteristics which disqualified it; for instance, a duplication of the old reciprocating engine with the inevitable wasting of exhaust steam. A condensing engine would have been expensive and no material improvement. Again, an electric motor, while comparatively cheap to install, would have been much more expensive when the electric-power bill was added to the cost of energy lost in wasted exhaust steam. And finally, it was still more expensive to install a turbine generator and an individual electric drive, because the existing equipment was of an entirely different character. In a new plant where all equipment is being installed for the first time, the individual electric drive is by far the best, for reasons too well known to need discussion here.

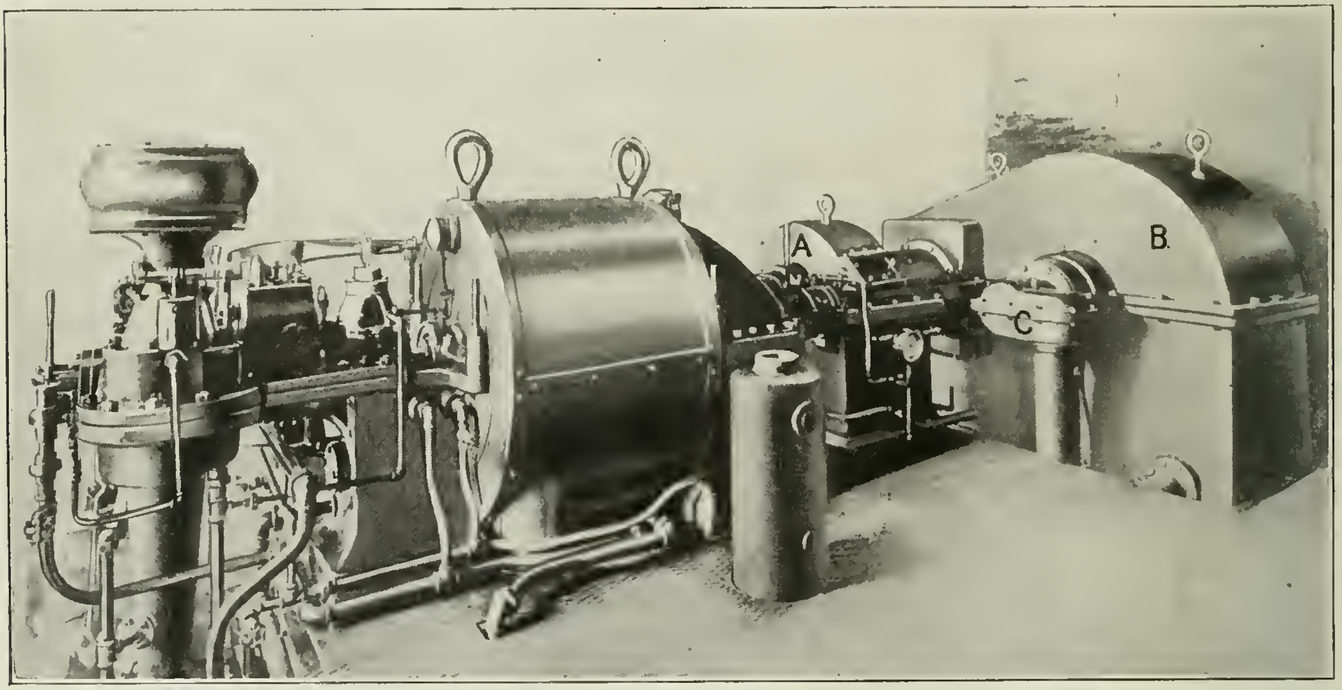


FIG. 1 LOW-PRESSURE STEAM TURBINE WITH DOUBLE-REDUCTION GEARS

A few approximate figures will show more clearly the fitness of the low-pressure turbine for this application. The exhaust steam from the 700-hp. Corliss engine was more than sufficient to give 600 hp. in the low-pressure turbine. The engine takes steam at 150-lb. pressure and exhausts into an oil separator at a back pressure, depending on the load, from 0 to 4 or 6 lb., which is approximately the pressure of admission to the low-pressure turbine. The steam is then expanded in the turbine down to a vacuum corresponding to 27.5 in. of mercury referred to a 30-in. barometer, the vacuum being maintained by a Westinghouse-Leblanc low-level jet condenser and air pump. The pumps are centrifugal and are driven by a small steam turbine through a reduction gear. They take their water from a near-by creek and discharge it from the condenser into a reservoir at an elevation of 45 ft. This water is used in the manufacturing processes. The small turbine runs noncondensing, and its exhaust steam goes to the feed-water heater, so that only a part of the heat energy in the steam used by it can be charged to the turbine, and even that cannot be charged against the main turbine, for it is used to do work in elevating the discharge water from the condenser to the reservoir and should be charged against the total cost of manufacturing. In brief, it may be said that this paper company actually gets 600 hp. without paying a cent for steam and is using just one-half the steam formerly used with two reciprocating engines for the same power.

While this particular mill was not enlarged, it is evident that with a given amount of exhaust steam, either for noncondensing engines or condensing engines run noncondensing, a large increase of power is made available by the installation of a low-pressure turbine. Further evidence of this possibility for expansion is the fact that, in this paper mill, when the two lineshafts were driven by noncondensing reciprocating engines, a battery of 13 boilers was required, whereas now only eight are required for the maximum load.

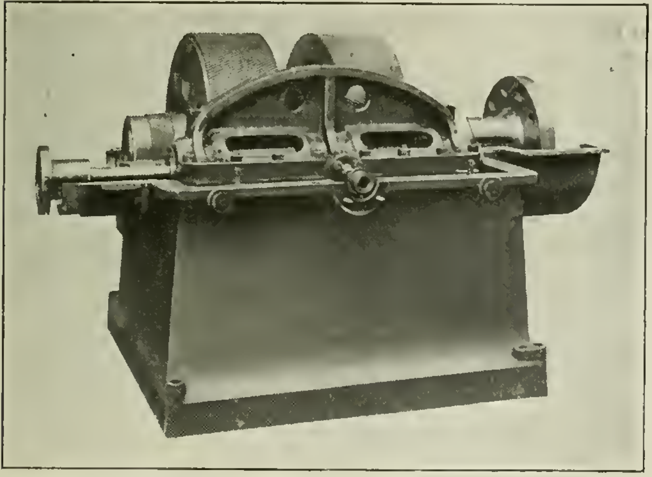


FIG. 2. FLEXIBLE-FRAME GEAR WITH COVER REMOVED

Although the application of the low-pressure turbine is an interesting one, the means of transmitting its high-speed power to a slow-speed lineshaft is fully as interesting and as important. The change in speed is made by means of two reduction gears, shown at *A* and *B*, Fig. 1, because the first cost of a single gear and pinion of ratio 36 to 1 would be prohibitive and the gear would be very large and unwieldly. The first speed reduction, 3600 to 720 r.p.m., is made with a fixed bearing type of reduction gear, the gear shaft of which is direct-connected to the pinion shaft of the second gear, which reduces the speed from 720 to 103 r.p.m.

This larger reduction gear is of the flexible-pinion frame type, known as the Westinghouse I-beam type. In this the pinion is supported on three bearings in a frame, as shown in Figs. 2 and 3. This frame is supported under the middle bearing on an I-beam at right angles to the pinion axle. The flexibility of the web of this I-beam support allows the pinion to tip slightly and to let the teeth of the pinion line up with those of the gear. This lining up is entirely automatic and instantaneous in operation, so that no mechanical complications are encountered and no adjustments from the outside of the gear case are necessary at any time.

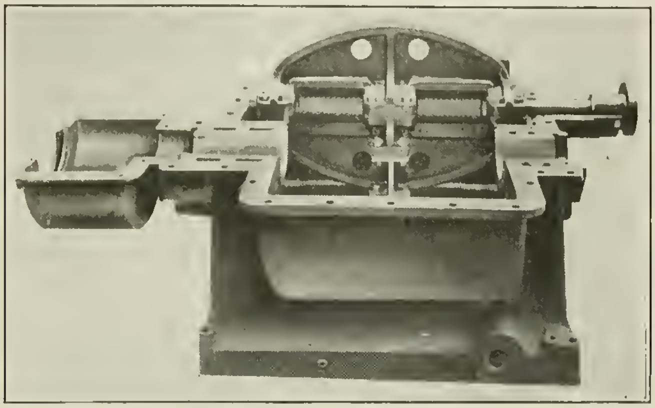


FIG. 3. FLEXIBLE-FRAME GEAR SHOWING HOW THE THREE PINION BEARINGS ARE SUPPORTED

Both reduction gears are lubricated by sprays of oil directed upon the teeth just before they mesh. The oil pressure is maintained by a pump geared to the gear shaft, as shown at *C*, Fig. 1. This pump also supplies oil under pressure to all the bearings in the two reduction gears. For starting, a hand pump is provided which insures a plentiful supply of oil at the bearing and teeth.

It may be asked why a fixed-bearing type of reduction gear was used in one case and an I-beam type in the other. It was a question of tooth pressure which determined the design. Take, for instance, a pinion transmitting 600 hp. at 3600 r.p.m., which was the case of the first reduction gear in the particular installation under discussion. If the same pinion was to turn at 720 r.p.m. and with the same tooth pressure, that is, pounds pressure per inch of tooth face, it would be capable of transmitting one-fifth of 600 hp., or 120 hp., only. It follows, then, that the second gear would have been made five times as large as the first if the same type had been used, and for the transmission of the same amount of power. Such a reduction gear would have been large and bulky. It would also have been costly, because cost is a function of size.

In order, then, to make a reduction gear that would be within reasonable limits as to size, and at the same time marketable, the allowable tooth pressure had to be increased, or in other words, the factor of safety included in the allowable stress in fixed bearing design had to be lowered. But if this were done, some other safety factor would have to be incorporated to insure reliability of operation, otherwise a slight misalignment of the teeth and uneven distribution of tooth pressure would result in a failure of the gear. This safety factor was found in the I-beam support for the pinion, which corrects any misalignment and uneven pressure distribution that might otherwise exist.

In the case of the reduction gear with fixed bearing support for the pinion, misalignment, although practically prevented by good workmanship, will not have disastrous results if it should exist, because of the high factor of safety used in the tooth design.

The actual efficiency of the two gears together is 97 per cent.; that is, only 3 per cent. of the total power transmitted is lost in them. This energy is dissipated in the form of heat and is taken up by the oil, which in turn is cooled by a water-cooling system. As to reliability, in the paper mill under discussion the double reduction gear has run 24 hours per day, six days per week, under maximum load, and it has never been shut down on account of trouble with the gears.

The Cost of Coal

DURING the first few weeks of this year, when the entire country was in the grip of unusually severe winter weather and the railroads were unable to meet the demands made upon them for the transportation of fuel, the price of coal was a matter of secondary importance. The main consideration was the possibility of getting coal, regardless of kind, grade or size, at any price whatever.

Now that moderate weather has decreased the pressing demand for coal and has allowed the railroads to recover somewhat from their congestion, the coal user naturally turns again to a consideration of the cost of his fuel.

The cost of coal to the consumer is the sum of several items, each of which can be reckoned more or less exactly. The first of these is the price of the coal per ton at the mine. This is fixed by the Government, since a definite schedule of rates is set to cover the selling prices of the various kinds and sizes of coal. These prices, per ton f.o.b. at the mines, are given in Tables I and II. They should be increased by the amounts allowed for wage increases, as given in the footnotes to the tables. Also, the reductions allowed during certain months of the year should be taken into account in all cases in which they are applicable.

Since the issuance of the order putting into effect the reduction of 30c. a ton on anthracite for domestic use, the Interstate Commerce Commission has granted the railroads an increase of 15c. a ton on all coal freighted. As a consequence, coal dealers are puzzled to know whether they shall reduce their price 30c. and pay the increased freight of 15c. or whether they shall reduce the price to the consumer only 15c. The Fuel Administration will be asked to decide the matter.

TABLE 1. PRICES OF ANTHRACITE

	Grate	Egg	Stove	No. 4	Pea	Buck.	Slack
Arkansas:							
Bernice district....	$7 30	$7 55	$8 30	$8 30	$6 30	$2.85	$2 50
Spadra district....	6 80	6.80		7 30	4 80		2.50

The foregoing prices are f.o.b. mines and nothing to be added.

All these prices—except those for slack—are subject to the following reductions: 90c. in April, 1918; 75c. in May; 60c. in June; 45c. in July; 30c. in August; 15c. in September.

Pennsylvania:	Broken	Egg	Stove	Chestnut	Pea
White ash	$4 55	$4 45	$4 70	$4 80	$3 40
Red ash	4 75	4 65	4 90	4 90	3 50
Lykens Valley	5.00	4 90	5.30	5 30	3.75

The foregoing prices do not include the 35c. per ton allowance for wage increase under the President's order of Dec. 5, 1917

Beginning Apr. 1, 1918, and continuing to Sept 1, 1918, the prices on all Pennsylvania anthracite for domestic use are subject to a reduction of 30c. per ton

The first schedule of Government prices, which went into effect less than a year ago, covered only such coal as had not been contracted for, or, in other words, free coal. By the first of April of this year, most contracts will have expired, and any further purchases or contracts to purchase will be made on the basis of the new prices. The prices shown in Tables I and II include all changes and modifications up to the fifth of April, 1918.

Jobbers' commissions as separate items of cost have been eliminated; instead, the commission of the jobber is included in the price at the mine, beginning Apr. 1, so that the retail dealer will obtain coal at the same price, whether purchased through a jobber or direct from the mine.

Still another item of cost that may have to be considered in connection with bituminous coal is the allowance for cleanness. According to a ruling of the Fuel Administration, operators who use special means to eliminate impurities from their products will be allowed to add 20c. a ton to the Government prices for coal at the mine. The objects of this concession are to stimulate production and to insure a better quality of coal. The offer embraces the period from Apr. 1 to July 31, 1918, and permits will be extended beyond Aug. 1 in all cases in which such action seems proper. Retail dealers must also obtain permits from the Fuel Administration before they will be allowed to add to their prices the allowance made to the operators. Specially cleaned coal will be designated by cards in the cars in which such coal is loaded and also by notations on the invoices.

The next item is the freight on the shipment. As the freight rates of the various railroads engaged in interstate transportation are subject to the approval of the Interstate Commerce Commission, they can be determined by addressing an inquiry to the commission. Thus, the freight charge per ton of coal from the mine to the destination of the shipment may readily be ascertained.

In many cases the coal must be transported a part of the way by barges or steamers. This is particularly true of the coal consumed in New York City and many parts of New England. Transportation by water adds another charge for lighterage or water freight. In normal times the water haul from New York to Boston is about 50c. a ton, and from Newport News to New England ports it is from 70 to 90c. a ton; but under the stress of a scarcity of coal-carrying bottoms these charges rose to as much as $4 a ton during the recent fuel crisis.

If the coal is purchased through a local dealer, or if the purchaser must pay for hauling the coal from the wharf or railway to his plant, there will be a charge for delivery. The amount of this item is easily and directly obtainable.

After the several items of cost have been determined or estimated, the reasonable total cost of the coal per ton may be found by adding them. The sum will give the consumer a fair idea of what his coal should cost. If the price he is paying is very greatly in excess of the calculated price, he may feel reasonably certain that someone is profiteering at his expense.

TABLE II. PRICES OF BITUMINOUS COAL PER TON F.O.B. AT THE MINES

State	Run of Mine	Prepared Sizes	Slack or Screenings
Alabama:*			
Big Seam district	$2 15	$2 45	$1.85
Cahaba, Black Creek, Brookwood and Blue Creek districts	2 85	3 10	2 45
Pratt, Jaeger, Jefferson, Nickel Plate and Coal City districts	2 35	2 65	2 05
Corona district	2 40	2 75	2 05
Montevallo district	2 40	4 00	2 15
Coal mined in upper bench of Big Seam	2 35	2 65	2.05
Coal mined at Lynn mines of Monroe Warrior Coal and Coke Co. for use at Macon, Ga	3 50	4 00	3.10
Coal mined by Cahaba Southern Coal Mining Co., Hargrove, Bibb County	2 85	3 70	2 45
Climax Seam, near Maylene, Shelby County	4 25	4 50	2 15
Arkansas	2 65	2 90	2 40
Johnson, Franklin and Sebastian Counties, except Excelsior district	3 70	4 60	2 40
Logan and Scott Counties and the Excelsior district of Sebastian County	4 35	5 15	2 60
Colorado	2 45	2 70	2 20
Domestic coal, domestic field †	2 25	3 50	1 25
Steam coal, Trinidad district ‡	2 35	3 25	1 65
Lignite coal	2 25	3 25	1 00
Georgia	3.25	3 50	3 20
Illinois:			
Mercer, Bureau, Kankakee, La Salle, Grundy, Will, Putnam, Marshall, Livingston, Woodford, and McLean Counties	2 65	2 90	2 40
Rock Island, Henry, Warren, Knox, Stark, Peoria, Hancock, McDonough, Henderson, Fulton, Tazewell and Schuyler Counties	2 40	2 60	2 10
Menard, Logan, Dewitt, Champaign, Vermilion, Sangamon, Macon, Pratt, Christian, Moultrie, Shelby, Greene, Macoupin and Montgomery Counties, Madison County north of latitude of Alton, and all mines which are not included in other rulings	2 00	2 20	1 70
Bond, St. Clair, Monroe and Randolph Counties and Madison County south of latitude of Alton, and Clinton, Washington and Perry Counties, not including mines along Illinois Central R.R. between Vandalia and Carbondale	2 00	2 20	1.70
Jackson County, not including mines along Illinois Central R.R. between Carbondale and Duquoin	2 40	2 60	2 10
Marion, Jefferson, Franklin, Williamson, Johnson, Hamilton, Saline, White, Gallatin, and mines along main line of Illinois Central between Vandalia and Carbondale in Clinton, Washington, Perry and Jackson Counties	2.00	2 20	1 70
Indiana	1 95	2 20	1.70
Brazil Block field		2 95	1.70
Iowa	2 70	2 95	2 45
Appanoose, Wayne, Boone, and Webster Counties	2 75	3 10	2 00
Marion County	2 70	2 95	2 45
Kansas	2 55	2 80	2 30
Osage county	3 05	4 50	2 80
Mines at Leavenworth	3 15	3 40	2 90
Kentucky	1 95	2 20	1 70
Harlan, Perry and Letcher Counties, and operations in Pike County on the Levisa Fork of the Big Sandy River.	2 20	2 45	1 95
East of the 85th degree of longitude, except Harlan, Perry and Letcher Counties and operations in Pike County on the Levisa Fork of the Big Sandy River	2 65	2 90	2 40
Maryland	2 40	2 65	2 15
Michigan	3 15	3 60	2 20
What Cheer, Banner, Bliss, Robert Gage, Beaver and Consolidated & Wolverine coal companies	3 40	3.95	2 25
Handy Bros	3 70	4 25	2 55
Caledonia mine	4 55	5 05	3 55
Flint mine		5 55	3 55
Missouri	2 70	2 95	2 45
Lafayette, Ray, Clay, Platte, Linn and Putnam Counties, and Longwall thin seam vein in Randolph County	3 15	3 40	2 90
Montana	2 65	3.30	1 50
New Mexico	2 40	2 65	2 15
Raton district	2 75	3 25	2 00
Sugarite and Monero field	3 00	4 00	2 00
Gallup field	3 05	4 50	2 00
Cerillos and Carthage fields	4 05	5 05	3 55
North Dakota (lignite):			
Run-of-mine		....	2 25
Screenings		....	1.25
Screened lump	....	....	2 50
6-in. steam lump	....	....	2.00
Ohio:			
Thick vein	2.00	2 25	1 75
Thin vein	2 35	2 60	2.10
Deerfield, Palmyra, Massillon and Jackson fields	3 25	3 50	3 00
Jefferson, Harrison, Belmont, Carroll and Monroe Counties	2 00	2 25	1.75
Oklahoma	3.05	3 30	2 80
Leflore, Haskell, Okmulgee, Tulsa, Rogers, and Coal Counties and the Hartshorn-Wilburton vein in Pittsburg and Latimer Counties	3 70	4 60	2 40
McAlester vein in Pittsburg and Latimer Counties	4 25	5 10	3.00
Pennsylvania	2.00	2 25	1.75
Operations in Tioga, Lycoming, Clinton, Center, Huntingdon, Bedford, Cameron, Elk, Clearfield, Cambria, Blair, Somerset, Jefferson, Indiana, Clarion, Armstrong, Butler, Mercer, Lawrence and Beaver Counties, and in Allegheny County from Lower End of Tarentum Borough north to county line, and in Westmoreland County from point opposite lower end of Tarentum Borough north along Allegheny River to Kiskiminitas River and along Kiskiminitas River eastward to Conemaugh River and along Conemaugh River to Cambria County line, and operations on B. & O. R.R., from Somerset County line to and including Indian Creek and Indian Creek Valley branch of B. & O. R.R.	2 60	2.60	
Pittsburgh field, including counties of Washington, Green, Fayette, Westmoreland and Allegheny, except (1) that portion of Allegheny County from lower end of Tarentum Borough north to county line; (2) territory in Westmoreland County from a point opposite lower end of Tarentum Borough north along Allegheny River to Kiskiminitas River and along Kiskiminitas River eastward to Conemaugh River, continuing along Conemaugh River to county line of Cambria County; (3) operations on Indian Creek in Westmoreland County; (4) operations in the Ohio Pyle district of Fayette County.	2 00	2.25	1 75
Ajax Hocking Coal Co., Clearfield and Somerset Counties	2 75		
Tennessee:			
All except Overton and Fentress Counties	2 65	2 90	2 40
Overton and Fentress Counties	2.20	2.45	1 95
Texas	2.65	2 90	2 40
Operators at Thurber and Strawn	3 60	4 40	2 25
Operators at Bridgeport	4 25	5 05	2 25
Young, Erath, and Palo Pinto Counties	3.60	4 40	2 25
Wise County	4.25	5.05	2 25
Lignite run of mine	....	. .	1 40
Lignite, screened, with at least 15 per cent. of screenings taken out	....	.	1 50
Lignite screenings	. .		0 85
Utah	2.65	3 30	1 50
Virginia	2 00	2 25	1 75
Lee, Wise and Dickenson Counties, and Russell County west of Finney on the Norfolk & Western Ry	2 20	2 45	1 95
Washington (Screened Coals):			
Kittitas County	3 55	3 95	2 50
Kittitas County, special steam and gas		3 25	
Lewis and Thurston Counties, sub-bituminous	2 75		1 25
Lump		3 95	
Lump nut		3 25	
Nut		3 00	
Washington (Washed Coals):			
Kittitas County		4 00	
Pierce, King, Lewis and Skagit Counties			2 50
Lump nut		6 00	
Mixed steam		5 25	
Straight steam and gas		4 80	
King County, sub-bituminous			1 50
Lump nut		5 00	
Pea		3 50	
Buckwheat		3 25	
Lewis County, sub-bituminous			1 25
Lump		3 95	
Nut		3 75	
Pea		3 00	
Buckwheat		1 50	
West Virginia	2 00	2 25	1 75
Pittsburgh seam in Hancock, Brooke, Ohio, and Marshall Counties	2 00	2 25	1 75
Kenova and Thacker fields and Preston County	2 40	2.65	2 15
Tug River district, coal mining operations on Norfolk & Western Ry., west of Welch to Panther, including branches, except Newhall, Berwind, Canebrake and Hartwell	2 40	2 65	2 15
Pomeroy field	2 35	2 60	2 10
New River	2 15	2 40	1 90
Davy-Pocahontas Coal Co. in McDowell County	2 75		
Ajax Hocking Coal Co. in Mineral County	2 75		
Wyoming	2 65	3 30	1 50

The foregoing prices are f.o.b. mines basis for ton of 2,000 lb. and do not include the 45c. per ton allowed in President's order of Oct. 27, 1917.

* Increase of 45c. per ton does not apply to these mines.

† Prepared sizes subject to following monthly reductions in price: Apr. 1, 70c.; May 1, 50c.; June 1, 35c.; July 1, 15c.; base price again effective Aug. 1

‡ Prepared sizes subject to following monthly reductions in price: Apr. 1, 40c.; May 1, 30c.; June 1, 20c.; July 1 10c.; base price again effective Aug. 1

Fall and Rise of Government Bonds on Account of War

GOVERNMENT bonds, like people, act pretty much like one another under similar conditions. Whether they are French, English, German, Russian, Japanese, American or any other nationality, people will act according to well-established psychological traits, laughing at about the same thing, crying over similar events and manifesting fear under given situations. Corresponding to human temperament, the market value of Government bonds is also subject to well-defined changes, and one of the most consistent similarities of conduct which history shows to be true of them is their habit of temporarily dropping on account of war.

Sometimes they do so to an alarming extent, no matter how stable the government that issued them, no matter how rosy its military situation and no matter how unimpaired the resources behind the securities may be, guaranteeing the prompt payment of their interest and their redemption for full face value at maturity.

But just as consistently as history shows that government bonds go down during the war, no less does it record that their usual habit has been not only to recover to their original price, but also, in many instances, to rise to a marked degree above it after the end of the war.

At the present writing your Liberty Bonds are quoted in the market at about 97. Taken as a detached condition, without regard to history, and looked at simply from the narrow pocketbook point of view, the fact that something you paid $100 for a short time ago will bring you only about $97 at the present moment may seem to be disquieting. But it simply means that United States bonds are now doing what the bonds of all nations do in war time.

Our bonds have depreciated to a lesser degree than most government bonds have done under similar circumstances. One instance may be cited where the bonds of a foreign government went down to almost 50 during a war, but although that nation suffered a crushing defeat and tremendous material losses, within a comparatively few years after the war was ended those same bonds went up to more than 105.

The fact that your $100 Liberty Bond is now selling for about $97 does not in any sense imply a loss of intrinsic value nor uncertainty either as to its principal or interest. It merely implies that because of a complexity of economic factors your Government bond is normally following the way of its historic fellows. Even though Liberty Bonds have thus fluctuated to prices below par, there has been absolutely no fluctuation in the fact that the Government will go on paying the promised interest on them without delay as it falls due, nor in the fact that when the time comes it will redeem them at the full face value regardless of the ups and downs in the market quotations meanwhile.

These ups and downs in the market quotations of government bonds during wars are, in the history of nations, analogous to what the rise and fall of the thermometer is to the weather. Just as you can tell the changes in the temperature by watching the fluctuations in the height of the column of mercury, an expert in finance could almost tell the changes of a country from peace to war merely by looking at the fluctuations in the column of government-bond quotations year by year. He could make a pretty fair guess that the country was at war when bond prices suddenly dropped and fluctuated below the prices of previous years, and then in after years returned to their former levels or higher.

Take the case of Great Britain. Her national debt is funded in the consolidated annuities, or bonds, popularly known as "consols." In 1792 these consols were quoted at 97, but during the Napoleonic wars, 1793-1815, they dropped down to as low as 47¼ in 1798. These consols have fluctuated with England's periods of peace and of war until in 1896 they were quoted at 114. The effect of the present war is shown in the downward quotations of these consols. In 1915 the highest point was 76½ and the low was down to 54, while in 1916 the high was 62¼ and the low 50. In 1917 the high was 56⅜ and the low 51.

The history of the French government bonds, or rentes, shows similar fluctuations on their part. During the Revolution the 5's rentes dropped to 50, and the 3's to 32½. As a result of the Franco-Prussian War, 1870-71, the 3's rentes dropped to 50.35. Although France was defeated, losing Alsace-Lorraine and having to pay a billion-dollar indemnity to Germany, and although there were two funding operations reducing the interest rate, nevertheless the price of France's bonds continued to rise until in 1897 they reached their maximum of 105.25. The present war, true to precedent, has again sent them plunging downward. In 1916 the high was 58 and the low 52.5, and in 1917 the range was 55.5 to 73.25.

Prussian bonds have also felt the full effect of the present war. In 1914 Prussian 4's recorded a high of 86 and a low of 81. In 1915 the high was 65¼, the low 52¾, and in 1916 the high was 58⅛ and the low 50¼.

The United States 4's of 1925, while not showing a very marked decline during the Spanish War, did show a notable rise the year afterward. Their range for 1897 was from a low of 120⅛ to a high of 129½. The year of the war the low price sank to 117¾ and the high during the war period was only 128½. But in 1899 they rebounded sharply, the high for that year being 134½ and the low 128.

Therefore, in their present market quotations below par, United States Liberty Bonds are simply following the trait of their kind as they normally might be expected to do. By the same token, after the war is over, there is no reason to expect otherwise than that they will return to par and then go above par. More than this, in their present comparatively slight depreciation they are showing typical American stability. Instead of falling only two or three points below par, they might have dropped ten or fifteen points without exhibiting a fluctuation as violent as has been shown by the bonds of other less wealthy nations which have finally soared many points above par.

Editorials

Forestalling a Fuel Famine

THE proper period for laying in a supply of coal for the coming winter is the six months now beginning. There is nothing ludicrous in the statement, even though the country stands on the threshold of warm weather. If any individuals are stirred to mirth at the mention of coal and midsummer in the same breath, it is proof that they have failed to profit by the bitter experiences of the winter that is past.

The crisis that gripped the country during the early part of the year was due, in a large measure, to a failure to exercise ordinary prudence and foresight. The country had become so accustomed to living in a hand-to-mouth fashion that this came to be the accepted mode of existence. But the effect of increased fuel consumption due to the war industries had not been taken into account. As a result, the means of supply and distribution that were satisfactory in normal times utterly broke down under the double burden.

Among the many lessons of importance that the war has taught, none is of more consequence than that of our fuel distribution, which touches at the same time the physical comfort and the commercial prosperity of the nation. It has been demonstrated that we cannot wait until the demand has arisen and then expect it to be met instantly. That plan proved a dismal failure.

As a people, we are beginning to extend our vision beyond the tip of our nose, and the range is lengthening rapidly in the light of swiftly moving events. Obviously, the way to avoid a repetition of fuel famine is to accumulate supplies of fuel sufficient to meet necessary requirements at or near the points where they will be needed.

This should be done now, without delay. The placing of orders at this time, with delivery during the summer, will keep the mines working at full capacity, which is highly important. Recent weekly reports have shown alarming drops in coal output, the decrease in some cases being as much as half a million tons. The country needs a definite amount of coal each year, and if the production falls off at one season it must be made up at another; but unfortunately, it may not be possible to speed up production just when the increased demand arises.

Another phase of the matter should be kept in mind. The living expenses of the mine workers go on whether the mines are working or idle. If the orders on hand necessitate continuous operation, the miner can be kept at his job. But if there is a prospect of weeks of part-time work, the miner is going to seek some other kind of labor in which he can earn a steadier—and probably a larger—income. He cannot be blamed if he does. But if the labor at the mines is diverted to other channels, no wiseacre is needed to point out the predicament of the country when the cold weather arrives.

Further than this, the railroads are now in position to deal effectively with the transportation of the coal supply, if it is distributed over the entire summer. The zone system put into effect by the Fuel Administration will reduce the average length of trip, cut out cross-hauling and simplify the whole problem considerably. But all these efforts for the common good will be completely nullified if the public puts off ordering its coal until the first chill winds of October begin to blow. In that direction lies disaster.

Put in your order at once. You need not be perturbed over the thought that you will be accused of hoarding. The Fuel Administration has seen to that. You will be allowed to accumulate all the coal required to meet your normal needs, and no more.

Protect yourself against future discomforts and perform a patriotic service at one and the same time.

Remember the first few weeks of last January.

Put in your coal orders—NOW!

Internal-Combustion Economy

A PRIME condition of high economy in any heat engine is the avoidance of heat waste. This is so obvious in steam-engine practice that it needs no comment, but it is doubtful if, outside of the field of vision of the designing engineer, it is so well recognized in connection with internal-combustion engines. Briefly, all the potential heat of the fuel that is not transformed into work given off at the shaft is wasted. While much of this waste is inevitable, some of it can be avoided. To grasp fully the significance of this factor we should know in just what way heat is wasted. Heat not transformed into mechanical power passes away in the cooling water, in the exhaust and in friction and radiation. The friction of the piston and the bearings passes off in two directions—by direct radiation from the bearings principally, from the piston by conduction through the walls of the cylinder and to some extent by radiation from the interior.

The internal-combustion engineer regards the operation of the engine in two ways—one from the viewpoint of indicated work on the piston and the other from the viewpoint of power delivered to the flywheel. From the viewpoint of indicated work we have the heat of the engine divided into three principal parts—work, jacket loss and exhaust loss. Roughly, the division for the average engine is about even, or one-third to each. Taking the average of tests of gas engines ranging from six to sixty horsepower, the heat distribution runs thirty-eight and three-tenths per cent. in the exhaust gases, twenty-seven and four-tenths per cent. in cooling water and radiation, and thirty-four and three-tenths per cent. indicated work.

The average mechanical efficiency of this same group of engines is about eighty-five per cent. This summary of heat losses gives a goal that the operator should strive to reach or surpass. Both exhaust and jacket losses may be increased by poor adjustment of valves or ignition or other derangement of the function of the cycle. Jacket loss is increased by keeping the jacket cooler than necessary. Excessive friction is a source of loss that should not be tolerated in any well-conducted engine room.

For a Diesel engine the average heat distribution is: Exhaust gases, twenty-three per cent.; cooling water and radiation, thirty-four per cent.; and indicated work, forty-three per cent.

The average mechanical efficiency of the Diesel is seventy-eight per cent. The high friction loss as compared to that of the gas engine is due to the auxiliaries and especially the air compressor for injection. It is interesting to notice that the final efficiencies of the Diesel and a good gas engine of moderately large power are very closely equal. The efficiency, based on the brake-horsepower, of the Diesel seldom exceeds thirty-five per cent., while gas engines of moderate size have shown total efficiencies of thirty-two and five-tenths per cent.

The value of this knowledge to the operator will be appreciated when he realizes the fact that the efficiency of the engine depends upon keeping it in the very best of operating condition at all times. Excess of friction, improper cooling or any derangement of the valve or ignition mechanism is shown promptly in an increased fuel consumption.

Consideration of heat wastes shows the engine designer opportunities for improvement. One of the most promising fields of endeavor appears to be along the line of cutting down the exhaust waste. The method that gives the greatest assurance of improvement is complete expansion. It has been attempted, but there is one serious stumbling block in its path, and that is friction. It is an easy matter to increase the indicated efficiency by expanding beyond the pressure at which the exhaust is released ordinarily; but to offset that gain, there is the increased friction of the engine, which is likely to equal, if it does not exceed, the gain obtained by increased expansion.

Help the Counter-Offensive by Buying Liberty Bonds

THE whole civilized world at this moment of writing is interested in one thing, the counter-offensive. When will it start, how will it fare against the hordes of Hindenburg now engaged in their mighty and ferocious bid for a world decision?

But the great drives of the western front are not affairs of days or weeks. They come after careful preparation; some before this have taken months to run their course. And so with the counter-offensive. It must be deliberately well-timed, and it must have a duration in proportion to the sustained thrust it is designed to defeat.

Both these conditions have been happily fulfilled for our own share in the counter-offensive here at home. Possibly it has never occurred to a great many anxious patriots, scanning the headlines for some confirmation of hope in this critical time, that they have a personal and vital part to take in the effort to halt Hindenburg. This counter-offensive was started on Saturday, April 6, the anniversary of our entrance into this titanic struggle for everything that makes life sweet. It will last a month, following a schedule as carefully mapped out in advance as any the Germans have ever prepared for a march on Paris. Its result, a huge oversubscription to the Third Liberty Loan, will have carried every objective, financial and moral, which it is at present our function to carry in our majestic progress toward victory.

This is not a mere figure of speech which defines our Liberty Loan campaign as a counter-offensive. This is not a war simply of military and naval forces, but of whole nations, of the stay-at-home civilians of either sex and every age as surely and completely as of soldiers and sailors. At home the mobilization of money and industry for the prosecution of war, a process involving every inhabitant of the country when successful, is as vital a part of the vast conflict as the give and take across No Man's Land. With a great national response to this, the Third Liberty Loan, we Americans at home here, from three to six thousand miles from the scarlet waters of the Somme, are launching an offensive against Hindenburg as sure to hit his line as if we were plunging over the top tomorrow with bayonets fixed to attack his shock troops.

Keeping Down the Cost of Coal

THE United States Fuel Administration has adopted strict rules to govern the distribution of coal. Licensed distributors may not serve as middlemen unless their services are bona fide. If it is found that the licensee as purchasing agent has direct or indirect control of the mine owner, no commission will be allowed; or, if the licensee is in position to dictate to the mine owner and prevent him from selling to any consumer or retail dealer who has not employed the licensee as purchasing agent, it will be assumed that there is direct or indirect control. Any licensed distributor who attempts to obtain a purchasing agent's commission unless actually engaged as a purchasing agent will have his license revoked.

The object of this ruling is to give the consumer or retail dealer free choice as to whether he will employ a purchasing agent. Further than this, it is possible that all coal contracts made before April 1, 1918, will be declared void, thus putting the whole coal output on the market at the Government prices.

To public-utilities commissions, petitioned to allow increases of rates on account of the high cost of fuel, we suggest that raises, if allowed, be in the proportion that the increased fuel cost bears to the present price. Of the eight- or ten-cent rate to the small consumer it is a very small proportion; of the one- or two-cent rate to the big user it is a large fraction. There is no reason why the small user should be made to carry more than his share of the increased cost.

The old-fashioned wood engraver was unable to make a picture of a chimney without a picturesque cloud of smoke issuing from it, or of a machine without a man with a tall hat and cane in the foreground. The modern artist is still so possessed of the ideals of a past generation that he cannot depict an engineer without a workingman's cap with a visor on it.

Correspondence

Indexing Trade Literature

Trade pamphlets, circulars, catalogs, etc., are of value to the power-plant engineer and should be preserved; but when the engineer stops to contemplate the large volume that will accumulate in a year, he begins to realize that it is sometimes like hunting for the proverbial "needle in the haystack" to find the particular piece of information that is wanted unless some system of indexing and filing is employed.

Many of the large companies making a variety of articles issue large and expensive general catalogs which contain much information other than listing sizes, etc., and which are of value to the engineer or purchasing agent. Then there are bulletins and pamphlets which are of uniform size and intended to fit suitable binders. But there are many pieces of advertising matter received that are outside the scope of the plant and of only general interest to the engineer. For instance, the chief engineer of a department store using 220-volt direct-current service from his own plant will receive catalogs of, say, a new 150,000-volt transformer or hydro-electric machinery or relating to special street-lighting equipment, which represent considerable expense on the part of the manufacturer.

Many pamphlets, circulars and data sheets are sent out to supersede former issues on the same subject, and are usually so marked but not always. Unless they are marked, the engineer may keep both copies, thereby congesting his filing system and possibly causing confusion by getting the older copy when looking for information. Valuable data are in the many loose sheets which are received from time to time, yet they are difficult to save unless some system is followed.

In the modern manufacturing power plant trade literature on all parts of the plant is essential and, in addition to power-plant machinery, must include a variety of subjects, and the system used to keep these numerous pieces convenient for use will depend on the space available and on the ideas of the engineer.

One of the simplest yet efficient systems that has come to my attention is that of a public institution which receives a large amount of trade literature. In the system formerly employed all the large catalogs were numbered from 100 up, and the smaller pieces sorted out as to subjects as much as possible and placed in file boxes which were numbered beginning with No. 1. The large catalogs were numbered with a sticker on the back and set on the shelves, as were also the file boxes. A card index was then made of the subjects, with the file or catalog number showing just where the desired information could be found. After a few years this system outgrew the available space and a metal file cabinet was installed. This case has seven drawers 16 in. wide, 11 in. high and 24 in. deep. In each drawer there are from four to eight numbered index cards. The large catalogs are listed as before, and the small catalogs, etc., are given a file number beginning with No. 1, and as far as practicable sorted out as to subjects. It is not possible to do this in every case as there are many small catalogs that contain several separate and distinct items. A new card index of this literature was then made, and also another index of firms. If it is desired to find the catalog of a certain firm, it can be quickly done by referring to an index of firms.

The principal advantage of this system is that it is simple and compact. The hundreds of pieces of trade literature are kept where they are easily reached, and after the engineer has used the system for a few months he can, in many cases, find the desired catalog without referring to the index, provided it is replaced where it should be when used. After the system is installed, the work of keeping it up is slight. When a new catalog is received, it is numbered as to subject and an entry made on the proper index cards. About once a year the whole system is gone over, and obsolete and duplicate matter cleaned out. J. C. HAWKINS.

Hyattsville, Md.

Burning Wood To Save Coal

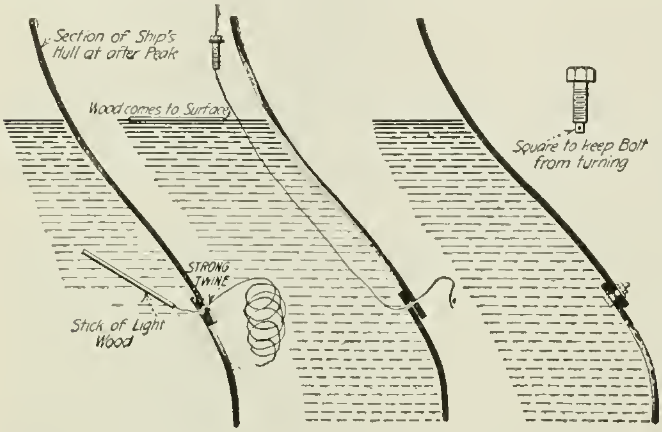
Commenting on G. N. McIlhenny's letter on page 194 in the issue of Feb. 5, I would say that there is no doubt that the substitution of wood for coal is entirely feasible and advisable under present conditions in many Southern plants, especially if good, dry wood is available. Full capacity may be had from almost any coal-burning boiler with dry wood, but not with green wood. Burning green wood entails great waste as a large percentage of the heat in wood is required to dry the wood itself in the furnace. It takes from three months to one year, depending on the kind of wood and climatic conditions, to thoroughly dry wood stacked in the open.

To successfully burn green wood a strong draft is required and a much greater distance between the grate and the boiler than is found in the ordinary coal-burning installation. In firing green wood the furnace should be kept "crammed full," replenished as fast as burned and the intensity of the fire regulated with the damper. I can say, however, from a wealth of experience that there will be few occasions to close the damper when firing green wood; the big worry is to keep steam if there is much of a load on the boiler. The idea of burning or drying the wood in the combustion chamber is no good. Besides the trouble of getting the ashes out, it would be necessary to let the fire die down to a certain extent to allow the fireman to get at the wood in the combustion chamber to drag it back on the grate. No boiler could be fired at half of capacity under these conditions. As to iron bars to protect the blowoff pipe, they might last a week, probably less, in the direct path of the heat under a hard-fired boiler.

Ash Fork, Ariz. W. G. CAMP.

Bolting a Rivet Hole Under Water

The illustration, "Bolting a Hole Under Water," on page 81 in the Jan. 15 issue, suggests that the artist had in mind a situation one may be up against on board a ship, although the necessity of closing a bolt hole under water may arise in connection with open tanks on land. The kink there illustrated, however, does not appear as certain of quick success as the one shown herewith, which is an old catch at marine engineer's examinations.



METHOD OF BOLTING A RIVET HOLE UNDER WATER

The principal points against the first-mentioned method are that with even the slightest current or other disturbance of the water it would be rather difficult to get a hold on the string with the wire hook so as to fish it through the opening, and the idea cannot be used if the opening is at a joint in curved plates, as shown herewith.

However, as a practical expedient, I believe that a pine plug or one made of other wood that will swell greatly when in contact with water has its advantages, at least until such time as the insertion of rivets or bolts becomes conveniently possible. This temporary plugging with wood was once successfully resorted to during my experience as a marine engineer, when two rivets had jumped out of a joint in the ship's hull about 14 or 16 ft. below the water line. The plugs remained securely in place until the next dry-docking the ship underwent, which happened to be soon. Of course we could hardly have stopped the ship for such a comparatively small matter, and besides, as there was quite a sea running, the bolting "kink" would have been pretty hard of execution.

H. J. Vander Eb.

Hartford, Conn.

Distant-Load Indicator

The following scheme is used in a system where it is desired to obtain frequent load readings at the office of the central station, the power plant being about a mile and a half away. There is no indicating wattmeter in the plant, but an integrating watt-hour meter measures the total energy supplied to a transmission line.

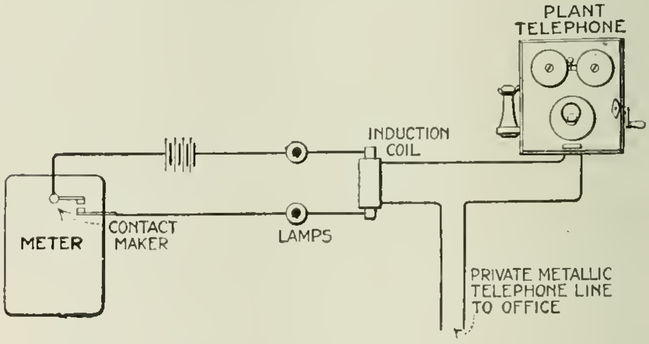
The register of the watt-hour meter was sent to the manufacturer, and a counting or contact-making device applied, which makes momentary contact for a certain number of revolutions of the meter disk. The company maintains a private telephone line between its office and plant, and the indications are transmitted over this line by means of the contact-making device shown in the drawing, wired so that its operation does not interfere with talking on the line at the same time the indications are sent.

Referring to the drawing, it is seen that the telephone line forms the secondary circuit of an induction coil. The primary circuit contains four dry cells and two 60-watt 110-volt type B Mazda lamps, the latter being used merely to act as rheostats to limit the primary current and inserted in each side of the circuit for protection in case the potential or current transformers supplying the meter should break down and subject the telephone line to high voltage, the supposition being that the lamps would either light or burn out in case of trouble.

As a further precaution and also to reduce noise on the telephone line caused by possible leaks in the meter or its transformers, the induction coil is specially constructed, the primary being wound around a core 0.25 in. in diameter, made of No. 18 soft-iron wire and inserted in a glass tube, the secondary coil being wound on the outside of the glass. The induction coil, when finished, is 3.5 in. long and 1.5 in. in diameter. The glass tube was obtained by cutting off a section of a round vial. The coils are wound with No. 30 single cotton-covered wire, there being approximately 2500 turns in the primary and 2000 turns in the secondary.

The primary circuit is closed by the contact-maker in the meter, and this produces a faint though audible click in any receiver of the telephone sets on the line.

The time between two successive clicks is inversely proportional to the load being registered by the meter, and with a stop watch and the following table, the load at the plant may be determined from any station on the private-telephone line:



WIRING DIAGRAM FOR DISTANT-LOAD INDICATOR

Time Between Successive Clicks, Seconds	Kilowatt Load
10.6	100
15.9	75
21.2	50
42.4	25

The complete table used by this company gives the load in kilowatts for every 5 kw. from 5 to 150, and the corresponding time in seconds. The table must, of course, be calculated for the installation it is used on, from the disk constant of the meter, the ratio of the reducing motion on the contact maker and the ratio of the transformers.

R. S. Seese.

Carthage, Tenn.

Heat from the Atmosphere a Substitute for Fuel

Technically, this proposition is known as perpetual motion of the second kind, and is commonly believed to be nothing more than a mere chimera, simply because the idea of its realization seems to be absurd. In the particular branch of science which treats of the motive power of heat, treatment of this idea as chimerical is the fundamental dogma from which is derived the so-called "second law of thermodynamics" and underlies the entire science as it is taught at the present time.

In the year 1824 Sadi Carnot, a noted scientist of France, demonstrated that realization of perpetual motion of the second kind meant the effect of combined action of two distinct heat engines, one acting as a heat pump driven by the other acting as a heat motor; furthermore, that the motor must be operated by a working substance that is more efficient as a medium for converting heat into work than the working substance which is used in the pump to produce a reversed effect.

Carnot stated that realization of this requirement must be impossible simply because its resultant effect would be absurd; and in accord with this assumption he concisely formulated the following principle which bears his name, and is considered the best formulation of that dogma: "The efficiency of a thermodynamic reversible cycle is independent of the working medium." Stripped of all camouflage, this is the real question which the United States Government must settle if it undertakes to investigate the feasibility of obtaining free energy from the atmosphere.

Unfortunately for the cause of the advancement of science, at various times individuals possessed of various degrees of honesty and knowledge of the subject have appeared in the limelight and failed to deliver the goods in regard to this question of free energy. However, it may be said that present-day experimentally derived knowledge of the physical properties of elastic fluids indicates that Carnot's postulate is fallacious; and as a consequence obtainment of free energy from the atmosphere, and in fact from all matter possessed of temperature, is not necessarily impossible.

Milwaukee, Wis. JACOB T. WAINWRIGHT.

Different Rate of Scale Formation

Replying to Mr. Pascoe in the issue of Apr. 9, page 521, I would suggest that the scale formation is greatest on the side of the boiler nearest the soot-blowing openings, because there is less soot on the tubes on that side, therefore the heat transfer is better and more water is evaporated in these tubes; hence the extra scale.

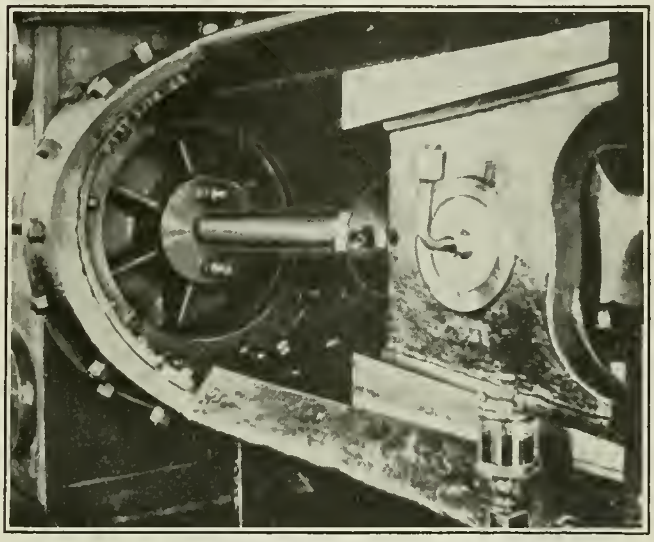
New York City. J. LEWIS.

Corliss Engine Frame Repaired

About three years ago I found that the frame of our 18 x 42-in. Corliss engine was cracked where the flange on the frame is faced to receive the cylinder head. The first method of repair thought of was to have the frame welded, but while many firms would undertake the job none would guarantee it to be a success on account of the strains set up by the process, so I decided to patch the frame with a piece of boiler plate.

As may be seen in the illustration, the recess back of the guides is considerably larger than the bore of the guides themselves. The distance from the end of the guides to the end of the frame is 8 in. and the diameter back of the guides 24½ in. From these dimensions I gave the boilermakers an order to form a cylinder of ⅝-in. boiler plate 24½ in. outside diameter, 8 in. long, with a 4-in. flange turned inward on one end. When the blank came, it was faced on the end that was to be placed against the finished end of the frame under the cylinder nuts, and was then laid out and drilled for the cylinder studs.

The problem then was to get as much of this flanged cylinder in back of the guides as possible. I had decided upon two-thirds of it going in one piece, but exactly how it was to be put in was not fully decided until a friend came in and suggested that I make a galvanized iron templet like the patch and then cut it in two parts in order to ascertain how large a part of it would go in place.


REINFORCEMENT PLATE INSIDE OF ENGINE FRAME

Then the old cylinder studs were all taken out by drilling a ⅜-in. hole, half in the stud and half in the nut, inserting a piece of ⅜-in. round iron to lock them and unscrewing with a 1-in. solid-end wrench. The patch was heated, using charcoal, closed, put in and opened out, or expanded, with bars and jacks, and long tapered wedges were driven between it and the ends of the guides to keep it forced back in place. At first it was thought that rivets would be good to fasten the plate in place, but it was decided that turned bolts ⅞ x 4 in. would be the best with the holes drilled 27/32 in. and reamed to a driving fit for the ⅞-in. bolts. When finished and the cylinder studs put in and drawn up tight, it made a good job.

The drilling was all done with an air motor and the reaming by hand. The total cost of the job was $90, and the engine was out of service five nights. This job was done three years ago and has proved perfectly satisfactory. None of the bolts ever slacked enough to require tightening up at all. J. T. SHARP, JR.

Canton, Miss.

Cook Boiler Explosion at East Chicago

I have read the interesting article on page 382 of the Mar. 12 issue of *Power* on the explosion of a Cook boiler, and the cause of the accident. In a case of this kind all have a right to an opinion as to the cause of the explosion, and I can hardly agree with the deduction as published.

It is stated that the initial fracture occurred in the joint or flange connecting the center tube to the lower tube sheet. It is further expressed in opinion that this type of construction is wrong. Cook boilers have been in operation for about 25 years, and it seems rather a late date to discover an error in construction. Had there been a defect in the design of the boiler, it would have appeared a great many years ago. The illustration, Fig. 2, as published, of the lower drum after the explosion shows the lower tube sheet drawn up into a shape of a bell. This indicates, in my opinion, that the center tube held to the tube sheet and was the last portion to give way. It indicates that this was the final rupture and not the initial rupture. In discussing the explosion of a boiler after it happens, we are prone to criticize the design and give too little attention to the care and management. The statement to the effect that some twenty tubes were renewed just previous to the explosion indicates, in my opinion, the prime reason for the explosion.

The tubes in a boiler of this type which are renewed frequently are those in the front bank facing the fire. In a boiler used for utilizing waste heat these tubes will be renewed several times in 17 years. The repeated rolling will enlarge the tube holes, and the result is that when new tubes are put in, they will not hold if care is not used in rolling. It is my opinion that the new tubes were not properly rolled into the lower drum. They were probably surrounded by other tubes that were warped and consequently pulled out of the lower drum, causing the explosion. It is not unusual for an inspector to find tubes in the lower drum of a boiler of this type improperly rolled. The short drum and the stays make it somewhat difficult for the boilermaker to work in this position, and he is liable to slight the job.

It is also stated that the boiler was fired up from a cold boiler in one hour. This is an unusually short time to fire up any boiler, but I can hardly agree that this particular type is less likely to stand it than any other. The reputation of the Cook boiler was based on its free circulation and quick steaming qualities, and its popularity as a waste heating boiler, and was based on every quality which the report indicates it lacked.

G. W. Cook,
Senior Inspector, Travelers Insurance Co.
Springfield, Mass.

In *Power's* report of the boiler explosion at East Chicago two theories were mentioned as to the cause and each involved unequal expansion, caused no doubt from hard firing. The report says, "One hour before the explosion the boiler had been fired up cold and within this period the pressure had built up to 50 lb.," which in itself explains the primary cause, for no boiler will stand that strain for long.

Engineers and firemen do not fully realize the strain caused by unequal expansion in firing up a cold boiler in two hours or less—something has to give way sooner or later if this practice is kept up. Boilers and settings should be warmed up gradually, and what applies to boilers also applies to steam lines, only with the latter one must be doubly vigilant in order to get rid of the condensation also.

W. H. H. Plowman.
Philadelphia, Penn.

[It is not always possible, in fact, it is often impossible, to determine the exact cause of a boiler explosion, because it is usually so badly demolished. In this instance information has been received to the effect that the lower tube sheet was much thinner at the line of fracture around the center flange. The first impression seemed to be that the thinness was due to corrosion, but it has since been determined that it extended uniformly all the way around at the turn of the flange, and it is the opinion of experts that this thinness is due to the flow of metal at the time of forming the flange. In conversation with William H. Boehm, vice president of the Fidelity and Casualty Co., regarding the subject, the following case was cited as bearing out this opinion. Mr. Boehm said regarding the thinning of the material at the turn of the flange head:

> Several years ago, when a boiler exploded down in Mississippi, we found a similar condition; that is to say, the condition where the drumhead was about ⅛ in. thinner at the turn of the flange than elsewhere. We inspected similar drums in the same plant and found that their drumheads also were thinned by the flanging process. We wrote a little article on the subject at the time, and it is my understanding, mostly on this account alone, that it has been the practice in recent years very greatly to thicken up the heads of drums and tube sheets likely to be thinned by the flanging process.

Mr. Boehm is of the opinion that investigations of such explosions will show that the most likely cause for such accidents is due to this thinning down of the tube sheets by the flanging process, together with the crystallization that has been going on during the period the boiler has been in service. Furthermore, unfortunately, it is not possible, through ordinary means of inspection, to discover a condition of this sort. Even if all the tubes in a boiler have been removed, the thinness of the metal at the turn of the flange would not manifest itself, as the edge of the nozzle and also the edge of the flanged part of the head would show the usual thickness. The best way to make a determination of this sort would be to drill a small hole in the turn of the flange and then to measure the thickness with a short piece of bent wire. Boiler inspectors would hardly resort to such a method and boiler owners would probably not permit the drilling of the head at this point.—Editor.]

Correction Regarding the Use of 85 Per Cent. Magnesia

In my statement, "A Correction Regarding the Use of 85 Per Cent. Magnesia," appearing in *Power*, Apr. 2, 1917, issue, at the top of page 484, lines 2 and 3 read: "a reprint of a report made by the Mellon Institute on heat-insulating materials." This should read: "a report made by Sargent & Lundy on heat-insulating materials."

E. R. Weidlein,
Acting Director,
Mellon Institute of Industrial Research, University of Pittsburgh,

Inquiries of General Interest

Damage from Handhole Cover Dropped in Water-Leg—What damage would result from dropping a handhole cover and leaving it in the water-leg of a locomotive boiler?
A. H. B.

There would be practically no harm done, unless the handhole cover was lodged at or near the bottom of the water-leg in such a position as to cause accumulation of sediment that would endanger the fire sheet to burning.

Shaft Out of Line with Cylinders—If the cylinder center lines of a twin-cylinder hoisting engine are parallel and the shaft center line is ⅜ in. below each cylinder center line, will the difference of level affect the operation of the engine?
H. M. N.

In a hoisting engine of ordinary size, the discrepancy would make no appreciable difference in the wear or operation of the engine.

Pitch Required To Retain Given Percentage of Plate—With rivet holes ¾ in. in diameter, what pitch of rivets would retain 70 per cent. of the solid plate along the pitch line?
A. H.

To have 70 per cent. of the material retained along the pitch line, the material removed for ¾-in. diameter holes would amount to 100 − 70 or 30 per cent., and therefore 100 per cent. of the pitch, or the distance center to center of ¾-in. diameter holes, would need to be ¾ in. ÷ 30 per cent. × 100 per cent. = 2½ inches.

Lap, Lead and Angular Advance—What is meant by the lap and the lead angle and angular advance of an eccentric?
C. B. S.

The lap angle is the angle through which the eccentric must be set more than 90 deg. in advance of the crank to have the valve moved far enough to obtain admission of steam at the beginning of the stroke. The lead angle is the angle through which the eccentric is set in advance of the lap angle to obtain the lead or amount of valve opening at the beginning of the stroke. The sum of the lap and lead angles is called the angular advance of the eccentric.

Apparently Excessive Water Metering—What reasons can be given why the metered water consumption of an office building reported for the month of February should be much in excess of the ordinary monthly consumption? The meter was pronounced correct at the end of the period and there was apparently no unusual use or waste of water.
E. H. H.

Prior to the month in question, the meter may have been "too slow," though it is probable that if pronounced correct at the end of the period, the previous rate of error was not materially different. There may have been a larger supply than usual during this coldest month of the year to make up such wastes as leaving taps open to obtain hot water, or circulation to prevent freezing; or there may have been unobserved wastes of water, as from leaky tank valves or a leaky boiler blowoff valve. Another cause for an apparently higher metering, and one that is largely responsible for popular distrust of meters, is that the final registration charged against the particular month may have been read down closer than usual, thereby including an accumulation of meterings that belonged to a prior period.

Determining Benefits of Aligning Shafting—What methods are employed to determine the benefits derived from lining and leveling shafting of a power plant?
G. H. W.

The benefit of truer alignment in reducing bending stresses will become apparent from reduction in frequency of breakages, less wear and cooler running of bearings from less loss of power from friction, requirement of less lubricant and less vibration of bearings, hangers and other supports. The actual benefit of reduction in power required for overcoming friction must be determined by measuring the power required for driving the shafting before and after it is aligned. For complete information, the improvement should be ascertained with respect to both the bare shaft and with the shaft carrying its regular load. The relative power required by the unloaded shaft will usually be the better index on account of difficulty in obtaining the same load before and after the shaft is lined. For making a comparison, the best method of measuring the power is by means of a transmitting dynamometer, using the same instrument under identical conditions; or by ascertaining the input to an electric motor when used for driving the shafting and whose efficiency has been calibrated for the conditions. Comparable measurements of power may be made with sufficient precision for most practical purposes by carefully indicating the regular driving engine without change of any of its adjustments that would alter the friction of the engine. The diagrams should be made with steady speed of the engine and lowest steam pressure and scale of indicator spring compatible with the load, so as to obtain diagrams that can be measured with greater accuracy.

Obtaining Required Length of Piston Rod—How would dimensions be taken for the length of the piston rod for an engine?
J. E. R.

The important consideration is to provide length suitable for securing equal piston clearance at each end of the stroke. For this purpose, first determine the required finished length from the piston to the crosshead. Having the shaft square with the cylinder center line, and the connecting-rod in place with brasses shimmed to give the average length of connecting-rod, make a mark on the crosshead to register with a mark made on the guide when the crank is on first one dead-center and then the other. The distance between these marks on the crosshead will be the actual length of stroke. Place the piston in the cylinder with a distance piece or pattern of hardwood on the cylinder-head side of the piston, to represent the dimensions of the piston rod with nut or other fastenings that are to project beyond the piston. With the cylinder head in place and piston with distance piece firmly pressed against the head, mark on a wooden rod the distance from the piston at the bore of the piston rod to the outside of the piston-rod stuffing-box, and on the same end of the measuring rod mark the distance from the same part of the stuffing-box to the same part of the piston while it is pressed hard against the crank end of the cylinder.

The difference of distance between the marks thus made on the measuring rod and length of stroke previously laid off on the guide will be the sum of piston clearance distances obtainable for both ends of the stroke. To provide for equal clearances, make a mark on the guide at one-half of this distance, measured toward the crank, from the crank end of the length of stroke previously marked on the guide. After disconnecting the connecting-rod, place the crosshead so the mark previously made on it comes opposite to the mark last made on the guide. Then with the piston hard against the crank end of the cylinder, rod the length for the finished piston rod from the end of the crosshead bore to the end of the bore of the piston. The additional length and dimensions required for machining the ends of the new piston rod will be governed by the design of the piston and crosshead.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Marine Engineer and His Work[*]

By AN EX-MARINE ENGINEER

This is not a technical discussion, but is intended to illustrate by a few experiences, the duties and responsibilities of engineers on board a North Atlantic greyhound.

WE WILL imagine ourselves at the pier in New York, having just arrived in port, and will go below and begin preparations for another voyage. As soon as the telegraph from the bridge rings, "Finished with the engines," all safety valves are raised by the easing gears, the main stop valves are closed and the fires drawn in all but two of the main boilers. As soon as fires are drawn, the water in the boilers is pumped overboard, the manhole doors are taken off, the smokebox doors are hoisted, and the work of withdrawing the retarders, some 6600 of them in number, and cleaning the tubes is begun by the shore gang, numbering about 150 men. By the time the tubes are cleaned, the boilers are cool enough for the men to go on cleaning the furnaces and combustion chambers, and then the work of scaling the boilers is started. We generally found on the furnace crowns a deposit of salty scale ranging from $^{3}/_{32}$ to ⅛ in., each run.

In the meantime the engineers having general supervision of this work are "passing the tubes," which means having a light held at the back end, passing along from tube to tube, and when one is found choked up, chalking it; then in turn inspecting all the furnaces and combustion chambers inside and out, stay-bolts and nuts, tube ends, boiler shells inside and out, all main lines of piping, valves, and in fact every piece of metal visible to the naked eye; withal keeping watch of the boilers under steam. As soon as two boilers can be cleaned and steamed up for the auxiliary service, the two that have been running are taken off and made ready like the others. While the cleaning is going on, a large crew of boilermakers are expanding tube ends, fixing air casings, calking seams which leaked at sea, repairing furnace doors and their catches—which, by the way, is of no small importance, for a steamship's furnace door must stay open until it is closed and stay closed until it is opened; otherwise, with the Howden forced draft, which we had, there will be some severely burned faces as a consequence. The blowing engines are also gone over as carefully as the main engines.

Boilers the Foundation for Good Records

In regard to the care of steamship boilers, or any other boilers under pressure, do not fail to see everything that can be seen, for bear in mind the boilers and their output are the foundation for good records both at sea and on shore.

In the engine rooms in the meantime the work is going on in the following order: Upon receiving the "finished with the engines" signal, the turning gears are connected and two of the most trusted engineers are sent to sound the shafts, this being done by screwing together a sectional sounding-rod about forty feet long, which is carefully machined at each end of each piece and screwed together till it butts metal to metal. This rod, as it is made up in the gloryhole aft (or what would be called the "'tween decks" over the propellers), is passed down through a cupped opening onto the shaft near the propeller bosses and the exact height recorded on these rods after each run. When the shafts are found down or deflected more than a certain prescribed limit, they must be lined up or there will be a repetition of the "Paris" disaster back in the 80's, when the shaft was said to be down 1¾ in. at the point where it failed. Incidentally, one of the senior engineers is liable to happen along at the time the readings are being taken. The circulating pumps on the main condensers are stopped, feed pumps connected by lines of hose to dock hydrants, the exhaust of the auxiliaries put into the auxiliary condenser or to the atmosphere and the steam cut out of all lines of pipe not in use, which means the closing of not less than 30 valves; and the work of overhauling the engines and pumps is now begun by the "shore gang," the ship's crew being off duty with the exception of three or four engineers until the next morning to get at least one full night's sleep or a run on shore—probably the latter.

Work Done in Port

As an example of the work done while in port, my notes taken on board the "St. Paul," when I had charge of her starboard engines, will serve, about the same work going along on the port engines. First entry, "Stripped and examined forward high-pressure piston." This work is done by one of the junior engineers with four or five firemen to assist. We generally found the wear on the piston packing rings in the high-pressure cylinders very severe, due to the high steam temperature, occasional priming which carried over more or less dirt from the boilers, and the very moderate use of cylinder oil, which for these large engines is not over one drop through the lubricator per minute, and frequently no oil at all is used. Sometimes we would find only a few pieces of the packing rings in the piston. This, however, was not a difficult repair, as we always carried spare rings, which were sawed diagonally across and left apart an eighth of an inch when in the cylinder to preclude any chance of cramping. These high-pressure rings are usually the ordinary snap rings called "Ramsbottom," and this same type of packing is used in marine-engine cylinders up to 50-in. in diameter; above that size, light steel springs are used to keep packing rings against the walls of the cylinder. Follower bolts were renewed occasionally as we often found them crystallized to such an extent that, laid across the jaws of a vise, they would break with a very light hand-hammer blow; while when new they could be bent double on themselves without fracture. To make sure that the follower bolts were screwed down tight enough, we generally provided the men with a light steel bar which was to be bent on every bolt in making it up.

"Overhauled piston-rod packing on aft high-pressure rod." "Examined second intermediate piston, found 12 springs broken, replaced with new ones." To do this on a 77-in. cylinder, we had a small manhole in the center of the cylinder cover through which we could enter without taking up the cylinder cover proper.

"Universal couplings on throttle-valve gearing repinned." "Overhauled and adjusted first and second intermediate valve-spindle guides." "Put lighter oil cups on all crossheads." A great fault of oiling service was that heavy cast-brass cups were held in position by light slot-headed screws, which never ought to be used except for holding the cylinder lagging. These cups are better if made of sheet brass and held in place by capscrews.

"Overhauled low-pressure crosshead." To properly overhaul crossheads, we generally had to hang the engine up, take the crosshead brasses off the rod and chip side clearance in the boxes, filing and scraping them before putting them together, for very often we would find the crosshead pins afloat; that is, not bearing in the bottom of the box after the engines had cooled down from a hard run. When we had the crosshead landed in the boxes, after giving the boxes side clearance, we adjusted the amount of running clearance between brass and pin by the use of wire made of pure lead and very soft. This adjustment is made by laying the lead wire across the pin at right angles to its axis and a little short of its half-circumference, one wire about an inch in from each end and one in the center, putting in the liners and putting the top half of the box and binder on and screwing the nuts hard down on the lead wires, marking the nuts before slacking them up so as to have a record of their position. Then, by putting in or taking out liners as required and by taking a final lead impression, we adjusted

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[*] Informal talk before the graduating class of the Massachusetts Institute of Technology.

these boxes to a clearance amounting to about a thousandth of an inch by micrometer calipers for every inch of diameter of pin or bearing. This method is used for all bearings of marine engines where adjustments are to be made.

"Found piston nut slack on forward circulating engines, and one follower bolt broken." "Reciprocating parts of these engines thoroughly overhauled." "Renewed oil-piping systems on high-pressure valve gear, which was thrown off at sea." "Sawdust connection put on condenser circulating pumps." This was done so that we would be able to inject sawdust into the condensers when leaking. "Air-pump valves and feed-pump valves and seats examined and renewed where necessary." "Filter cloths renewed." "Two copper bends (a practice now abandoned) put into auxiliary steam mains, reducing valves, main to auxiliary thoroughly overhauled, adjusted forward l.-p. crankpin (this adjustment being similar to that of the crosshead, except that we rarely had to give boxes additional side clearance)."

A word about the bedding of the main crankshafts of these ships and about the use of water on hot bearings is probably in order at this point. There is a difference of opinion in regard to the use of salt water on hot bearings. On one new ship we were permitted to use water on the bearings when they were above 110 deg., and this shaft went down uniformly about $\frac{1}{32}$ in. in all its bearings in about twelve months' running. In another, a sister ship, we had orders not to put the sea water on until the thermometers in the bearings (which are hung by wires just clear of the revolving shaft) registered 180 deg., or thereabout, but this shaft went down considerably more and gave a good deal of trouble. It is my practice to keep the temperature down, water or no water.

"Thrust bearing pumped out and refilled with clean oil." Thrust bearings require a great deal of attention and should be closely watched. When they do go wrong, they give a lot of trouble and are hard to handle. "Plates put over two bearings underneath platforms to keep dirt off; hotwell cleaned out." "New water end put in main boiler-feed pump and any number of small jobs too numerous to mention." Boiler-feed pumps on all the ships that I was ever in were about half large enough; technically speaking, they were ample, but in practice we were greatly bothered with them, especially with broken valves, split water ends, broken pistons and piston rods, feed pipes and feed-pipe anchorages, packing blown out of joints, etc. These should have ample margin, so that they can be run slowly.

Washing Down and Painting

On the day before sailing, after all this examination and repair, the washing down and painting is started and the engine rooms are all "slicked up" ready for sea, tools and tackle are all stored away and the boilers closed up and filled with fresh water from the dock. The last half-day before sailing, the ship's engineers are given another short run on shore, sailing hour being at 10 o'clock next morning. At 8 o'clock the night before sailing, the bottom fires in the boilers are lighted under the supervision of one of the senior engineers, who makes it his particular business to see that the water is well up in every one before the fires are lighted and that all the stop valves are opened from the cold boilers; he also sees that the main throttle is "cracked" in order that all the main lines of piping right through to the engine cylinders are warmed up gradually with the boilers. After the fires are started the men of this crew take one turn out of both main engines with the turning gears, first looking the engines over carefully to see that nothing is in the way, that all the small parts are connected, that the crankpits are clear and all is right for running. The turning gears are then disconnected so that, if the engines should move while the cylinders are being warmed, no damage would be done. This is all the trial these engines have before going to sea.

At midnight the high fires are lighted in all the main boilers, Scotch marine type, and the circulating of the water in them commenced. One boiler is taken at a time, and the water is pumped from the bottom of the boiler and back into it again, through the feed pipe, to warm the bottom of the boiler shell and surrounding parts under the fire line of the furnaces, so as to equalize the expansion of the shell. This is a very important part of the process and is under the eye of one of the senior engineers, for a little carelessness might mean the pumping out entirely of one boiler and the flooding of two or three more.

In the meantime the manhole covers in the bottom of the boilers are followed up and every water pocket in all steam mains is carefully drained, for the steam pressure now is 20 or 30 lb. and by 4 or 5 o'clock has reached 100 to 120 lb. The engineer and two assistants go all over the engine department, setting the main valves as they are to be run for the voyage—some of the main stop valves on the boilers are run 2 to 6 turns open, to retard priming where the draft of steam to the engines is heavier than to others. At 8 o'clock in the morning the 8 to 12 watch is detailed below "all hands," and begin filling the oil cups, start the main condensers, prove the telegraph, try the reversing gears and complete the warming up of the cylinders of the main engine, but do not start the main engine.

Getting Under Way

The stokers are given their stations, trim the fires and gradually raise the steam to about 195 lb. Occasionally, at about this time there are little things such as stay-bolt nuts giving way in the combustion chambers or tube ends leaking badly; this means that fires are drawn from the boiler affected and a lot of man-killing work, twelve or fifteen of the shore gang being kept to lend all the assistance they can. Finally, the "all ashore" is sounded and we are left to our own devices and the next thing we hear is "half-speed astern," for the two 10,000-hp. engines, which have each been dismantled in a dozen places and readjusted. Every order of the telegraph is registered in minutes and seconds in writing in a log book. This order is no more than carried out until we have "full speed astern, both engines" to carry us out into the river against the tide. All hands except the chief engineer are below, to assist in getting under way, handling the engine, etc. After a series of "half-speed ahead," "slow ahead," "stop," one side and then the other, we drop the pilot and get the "full-speed ahead" double order, and sometimes if the skipper is feeling extra well, triple order, and the real business of driving a greyhound across the Western ocean begins.

Here is where all the bad work done in port shows up; although every bit of the work was done under the eyes of the engineers, more or less of it had to be intrusted to a gang of machinists who are not engineers and who came aboard ship to get in time. Some of the bearings were adjusted too closely, some improperly put together, so that the first watch at sea between poor firemen and hot engine bearings is often a "hot one." Again, we might leave port without a particle of trouble. In regard to the driving of one of these ships, I wish to say a word about a man's personal character. Above all things, he must be a *man*, say what he means and mean what he says; for in so large a crew of men there are all sorts of dispositions, and in order to get the ship along, a man must have a level head and be more or less a manipulator of men as well as of engines; for if you are not a steam getter, your engineering ability will count for naught. Habitually following one revolution per minute behind the other watches, you will be called up to explain why. Sometimes the men claim to have a poor crew—that's easy; the chances are that the next time you leave port you will have the best watch of men on the ship, or the watch that has made the best time, and then if you fall short, your number may be called. It is a business proposition from start to finish.

On going below to take charge of a watch, the senior engineer will look over the gageboards, see that the reading of the revolution counters for the previous watch are properly recorded at 8 bells. In the meantime his watch of men has gone over the engines to see for themselves that everything is all right. The stoke-hole engineers at the same time have gone through the stoke-holes taking in the average height of the water in the boilers, the amount of coal in front of the boilers and the general condition of things under their supervision. If nothing is reported wrong inside of ten minutes, he will turn to his fellow senior with the words, "I've got her." Should anything be found wrong—for instance, low water in the boilers, hot guide, main bearings, a hot crankpin, eccentric straps, or the like—he may refuse to take the watch until the irregularity is straightened out. Should the water in the boilers be exceptionally short, for instance, he might go on deck till more water is put into the boilers. Or if it were simply a broken-down auxiliary which could be temporarily stopped for repairs, the required number of men would be detailed from the watch being relieved to make the repairs; these men would work for two hours of the watch coming on, when the same number of men would be brought down from the watch coming after—so that any number of men would be liable to be below eight hours on a stretch, for on a "liner" you are with your job all the time.

Troubles Not Always in Engine Room

The following will show that all troubles are not in the engine room. Once, in leaving New York, one of our coaling ports in the ship's side had not been properly secured and just as we were nicely ploughing into a February nor'easter, the door swung open, shipping water in "great shape." It was on my watch and I sent an assistant to tell the chief in person what had happened, thinking it might be necessary to "heave to" or "put the good side to the weather," but I started at once with six men to try to make the door fast between seas. We had no more than reached it when a fire in the dynamo room put the ship in total darkness temporarily. Between getting the door fast, putting oil torches by the side of water-gage glasses and about the engine rooms, we were busy. But after an hour or so we had some of the lights on and made the run without any further trouble.

Another time we were nicely around "the corner" of the Banks of Newfoundland, when a forward port main-bearing stud broke. This was handled about as well as any break of its kind I ever saw. First of all the turning engines were put into gear so that the main engines would not move while we were working over them. We then put a large ring spanner or solid wrench encircling the nut on top of the bearing over the nut; the wrench by the way, weighed about 300 lb., the stud being 6 in. in diameter. This was securely lashed close up to the bearing cap with chains, tightened by a "Spanish windlass" and chain-falls. For additional holding-down power we took one of the cargo-hoisting booms and cut it to reach from the cap to the reversing-shaft bracket, securely lashing top and bottom ends in position. After the turning gear was taken out, we were able to proceed for the rest of the voyage at about half-speed with this engine, occasionally tightening up our rigging.

Shortage of Water Causes Trouble

In regard to the possibility of the boilers being short of water, we were once westward bound, about four days out, running in a heavy beam sea. Through some mistake in a pumping order, two of the ship's trimming tanks were not entirely pumped out, and the ship made one tremendous lurch to port, about 37 deg. from perpendicular, as I remember it, and owing to slack water in the trimming tanks, held there for quite a period—long enough to melt the fusible plugs in five boilers at one time (the fusible plugs being in the side combustion chambers). This meant drawing fires out of forty furnaces (for the boilers were double-enders with four furnaces in each end, half a ton or so of incandescent fuel in each), the closing of the stop valve on each of these boilers and the releasing of the steam through the safety valves by the easing gears before we could get in the combustion chambers to screw brass plugs into the fusible plugs in place of the fusible metal. We accomplished this with a long socket wrench, lying on our backs on planks on top of grate bars which only a few moments before were covered with incandescent coal. You can imagine what this meant. We had sixty men from another watch to help draw the fires and rekindle them, while coal, wheelbarrows, red-hot rakes, slice bars and the like were thrashing from one side of the ship to the other. I have known of fusible plugs being temporarily plugged by very adept men when there was 30 to 40 lb. pressure in the boilers.

Occasionally, in going across we fall in with another ship of our own class going in the same direction. I remember in particular one time when we fell in with the "Campania." We can always tell by the smoke whether it's a ship with anything like our time or not, for if the smoke remains on the horizon an hour she is with us to stay. In coming the other way, we have her nicely abreast in an hour. We sighted the "Campania" astern about 8 o'clock one morning. At 8 o'clock the next morning she was just about abreast, a "stern chase," and at 8 o'clock the following morning her smoke was just in sight ahead, with practically one-third more power than we had, which speaks pretty well for the smaller ship. In the meantime they, in the forecastle, began to take a great interest. The 8 to 12 watch the first morning went below with a full determination to beat all previous records, which they did. The 12 to 4 in taking charge, found stars chalked all around, on the boilers, on wheelbarrows, in coal bunkers and even way up on top of coal piles, showing they had been up there for lump coal, for they certainly did not go up there to sleep. These came off watch with a better record and more stars and more revolutions made per minute. Not to be outdone by any of the other watches, the 4 to 8 went below and made a still better record, which I believe was the highest ever made by that ship before or since. I went forward myself to be sure this watch was properly called, and found them all ready to go below half an hour ahead of time. We had a one-armed fireman on this watch who was born for better work. He had been around the world probably a dozen times, and he said to me: "I heard them 'breaking her up' on the other watches, and I thought I would get the boys ready. She's making such good time I couldn't sleep for her turning." He was my mascot as long as I was in the ship and the boss of the watch in the forecastle. There is another point which I wish to bring out in regard to marine engineering, and which I will illustrate by an incident that happened on board the "New York." We were within twelve or fifteen hours of port when the connecting-rod broke on one of our fan engines, almost wrecking the engine. We could have made the run without this engine, but to go into port with anything broken down was not in our book. The word "helplessness" is not known in the business. The engine was properly repaired, a new spare crankshaft being put in in place of the old one, the frame patched with steel plates, and the engine made as strong as originally, the work being completed about two hours before we reached port.

The Coal Situation in France

Before the war France consumed a total of approximately 65,000,000 tons of coal, of which, in round figures, 41,000,000 tons was of domestic production and 24,000,000 tons was imported from Great Britain, Germany and Belgium. The monthly consumption in peace times thus amounted to 5,400,000 tons. In 1916 the domestic mines produced only 20,000,000 tons and the imported coal amounted to only 19,000,000 tons, making the total quantity available for consumption 39,000,000 tons. In November, 1916, a typical month, the French mines produced 1,800,000 tons of coal and the imports amounted to 1,500,000 tons, the available monthly supply being therefore 3,300,000 tons, which represents a deficit, compared with the monthly consumption in 1913, of approximately 40 per cent. It should be noted, however, that the average for 1913 includes also the summer months, whereas the consumption is necessarily greater in the winter months. The figures for December, 1916, compared with the monthly average of 1913, indicate a diminution of 44 per cent.

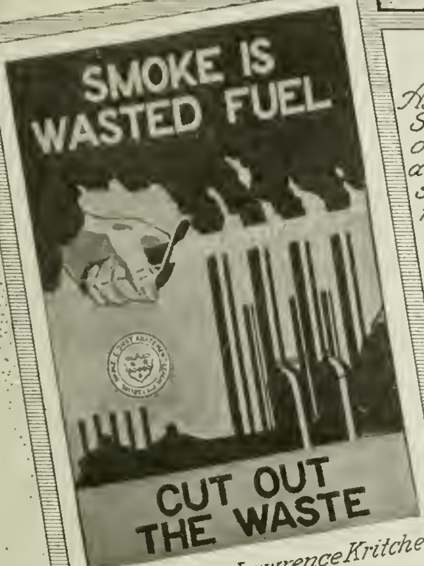
The most hopeful sign, pointing to the unlikelihood of a serious coal crisis during the remainder of the present winter, is furnished by the great increase in the domestic production of coal. In October, 1915, the French mines produced 1,700,000 tons; in October, 1916, 1,800,000 tons; in October, 1917, 2,782,000 tons. In November, 1915, the French coal mines produced 1,500,000 tons; in November, 1916, 1,600,000 tons; and in November, 1917, 2,690,000 tons, or an increase of about 80 per cent. in the two years. It should, of course, be noted that the invaded portions of France contain the principal French coal mines, and that therefore the war has cut off the chief source of supply and has made necessary the more intensive exploitation of the mines in the uninvaded regions.—*Commerce Reports.*

As announced in Power of February 5, the Smoke and Dust Abatement League of Pittsburgh in February conducted a competition to secure poster designs showing the relation of smoke abatement to fuel conservation.

Prizes were offered as follows: First prize, $50; second prize, $20; two prizes, $5; four prizes, $2.50; ten prizes, $1.

The winner of the first prize was Lawrence Kritcher, a first-year student at the School of Applied Design, Carnegie Institute of Technology.

Reproductions of seven of the prize-winning designs are shown on this page.



First Prize – Lawrence Kritcher

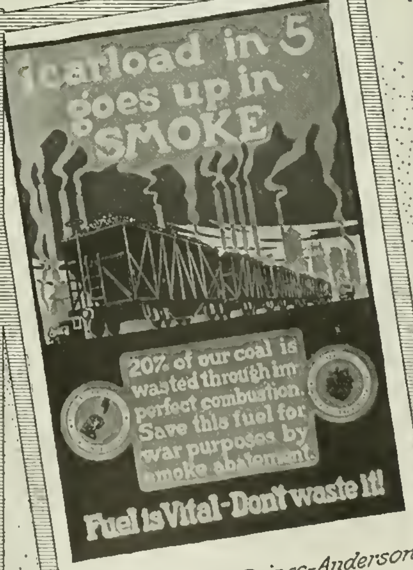
Second Prize - Lloyd Weninger

One of the Fourth Prizes - Mildred Floyd

One of the Fifth Prizes - Winifred Cramp

One of the Fifth Prizes - Hilda M. Kaji

One of the Fifth Prizes - Helen Barkhurst



One of the Fifth Prizes - Anderson

War Service of the Petroleum Industry*

By M. L. Requa

Director, Oil Division United States Fuel Administration

This war cannot be won without an ample supply of petroleum products. We must have, if we are to succeed, not only fuel oil, but gasoline, kerosene and lubricants as well; for them there are no known substitutes.

It is not possible to single out any one product and say of it, this is the most important for the winning of the war. We may say truly that the most important element is the spirit of the soul of the people, the morale of the nation, but in dealing with our industrial life we have absolute need of many things. Food we must have, or perish; steel, copper, chemicals, petroleum—we have need for all of these, and more, or we must suffer defeat. From the standpoint of the winning of the war, not one of these products is more important than petroleum. It lubricates the machinery of our transportation and manufacturing, it plows our fields, drives our vessels at sea and gives life to the airplane that watches over our soldiers and sailors.

As the application of steam and electricity grew, so grew the demand for more and better petroleum products. One to a large degree kept pace with the other. The original "puffing Billy" has grown into the Mallet compound of today; the original "Robert Fulton," wending laborious way down the placid Hudson, into the monster turbine-driven battleship. All these machines have been dependent upon lubrication, upon petroleum; and the more recent advances in marine construction have been predicated upon the use of fuel oil as the means of steam generation.

Rapid Rise of Internal-Combustion Engine

We have witnessed in the last decade the rise of the internal-combustion engine. Its profound effect on rural as well as urban life grows more and more manifest; it competes with the locomotive and the trolley as a means of rapid transit; and as a method of distributing freight in cities, plowing fields, and providing healthful recreation it is rapidly superseding the horse. As an instrument of war it is of paramount necessity; driving the swift-flying airplane that serves as the aërial scout to our armies; it makes possible observations for lack of which disaster would be the inevitable portion of our forces.

In the realm of the internal-combustion engine, petroleum reigns supreme. It supplies the motive power; it lubricates the machinery; it is, in short, the life fluid without which neither motor vehicle nor airplane could serve the needs of humanity.

The internal-combustion engine has created a demand for gasoline of hitherto undreamed-of proportions; it has made what was once considered almost a waste product into the most important element derived from petroleum distillation. Inability to supply the rising demand by recognized methods of refining has spurred inventive genius to new efforts, until today we have the new practice of pressure distillation with its resultant increase in gasoline output.

And what are our assets, with which to meet the demands which may be made upon us for petroleum? What is the strength of this young giant that responds to the nation's call to arms? We have produced from the year 1859 to date a total of more than 4,250,000,000 bbl. of oil. Our production has increased, by decades, from 500,000 in 1860 to 5,260,000 in 1870, 26,286,000 in 1880; 45,823,000 in 1890, 63,620,000 in 1900, 209,557,000 in 1910, and 330,000,000 in 1917. Over long periods the average increase has been about 7 per cent. of the previous year's production. At this rate of increase we shall require 460,000,000 bbl. per annum in 1927; and for 1918, if the average holds good, we shall require an additional amount above last year's production of approximately 23,000,000 bbl. It will be forthcoming, of course; from the known fields, if necessary; and perhaps in part from new discoveries.

We are beginning to realize, however, that our resources are not limitless. It is the consensus of opinion that the Appalachian, Lima (Indiana) and Illionis fields can add little in the way of increased production; leaving but three great known fields to meet our future requirements—Mid-Continent, Gulf and California.

The changes in the industry are startling; today a flow of oil, tomorrow a famine. Spindletop was discovered in 1901, and yet today the Southern Pacific brings oil from Mexico to supply its locomotives plying in Texas. We are confronted with constantly mounting consumption and a constantly increasing percentage of exhaustion. Some day the lines must cross, production will no longer be able to keep pace with consumption and we must seek other sources of supply.

Exact Extent of Future Supplies Unknown

Any mathematically exact estimate of the petroleum yet to be extracted from the rock formations of the United States is, of course, impossible. Undeveloped areas now unknown may add greatly to present estimates. Speaking broadly, however, I think I am safe in saying that it is our duty to conserve most carefully our remaining stores. Locked in the earth, they are of course valueless. Do not misunderstand me or imagine that I am arguing against production, against wildcatting, against the individual effort having for its incentive an adequate reward. I believe all these things must be done. But I am also of the belief that increasingly efficient methods of combustion, lubrication and general conservation will materially alter practices that can be safely characterized as wasteful.

In viewing the petroleum industry from the Governmental standpoint, it necessarily means the viewpoint of national welfare in contradistinction to individual gain; it means the wise husbanding of our available resources so that they may last the greatest time, in contradistinction to producing the greatest quantity in the least time and converting into money the treasures of nature's storehouse.

With the exhaustion of our oil or its advance in price we have, of course, the alternative of producing oil from shale. That there are enormous areas of such shales in the United States is well known among geologists and others who have taken the pains to investigate. These shales will undoubtedly in time be mined for oil, but we must remember that to produce a quantity of oil equal to our present production we shall have to mine a daily tonnage of shale in excess of the tonnage of coal now mined daily. The magnitude of such an undertaking is obvious. It will not be the growth of a day, but of years. And it is likely that because of plentiful supplies of oil which may be brought to the United States by water—cheap oil from Mexico and Central America—it will be many years before these shales are utilized.

Present Necessities Call for Economic Discipline

The stern necessity that has imposed unparalleled economic discipline upon the people of Europe will not disappear or be forgotten with the coming of peace.

This is no time to quibble over technicalities, no time to debate the power of the Government to perform any proposed act. We are at war. The life of the nation is at stake. The preservation of our national existence is of such paramount importance that nothing else really matters, compared with that duty.

Each month during the war the priority demands of the Government will become more and more insistent, the duty of the citizen to supply those demands more and more clearly defined.

If zonal distribution of petroleum products is necessary to supply national needs, zonal distribution will be accomplished. If pooling of tank cars and ships will more efficiently meet national demands, those facilities will be pooled. If well-drilling supplies must be allocated to produce the greatest quantity of oil to meet the increasing demands for oil, well-drilling supplies will be allocated. If licensing of jobbers and others is necessary, they will be licensed. If the petroleum industry or any part of it is so unwise as to engage in profiteering, ways and means will be found to correct that condition. In short, whatever the national needs may be, everything that is necessary will be done to meet those requirements.

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*From an address delivered at the Petroleum Congress, Chicago Ill., Mar. 29, 1918.

Twenty-Million-Dollar Power Extensions Urged

Recommending extensive hydro-electric development in the southern part of California at an expenditure of $20,000,000 within the next two years, to meet the increasing demands for power and light and for the conservation of fuel, the Railroad Commission of California has issued a decision in its investigation of the construction and operation of electric utilities during the emergency created by the war.

Specificially, the commission recommends that the Southern California Edison Co. take immediate steps for the carrying out of a comprehensive plan for the financing of approximately $15,000,000 for building power plants, that the Southern Sierras Power Co. construct its Rush Creek Bishop line, and the San Joaquin Light and Power Corp. insure the building of additional plants for the increase of facilities, or by purchase agreement, the maintaining of an adequate power supply for agricultural and industrial needs.

The Railroad Commission's investigation was state-wide, but the present decision deals only with the territory south of Merced, the northern part of the state to be considered later. The decision says that though considerable economy of oil would result from more complete interconnection and coöperation of hydro-electric plants, yet the war emergency demands that the corporations take immediate steps to build additional power plants to meet the constantly growing needs for power made by normal increase of manufacturing and agriculture and the special needs of war industries which are rapidly multiplying in California.

The southern part of the state, which is considered in the commission's recommendations, comprises that portion of the San Joaquin Valley south of Merced and served by the San Joaquin Light and Power Corp. and the Mt. Whitney Power and Electric Co., and southern California, which is served by the Southern California Edison Co., the Southern Sierras Power Co., the San Diego Consolidated Gas and Electric Co., the Los Angeles Gas and Electric Corp. and the City of Los Angeles.

The power produced by these companies in 1915 was approximately 930,000,000 kw.-hr., in 1916, 1,010,000,000 kw.-hr. and in 1917, 1,146,000,000 kw.-hr. Of this last amount 911,000,000 kw-hr. was produced by hydro-electric plants, the remainder by steam, requiring a total oil and gas consumption equivalent to 1,316,000 bbl. of oil. It is estimated that the growth in business due to the normal developments and the special war industries will approximate 140,000,000 kw.-hr. per year, and a requirement of plant capacity of about 25,000 kw. and then, in order to keep down the oil consumption of electric utilities to that existing in 1917, will require that amount of development each year.

Economical Effects of Interconnection

The report shows that considerable economy will result from the interconnections now existing and those contemplated by the companies, but even with that saving it will be necessary to increase the hydro-electric facilities at least 20,000 kw. of useful capacity a year, and increase the energy output approximately 140,000,000 kw.-hr. under ordinary rainfall conditions. Consideration was given to the City of Los Angeles existing and proposed developments in connection with the aqueduct, where it appears that at a cost of between $2,500,000 and $3,000,000 the city would produce an additional peak capacity of 36,000 kw.-hr. and an output of at least 150,000,000 kw.hr. a year, resulting in a reduction of oil consumption of 600,000 bbl. a year.

The commission states that the development by the city would be largely completed within twelve months if priority orders were obtained for equipment, but that difficulties exist which apparently make it impossible at this time to count on the development of the plant. These difficulties arose from the fact that the City of Los Angeles contends that it cannot utilize bonds already authorized for the development of hydro-electric plants, but that this money must be used for the construction of distribution systems. The city believes that if a satisfactory agreement could be entered into with the Los Angeles Gas and Electric Corp. whereby that company would lease to the city its entire system, such agreement to contain an option for purchase by the city, the money authorized would be used for hydro-electric plants.

The Los Angeles Gas and Electric Corp., however, declines to consider the plan, which it contends constitutes a complete surrender of the possession of its distribution system to a competitor, and also that its trust-deed provisions make such a plan a legal impossibility.

The commission states that special pains were taken to attempt a solution of the problem, but that failure attended such efforts. It says that it has no authority or desire to order the city to develop the plants or deliver the power to the Los Angeles Gas and Electric Corp., nor authority to compel the Los Angeles Gas and Electric Corp. to accede to the proposition of the city.

The commission states: "It is to be seriously regretted that at this critical period, when conservation of fuel oil is one of the most important war needs, the give-and-take spirit should not be more in evidence and that all interests are not subordinated to actual war necessity."

Reported Power Possibilities

The commission discusses the reported power possibilities of the Southern California Edison Co., the San Joaquin Light and Power Corp., and the Southern Sierras Power Co., stating that the Southern Sierras Power Co. has two possible developments amounting to 17,500 kw. capacity in Mono and Inyo Counties which might be developed, but upon which sufficient funds are not available. It also states that the San Joaquin Light and Power Corp. has certain small developments that are being installed, but that definite information on any large developments has not been presented at this time. It urges, however, that the corporation give serious consideration to adding to its plants so as to meet requirements on its own system.

The Railroad Commission has authorized the San Joaquin Light and Power Corp. to issue $767,000 six per cent. first and refunding bonds payable in 1950. The money is needed, says the company, to buy property, construct, expand and improve its service and facilities.

The Sierra and San Francisco Power Co. has filed with the Railroad Commission an application for authority to issue $1,000,000 of its first-mortgage 5 per cent. bonds, the proceeds to be used for the construction of additional hydro-electric plant capacity on the middle fork of the Stanislaus River, the construction of storage reservoirs on the middle or south fork of that river, and the construction of additional flumes, ditches, etc.

The Mt. Whitney Power and Electric Co. has asked for approval of the Railroad Commission of a plan under which applicants for power will be required to advance a part of the cost of building the lines necessary to serve those making the application. The company states in its application that it will have to expend during 1918 upon its system $108,000 and that in addition to this sum it will have to spend $216,000 for the construction of extensions to care for new consumers, which the company estimates will be in the neighborhood of 4000 during 1918. The greater part of the new consumers will require power for agricultural purposes in the Counties of Kern, Kings and Tulare. The company is in doubt whether it will be able to dispose of its stock and bonds and says that it will have only approximately $600,000 available for the construction of extensions and consequently it is asking those seeking service to bear a portion of the expense of installation.

The Southern Sierras Power Co. has joined with the Corona Gas and Electric Co., the Bishop Light and Power Co., the Rialto Light, Power and Water Co. and the Coachella Valley Ice and Electric Co. for authority for the last-named four companies to sell their plants to the Southern Sierras Power Co.

The prices for these are respectively: $135,914; $60,576; $24,915 and $821,687.

Said B. T. Yew to C. O'Two,
"I work best when I work with you."
Said C. O'Two to B. T. Yew,
"When we are scarce the steam is, too."—*Fecony*.

All After Higher Rates

Electric light and power companies throughout the country are doing their best to obtain a higher rate—not, it is believed, that they are operating at a loss below actual operating expenses, but because they require a greater revenue in order to maintain their profits at about pre-war percentages. In many cases the demand for increased revenue has been granted in whole or in part by the public service commissions; in others the courts have refused increase, and other demands are still to be decided; franchises with "during the period of the war" charges, permitting of an increased rate, are declined, and others hold that contracts are mere "scraps of paper."

Recently, an electric-light franchise was granted to the Arkansas Light and Power Co., by the City of Clarendon, Ark. This franchise carried a 15 per cent. advance for the period of the war over the previous rate. It was rejected by the company for the reason, it is said, that the rate was not high enough on account of the advanced prices of materials and the cost of operating the plant.

Coming further east, the Cleveland Railway Co., Cleveland, Ohio, was not satisfied with existing rates and contemplated increasing trolley fares on Apr. 1. But this was not to be, as it is understood that Common Pleas Judge Pearson has granted the city an injunction restraining the railway company from increasing car fare as it had planned. Judge Pearson ordered the company to arbitrate with the city the necessity for an increase of fare. The increase the company sought to make called for a four-cent fare, seven tickets for a quarter, with the penny transfer charge rebated. The present fare is four cents, six tickets for twenty cents, and a penny charge for a transfer.

Journeying still further east, the transportation companies of New York City are desirous of a six-cent fare. Although the Cleveland Co. wants to charge but a four-cent fare and sell six tickets for twenty cents, New Yorkers have never even had a chance to purchase tickets at reduced rates. If one city can operate street cars for a four-cent fare, why cannot another is the question that many are asking.

When it comes to living up to contracts, some companies evidently look upon them as mere scraps of paper. For instance, the Public Service Corporation of New Jersey has a fight on its hands with the Manufacturers Council of the state. The council, representing hundreds of manufacturers throughout the state, contends that the abrogation of power contracts entered into by the corporation with numerous manufacturers is clearly illegal and that the corporation's notice to many consumers of the cancellation of these contracts is therefore without force.

The Public Service Corp., it will be remembered, canceled its contracts for power last winter when the coal shortage became so acute that it was almost impossible to generate electricity. There was no dissension heard then, and it was assumed that the manufacturers were willing to comply. The council's action furnished the first inkling that there was any objection.

It will be the aim of the council to take concerted action in behalf of those manufacturers who feel that they are aggrieved and who have been compelled, in order to insure a continuance of the power necessary for operating their plants, to submit to greatly increased rates.

Liberty Loan Committee for Machinery and Machine Tool Trades

A special Liberty Loan Committee for the machinery and machine-tool trades has been organized, with headquarters at 334 Fourth Avenue, New York City. The full personnel of the committee follows:

J. W. Lane, chairman, President, E. W. Bliss Co.; R. L. Patterson, vice-chairman, Pres. American Machine & Foundry Co.; Charles B. Houston, secretary, E. W. Bliss Co.; Norman Dodge, director of speakers, Vice-Pres. Mergenthaler Linotype Co.; Charles A. Hirschberg, publicity director, Publicity Mgr. Ingersoll-Rand Co. Committee: M. H. Avram, Slocum, Avram & Slocum; L. Barron, Sec. De La Vergne Machine Co.; Leigh Best, Vice-Pres. American Locomotive Co.; R. K. Blanchard, Neptune Meter Co.; G. D. Branston, Treas. Manning, Maxwell & Moore; Arthur W. Buttenheim, Pres. McKiernan-Terry Drill Co.; W. L. Callister, W. L. & J. T. Callister; De Courcey Cleveland, Pres. Central Foundry Co.; C. Philip Coleman, Pres. Worthington Pump & Mach. Corp.; C. I. Cornell, Treas. Pratt & Whitney Corp.; F. W. H. Crane, Pres. R. Hoe & Co.; J. J. Cuehler, Pres. Columbia Mach. W. & M. Iron Co.; C. G. Curtis, Pres. Curtis Turbine Co.; A. Davis, Pres. Davis-Bournonville Co.; F. S. De Lano, Treas. American Car & Foundry Co.; H. H. Doehler, Pres. Doehler Die Casting Co.; George Doubleday, Pres. Ingersoll-Rand Co.; F. F. Fitzpatrick, Pres. Railway Steel Spring Co.; Henry Fuller, Vice-Pres. Fairbanks-Morse Co.; P. H. Gill, Pres. P. H. Gill & Sons; R. E. Gilmore, Gen. Mgr. Sperry Gyroscope Co.; D. H. Haynes, Treas. American Machine & Foundry Co.; J. H. Hayward, Treasurer Hayward Co.; W. T. Hunter, Sec. A. Schrader's Son, Inc.; Isaac B. Johnson, Pres. Isaac G. Johnson & Co.; J. C. Kelly, Pres. National Meter Co.; W. P. Kethart, Sec. H. D. Berner & Winterbauer Co.; Hy. C. Knox, Treas. American Brake Shoe & Foundry Co.; John Lidgerwood, Pres. Lidgerwood Mfg. Co.; T. Frank Manville, Pres. H. W. Johns-Manville Co.; T. J. Menten, Vice-Pres. Schaeffer & Budenberg Mfg. Co.; Edward T. Morse, Sec. & Gen. Mgr. Morse Dry Dock & Repair Co.; C. E. Murray, Pres. Metropolitan Engineering Co.; Henry Prentiss, Pres. Prentiss Tool & Supply Co.; Joseph T. Ryerson, De Mant Tool & Machine Co.; E. A. Stillman, Pres. Watson-Stillman Co.; H. R. Swartz, Pres. Intertype Corp.; Charles Taylor, Clark, Dodge & Co.; Herbert G. Thomson, Pres. Anchor Post Iron Works; J. M. Turner, Pres. General Acoustic Co.; J. H. Walbridge, Pres. Lalance & Grosjean Mfg. Co.; J. Harvey Williams, Pres. J. H. Williams & Co.; J. B. Wing, Treas. Dexter Folder Co.

Progress of the Public Service Commission's Rate Hearing

Further evidence to show the economy of the isolated plant for combined lighting and heating was given on Apr. 8 at the resumed hearing before the Public Service Commission for the First District of New York. This evidence was based on the records of the steam plant in the Fifth Avenue Building, of which David Larkin is chief engineer.

According to the testimony of Mr. Larkin, the building occupies a plot approximately 236 ft. by 286 ft. and contains about 540,000 sq.ft. of floor space. It is mainly an office building, but the ground floor is occupied by stores and restaurants; in addition, the Aldine Club is located in the building. The service demanded of the plant is the furnishing of electric current for lighting and steam for heating, as well as the necessity of supplying live steam at a pressure of 40 lb. per sq.in. to the Aldine Club and the restaurants all the year round.

The relative costs of operation by private plant alone and by a combination of Edison service and private plant were determined from the records of the plant for the years 1916 and 1917. For 1916 the balance was $26,000 in favor of the private plant, and for 1917 it was $17,000 in favor of the private plant. In other words, these amounts show the additional costs that would have been incurred if the current for lighting had been purchased from the Edison company and the private plant had been used merely to furnish the steam required for heating and for the use of the restaurants and the Aldine Club.

As to the actual saving of coal, the figures were likewise in favor of the operation of the isolated plant alone. In 1916, which was considered an average year, the saving was estimated at 300 tons over that which would be required by combined Edison service and private-plant operation. In arriving at this result, it was assumed that the central station would burn 3 lb. of coal per kilowatt-hour delivered to the customer.

At the conclusion of Mr. Larkin's testimony, the hearing was adjourned until Apr. 29.

The French and British have nobly stood behind their governments in war loans. Where do you stand?

New Publications

STEAM TABLES FOR CONDENSER WORK

The Wheeler Condenser and Engineering Co., Carteret, N. J., announces that the fourth edition of its steam-table handbook is off the press, making a total of 20,000 copies. One reason why this handbook has met with such success is that the pressures below atmosphere are expressed in inches of mercury referred to a 30-in. barometer. Another is that it is complete. It includes a discussion of the mercury column, the errors in such measurements, and constants for their correction. A complimentary copy will be furnished on request to those in responsible positions who are not yet provided with a copy and who deal with steam and its many problems.

Personals

Henry D. Jackson, formerly of Timothy W. Sprague and Henry D. Jackson, consulting engineers, 88 Broad St., Boston, Mass., has joined the organization of Monks & Johnson, engineers and architects, 78 Devonshire St., Boston, as power engineer, taking charge of their power-plant and heating work.

R. W. Spofford, general manager of the Augusta-Aiken Railway and Electric Corporation, Augusta, Ga., who is a retired officer of the United States Navy, has been called to active service. W. C. Callaghan succeeds him as general manager. Mr. Callaghan has been with the J. G. White Management organization, New York City, the operators of the Augusta company, since 1913.

Engineering Affairs

The American Association of Engineers and the Committee on Engineering Co-operation will hold a joint annual meeting at the City Club, Chicago, on May 14. All technical societies are invited to send one or more delegates to this meeting.

Miscellaneous News

A Peculiar Flywheel Accident—In a rolling mill a number of circular billets were piled up in line with the pit of a 30-ft. flywheel. The removal of one of the billets in the lower row set the others to rolling. One of them rolled into the wheel pit and completely wrecked the large flywheel.

A Mortgage Has Been Filed in the office of the county clerk, Eugene, Ore., and executed by the Mountain States Power Co. in favor of the Illinois Trust and Savings Co., of Chicago. The amount of the bonds covered by the trust mortgage is $2,353,000 of an authorized issue of $15,000,000. The Mountain States Power Co. is the reorganized Northern Idaho and Montana Power Co. which operates it. The property covered by the mortgage is that located in various counties of Oregon and used by the Oregon Power Co.

Electric Service for Camp Perry—The Northwestern Ohio Railway and Power Co. will furnish electric service for Camp Perry. The later news with reference to the camp indicates that it is to be a cantonment capable of accommodating approximately 9000 soldiers who will be trained in target practice, both artillery and short-range rifle shooting, with moving targets. It is also to be used as an aviation training ground. Options have been taken on about 1600 acres in addition to the land already used for camp purposes.

The Municipal Civil Service Commission has announced an examination for mechanical draftsmen (electrical), Grade C (male and female), for which applications will be received at Room 1400, Municipal Building, Manhattan, until Apr. 25, at 4 p. m. Subjects and weights: Experience, 2; technical, 6; mathematics, 2. Candidates must be 21 years of age or over, must be citizens of the United States and residents of New York State; will be required to prepare drawings and to do other related work, such as computing, compiling data and plotting in connection with electrical installations for power and lighting. Applicants should have training and experience as a mechanical draftsman such as to qualify them for the position. They must have had actual experience in laying out, computing, drafting or other related work incident to the construction or operation of light and power or similar experience. They should have a good knowledge of the Electrical Code. Salary from $1200 to $1800 per annum.

Business Items

H. W. Johns-Manville Co.'s Youngstown (Ohio) office is now located at No. 520 Market St.

The Homestead Valve Manufacturing Co., of Homestead, Penn., has opened a branch office at No. 1 Franklin St., New York City.

The Brown Instrument Co., of Philadelphia, Penn., has let a contract for an addition to its factory to cost approximately $50,000.

The Yarnall-Waring Co., in order to obtain even greater benefit from a widely established reputation for efficient power plant accessories, has decided to group its several products under the family name of "Yarway."

The Machinery Sales Department, operated by the Merchants and Manufacturers Exchange of New York, is now establishing a permanent machinery exhibit and salesroom at Grand Central Palace, 46th to 47th St. and Lexington Ave., New York City, where prospective buyers may be shown up-to-date machinery and mechanical appliances, get first-hand information and at the same time place their business. Machinery manufacturers and allied industries can rent suitable offices and exhibition space by communicating with the Machinery Sales Department, Grand Central Palace, New York. L. R. Duffield, formerly of the Philadelphia Bourse, is now in charge here.

Trade Catalogs

Rails, Etc. Walter A. Zelnicker Supply Co., St. Louis, Mo. Bulletin 237. Pp. 17; 3½ x 8¼ in.; illustrated. Free copy upon request.

Automatic Reclosing Circuit Breakers and Relays. The Automatic Reclosing Circuit Breaker Co., Columbus, Ohio. Bulletin No. 30, Pp. 20; 8¾ x 11 in.; illustrated; general description, theory and application.

The "De La Vergne" Counter-Current Ammonia Condenser. De La Vergne Machine Co., Foot of E. 138th St., New York. Bulletin No. 174. Pp. 8¾ x 11 in.; illustrated.

Pipe Tools. Greenfield Tap and Die Corp., Greenfield, Mass. Catalog No. 38. Pp. 32; 4¾ x 7¼ in. Describing and illustrating complete line of pipe tools made by the various divisions of this corporation. Copy mailed free upon request.

Link-Belt Roller Chain. Link-Belt Co., Chicago, Ill. Book No. 358. Pp. 16; 6 x 9 in.; illustrated. Giving information on recent roller-chain developments.

Motor Driven Compressors—Westinghouse and National Types. Westinghouse Traction Brake Co., Industrial Dept., Pittsburgh, Penn. Publication No 9035. Pp. 113; 6¼ x 9¼ in. Describes and illustrates fully both lines of compressors and accessories, with complete information relative to sizes, capacities, ratings and dimensions, in tabulated form.

Diamond Soot Blowers. Diamond Power Specialty Co., Detroit, Mich. Bulletin 119. Pp. 48; 7¾ x 10¾ in. A review of current mechanical soot-blower practice, fully illustrated; with data on boiler-room efficiency, insuluminium, venturi nozzles, etc A copy of the bulletin will be furnished free upon request.

Reilly Steam Pumps and Air Compressors. National Foundry and Machine Co., Inc., Louisville, Ky., Vogt Bros. Manufacturing Co., of Louisville, are now exclusive manufacturers. Catalog No. 12. Pp. 160; 5¼ x 7¾ in.; copiously illustrated with information covering the various types of pumps and compressors; many useful engineering tables; indexed.

Industrial Storage-Battery Locomotives. The Jeffrey Manufacturing Co., Columbus, Ohio. Catalog No. 231. Pp. 24; 6 x 9 in. This catalog contains interesting illustrations and description of various installations, and other useful data. A free copy may be obtained by writing to the company's main office or to any of its branch offices.

NEW CONSTRUCTION

Proposed Work

Mass., Canton—The Springdale Finishing Co. is having plans prepared by A. Wright, Arch., 73 State St., Boston, for a 2-story, 45 x 55 ft., reinforced concrete, steel and brick power house to be erected on Pine St. Estimated cost, $20,000. F. Meyer, Mgr.

Mass., Sherborn—The State will soon receive bids for the erection of an concrete power house and the installation of 1 new engine generator and 3 tubular boilers, etc. Estimated cost, $68,211. R. D. Kimball Co., 6 Beacon St., Boston, Engr.

Conn., Bridgeport—The United Illuminating Co has been granted authority by the Public Service Commission to build a 3 conductor, 660 volt transmission line.

Conn., Thamesville (Norwich P. O.)—The Eastern Connecticut Power Co., c/o R. W. Perkins, Norwich, has had preliminary plans prepared by H. M. Hope Eng. Co., Engr., 185 Devonshire St., Boston, Mass., for the erection of a 1-story, 80 x 140 ft. brick power house here.

N. Y., Freeville—The Groton Electric Power Corporation, Groton, plans to build a new power plant here.

N. Y., Waterville—The Waterville Gas and Electric Co. has filed a petition with the Public Service Commission for authority to build and operate an electric distributing system here. R. Thomas, Ch. Engr.

N. J., Trenton—City plans to build a new 2-story, 26 x 300 ft. boiler plant in connection with the Municipal Hospital. Estimated cost, $85,000.

Penn., Newcastle—The Grasselli Powder Co., 589 Arcade, Cleveland, Ohio, will build a 1-story, 100 x 125 ft. brick, reinforced concrete and steel power house. Estimated cost, $100,000.

Penn., Parkesburg—The Parkesburg Iron Works plans to build an addition to its boiler house. Estimated cost, $18,000.

Md., Baltimore—The Consolidated Gas, Electric Light and Power Co., Lexington and Liberty St., Baltimore, will build a 4-story, 100 x 200 ft., concrete, steel and brick, boiler house at Westport. Estimated cost, $100,000. Noted Nov. 13.

Md., Mt. Airy—The Mount Airy Ice and Electric Co. plans to install an additional generating unit. C. C. Riddlemoser, Mgr.

N. C., Pine Level—The Citizens Power and Light Co. plans to build an electric transmission system connecting 2 towns and a substation in each one. C. L. Goodwin, owner.

N. C., Reidsville—City voted $10,000 bonds for extensions and improvements to its electric lighting plant.

S. C., Sumter—City plans to build an electric lighting plant.

Ga., Commerce—City plans an election soon to vote on $15,000 bonds for the erection of an electric lighting plant.

Ga., Macon—The Macon Gas Co. will expend about $40,000 for improvements to its plant. A. Magraw, Gen. Mgr.

Ga., Ty Ty—City voted $7000 bonds to build an electric lighting plant.

Miss. Fondren—The State Insane Hospital is in the market for two 250 hp. boilers, water heaters, traps, valves, feed water pumps, smoke stack, stokers, ash conveyers, etc., for its new boiler house. R. L. Paquette, Box 31, Ch. Engr.

Ohio, Cleveland—City will soon award the contract for the superstructure of a 1-story, 169 x 175 ft. power house to be erected on East 53rd St. High pressure boilers, 25,000 kw. generator, switchboards and other equipment will be installed. Estimated cost, $525,000. J Tufal, East 53rd St. Station, Engr.

Ohio, Hamilton—The Hamilton and Rossville Hydraulic Co plans to build a power plant in connection with a new plant soon to be erected. Stone & Webster, Engrs.

O., Lowellville—The Mahoning and Shenango Ry. and Light Co., 25-31 E. Boardman St., Youngstown, will build a transmission line from here to McDonald. R. T. Sullivan, Mgr.

Ohio, Ravenna—Portage Co. will soon receive bids for the erection of an electric transmission line from intersection of Ravenna-Mantua Rd. with east and west road 3 miles north of courthouse. Estimated cost, $1,521.

Ind., Attica—The Attica Electric and Power Co. has been authorized to issue $50,000 in stock and $50,000 in bonds for the erection of an electric light and power plant to replace one recently destroyed by fire.

Mich., Flint—The Citizens Hotel Co., Ellicott Sq., Buffalo, N. Y., is in the market for complete power equipment, 500 hp.

Ill., Homer—The Homer Electric Light and Power Co. plans to extend its transmission line from here to Fairmount. W. S. Thompson, Mgr.

Ill., Oaklawn—The Chicago and Eastern Illinois R.R., Chicago, is having plans prepared for the erection of an addition to its power house here. L. C. Hartley, 66th and Union Ave., Chicago, Ch. Engr.

Wis., Camp Douglas—The Orange Light and Power Co. plans to extend its transmission line from here to Hustler. A. M. Patterson, Mgr.

Wis., Eau Claire—The Sacred Heart Hospital is having plans prepared by Foeller & Schober, Engrs., 123 North Washington St., Green Bay, for the erection of a 40 x 95 ft. boiler house and laundry.

Wis., Markesan—The Wisconsin Power, Light and Heat Co., Milwaukee, has purchased the Omro Electric Light Co., Omro, and plans to extend the Kilbourn and Prairie du Sac transmission lines from here to Berlin and Omro. E. B. Hemibach, Supt.

Wis., Orfordville—The Orfordville Light and Power Co. plans to build a 4½ mi., 3 phase, 60 cycle, 6600 volt, transmission line. A. E. Tomlin, Secy.

Wis., Rewey—The Mineral Point Public Service Co. plans to build a 33,000 volt transmission line from here to Platteville to connect with lines of the Interstate Light and Power Co., Galena, Ill. J. C. Meiners, Milwaukee, Pres.

Iowa, Eddyville—City voted $8000 bonds for improvements to its electric lighting plant. Noted Jan. 15.

Iowa, Sioux City—The Phillip Bernard Co. plans to build a heating plant and factory warehouse north of its factory on Floyd Ave. Estimated cost, $100,000.

Kan., Luray—City will soon award the contract for the erection of an addition to its electric lighting plant. Plans include the construction of a new power house and the installation of equipment.

Kan., Rossville—The Rossville Electric Light and Power Co. plans to enlarge its plant and extend its transmission line to Delia, Silver Lake and Willard. J. W. Phares, Pres.

Neb., Beaver Crossing—City plans to issue $9000 bonds for the installation of an electric lighting plant.

Neb., Schuyler—City is having preliminary plans prepared by the Electrical Development Co., Sioux City, Iowa, for improvements to its electric lighting plant.

S. D., Blackwell—City voted to issue bonds for improvements to its electric lighting plant and water-works system.

Mo., Garden City—The Green Light and Power Co., Pleasant Hill, has purchased the plant of Kaufman & Son, and plans to build a transmission line soon.

Mo., Kansas City—The Southwestern Milling Co., Dwight Bldg., is in the market for 400 hp. power plant equipment.

Mo., Otterville—K. Starten plans to install an electric lighting plant here.

Tex., Humboldt—City plans to improve its electric lighting plant. Plans include the installation of a new 300 kw. turbine, condenser and auxiliaries. W. M. Case, Gen. Mgr.

Okla., Hartshorne—The Choctaw Power and Light Co., McAlester, has been granted a franchise to build and maintain an electric lighting plant here. W. H. Vorce, McAlester, Gen. Mgr.

Okla., Ryan—City plans to install a crude oil engine in its electric lighting and water-works plant. W. C. Willard, Gen. Supt.

Okla., Shawnee—C. Sells, Commissioner of Indian Affairs, Washington, D. C., will receive bids until Apr. 30, for the installation of a steam heating system in the Shawnee school.

Ariz., Phoenix—The State Hospital for Insane has plans under way for the erection of a power house.

Wash., Bremerton—The Bureau of Yards and Docks, Navy Dept., Wash., is in the market for 2 turbo generators. Estimated cost, $90,000.

Wash., Hoquaim—The Lamb Machine Works plans to install an electric steel furnace in its proposed foundry and machine shop.

Wash., Spokane—The Loon Lake Copper Co. plans to install electric motors to operate all mining equipment. F. G. Crane, Secy.-Treas.

Ore., Mapleton—The North Star Power Co. plans to build 2 miles of transmission line.

Ore., Portland—The Electric Steel Foundry, 24th and York St., plans to build a transformer station at its plant here.

Calif., Corcoran—The San Joaquin Light and Power Co., Fresno, plans to install an electrolier lighting system on Whitley Ave. G. Wilson, Fresno, Gen. Mgr.

Calif., Redding—The Shasta Land and Timber Co. of Redding plans to rebuild its electric power plant and planing mill which was recently destroyed by fire. Loss about $45,000.

Ont., Alvinston—City plans to install power machinery.

CONTRACTS AWARDED

Conn., North Grosvenordale—The Grosvenordale Co. has awarded the contract for building, rearranging and altering its electric power station, to the J. W. Bishop Co., Worcester, Mass. Estimated cost, $30,000.

N. Y., Rochester—The Department of Public Works has awarded the contract for the erection of a new power house, to J. Friedericks & Son, Rochester, $12,739. Pumping machinery, engines, etc., will be installed. Noted Feb. 19.

Penn., Clifton Heights—The Kent Manufacturing Co. has awarded the contract for equipment as follows: coal conveyors, to R. H. Beaumont & Co., Drexel Bldg., Philadelphia, Pa., $7,500; boilers, to the Union Iron Works Co., Bourse St., Philadelphia, Pa., $20,000; pumps to the American Steam Pump Co., Commercial Trade Blk., Philadelphia, Pa., $1600. Noted Mar. 26.

S. C., Charleston—The Charleston Consolidated Ry. and Lighting Co. is building a 500 kw. rotary substation near the Navy Yard.

Ohio, Cleveland—The Steel Products Co., 2196 Clarkwood Rd., is having plans prepared by Burchard Roberts & Wales Co., Engrs., 622 Swetland Bldg., for a 1-story, 50 x 100 ft. heating plant to be erected on East 65th St. Estimated cost, $15,000.

Ohio, Columbus—The Ohio University has awarded the contract for the installation of a 6 retort boiler for the new power plant, to the Underfeed Stoker Co. of America, 111 West Monroe St., Chicago. Noted Oct. 30.

Ohio, Sandusky—The Good Samaritan Hospital has awarded the contract for the installation of electrical apparatus and fixtures, to the Bonn Electric Co. Estimated cost, $10,000.

Wis., Ashland—The Ashland Light, Power and Street Railway, 212 West 2nd St., is building a new hydro electric plant at Superior Falls. Estimated cost, $100,000. Noted Oct. 16.

Wyo., Lusk—The town has awarded the contract for the installation of a 100 hp. semi-Diesel oil engine, a 60 kv.-a., 60-cycle, 3 phase, 2300 volt generator, directly connected, and a 20 hp. motor for water-works, to the Fairbanks-Morse Co., 13th and Liberty St., Kansas City, Mo.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Apr. 11, 1918	Individual Apr. 11, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular Apr. 11, 1918	Individual Apr. 11, 1918
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	5.10@5.85
Barley	3.40@3.65	3.10@4.10
Rice	3.90@4.10	4.10@4.85
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania..	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Apr. 11, 1918	One Yr. Ago	Apr. 11, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat ..	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes...	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes...	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties April 11, 1918	Mt. Olive & Staunton April 11, 1918	Standard April 11, 1918
6-in. lump ...	$2.65-2.80	$2.65-2.80	$2.65-2.80
2-in.-lump	2.65-2.80	2.65-2.80	2.65-2.80
Steam egg....	2.65-2.80	2.65-2.80	2.65-2.80
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut.....	2.65-2.80	2.65-2.80	2.65-2.80
2-in. screen....	2.15-2.30	2.15-2.30	2.50-2.65
No. 5 washed..	2.15-2.30	2.15-2.30	2.50-2.65

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba.	2.40	2.65	2.15

Government figures.

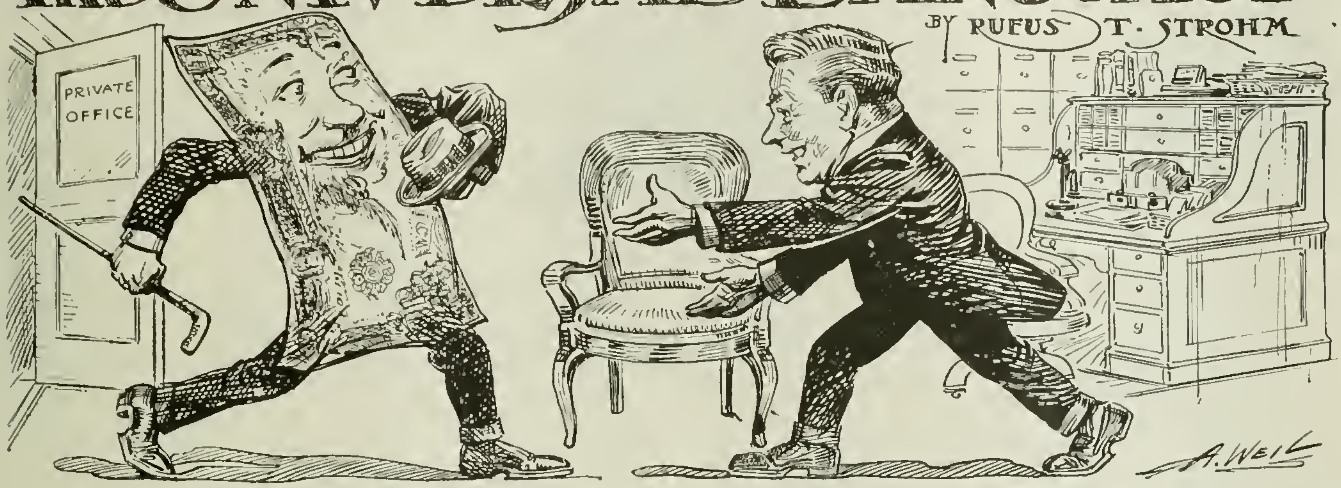
Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, APRIL 23, 1918 No. 17

THE UNIVERSAL LANGUAGE

BY RUFUS T. STROHM



NEARLY every power station owes its origin to men
Who expect the wealth invested to return to them again.
They are uninformed on technics, so that talk of B.t.u.'s,
CO_2 and kindred topics will but puzzle and confuse;
But they're clever at discerning how the cost of running trends,
And they show appreciation of substantial dividends.
Like as not they can't identify a gudgeon from a gland,
But the dollar talks a language that the owners understand.

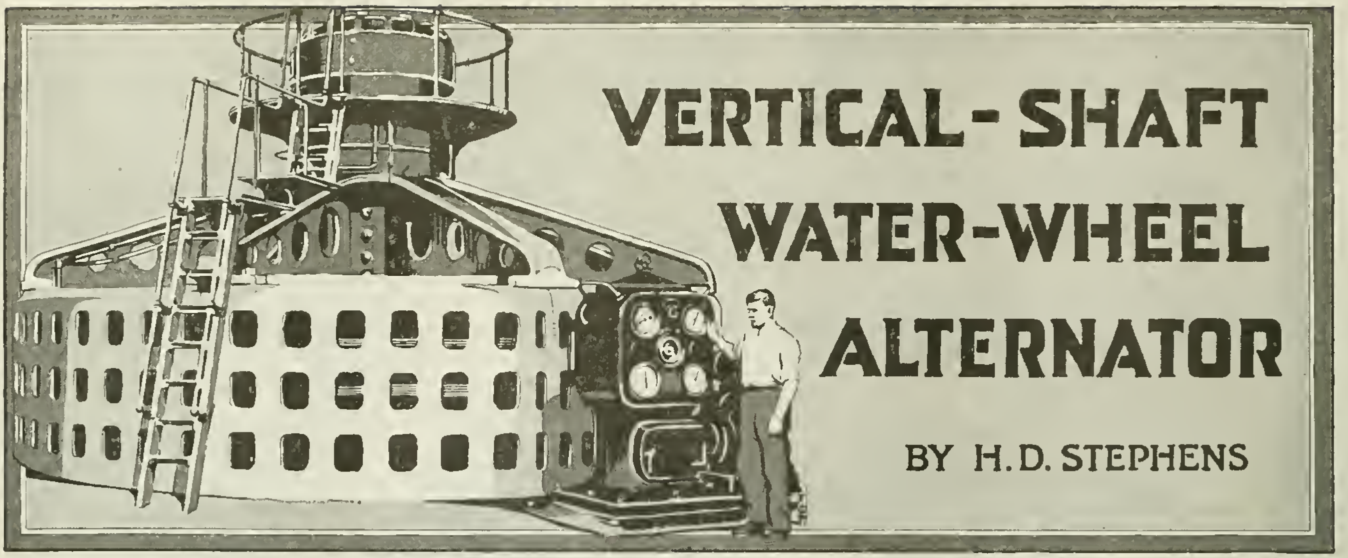
$

YOU have done your best to show them, in a mathematic way,
That you waste a lot of fuel through the ashpit every day,
And you've put the fact before them, just as plain as you can state,
That the economic method is to change the style of grate;
But their hearts are unresponsive and their eyes are hard and cold
Till you render the percentage of the saving into gold.
That's the sort of solar plexus that will never fail to land,
For the dollar talks a language that the owners understand.

YOU have doubtless had occasion to remind them of the need
Of a modern form of heater in connection with the feed,
And you've found that all your efforts were a simple waste of breath,
For their ears were deaf as marble and their lips were still as death.
So, suppose you change your tactics; jar their chill indifference
By translating facts and figures into quarters, dimes, and cents,
And they'll carry out your changes in the way that you have planned,
For the dollar talks a language that the owners understand.

$

IF a lessening of labor is the ground on which you rest
In the scheme of alterations or additions you suggest,
It is probable they'll bluster, and it's safe to say they'll growl,
And they'll meet your chain of logic with a fierce, forbidding scowl;
But their icy glance will soften and the frost will disappear
If you state how many shekels you can save them in a year,
And before you know what's doing, they'll be feeding from your hand,
For the dollar talks a language that the owners understand.



VERTICAL-SHAFT WATER-WHEEL ALTERNATOR

BY H. D. STEPHENS

Waterwheel-driven alternators may be classed under two types, vertical and horizontal. In this article the author describes the general construction, the thrust bearing, methods of lubrication and different schemes employed to drive the exciter, for the vertical type.

THE scarcity of coal which we have been experiencing has emphasized, perhaps as no other agency could, the urgent need for conservation of our natural resources, and action favorable to water-power development has been asked of Congress by President Wilson, and may therefore be hoped for in the near future.

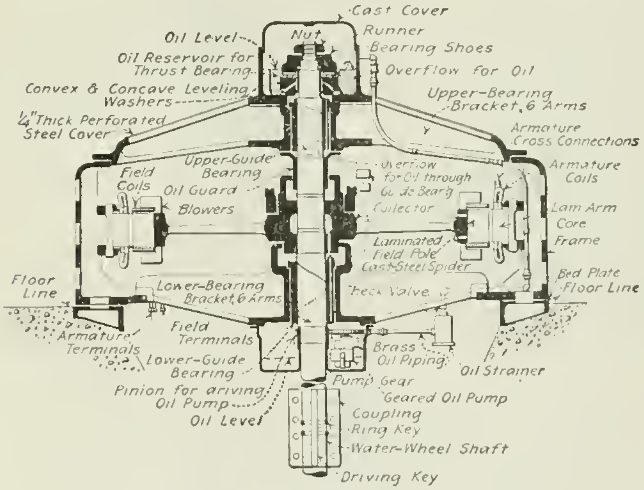


FIG. 1. CROSS-SECTIONAL VIEW OF VERTICAL WATER-WHEEL GENERATOR

With the prospect of considerable activity in water-power development during the next few years, the marked tendency toward a more universal adaptation of the vertical type of unit is of interest. Because of the high efficiencies obtained with the single-runner, vertical-shaft waterwheel, the simplicity of power-house layout and flexibility, as regards station-floor levels, permitted by its use, this type of prime mover becomes the logical choice for most low-head and for many high-head installations.

The vertical type cannot strictly be considered a new one, for it was used in the earliest developments at Niagara Falls; but it has only been within the last decade, and in fact since the advent of the high-efficiency, vertical, single-runner wheel, that its application has been seriously considered. if not actually adopted, for a majority of installations. Despite a very limited activity in hydro-electric work during most of this period, sufficient development has been going on to allow manufacturers and operators to work out those mechanical problems peculiar to the vertical unit to the satisfaction of both. While the wide range of capacity and speed encountered prohibits any absolute standardization of construction, the general problems of bearing supports, lubrication, etc., are common to all sizes, and the general standards resulting from a wide experience in this field are worthy of note. The information contained in the following paragraphs deals mainly with the product of the Westinghouse Electric and Manufacturing Company.

A typical cross-sectional view of a vertical generator is shown in Fig. 1, which covers a self-contained machine; that is, one with thrust bearing mounted on top of the generator, an upper and a lower guide bearing, one above and the other below the rotor, and arranged for connection to the waterwheel by means of a "muff" coupling. Most of the structural details of this type of unit are indicated in Fig. 1. The stationary frame extends, at both top and bottom, beyond the active section of the stator core a sufficient distance to form an adequate protection for the end turns of the armature winding. The cross-connections and wiring on the armature winding are on the upper side of the stator for convenience should any repairs after the initial installation be required. The leads from the armature and field and all the oil piping are ordinarily brought down just inside the stator frame in order to protect from possible injury.

Probably the most troublesome problem in early days involved the location of the thrust bearing. If this were mounted below the waterwheel, it was very inaccessible and therefore difficult to keep in repair. Mounted between the waterwheel and the generator, it usually required a special floor and therefore added expense to the cost of the power plant. It was finally decided to put this bearing on top of the generator, as shown in Fig. 1, and today practically all units being built are arranged in this manner. For a long time the thrust bearing itself was a matter of considerable concern. However, the introduction of the Kingsbury bearing has gone a long way toward eliminating, by its almost universal success over a wide range of capacity, the feeling of distrust of the vertical unit on this account. The detail of this type of thrust bearing is shown in Fig. 2. The bearing runs in a bath of oil, has exceedingly small frictional losses and therefore a low-temperature rise in service, and no appreciable wear.

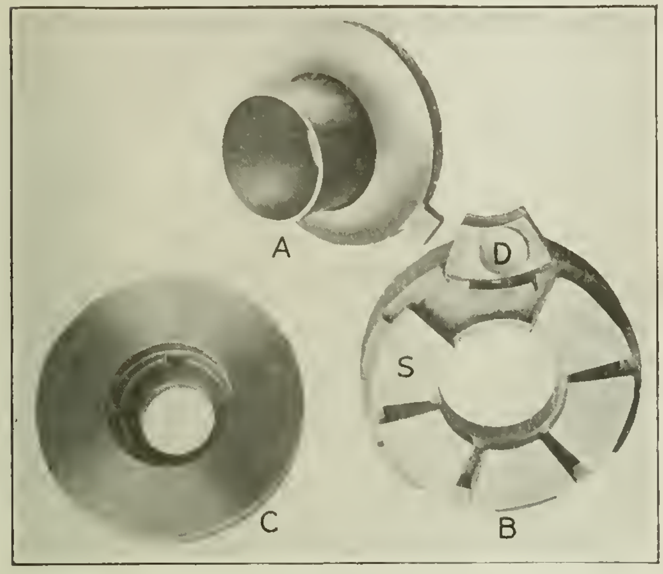


FIG. 2. PARTS OF KINGSBURY THRUST BEARING

As shown in the figure, the bearing consists essentially of three parts. *A* and *B* are what may be termed the convex and concave leveling washers, and *C* the runner; all three parts are contained in an oil-tight bearing housing and are shown at the top of Fig. 1. It will be seen that part *A* acts as a supporting casting to carry the entire weight of the revolving element. The concave surface on the lower side of part *B* rests on the spherical surface of part *A* to allow the proper alignment of the bearing. On the upper surface of part *B* are mounted a number of shoes *S*. Each shoe is babbitted on its upper surface and rests on a spherical seat on its lower surface, which in turn allows it to tip slightly when in operation. One of the shoes is shown turned over in Fig. 2 to show the spherical seat *D*. The runner *C* is a special casting which is securely fastened to the rotating shaft and rests on the shoes *S*, which tips slightly when the runner is revolving and allows a wedge-shaped film of oil to form between the runner and shoes.

There are four, six or eight shoes to a bearing, depending upon its size and the weight it has to carry. There is no direct contact between the shoes and the revolving runner except when the machine is at rest, and it has actually been found in practice that small tool marks on the babbitt surface exist for many months after the bearing has been in use. In other words, no appreciable wear can be detected.

The thrust bearing is called upon to carry heavy loads, from 300,000 to 400,000 lb. with the larger-capacity units, this being due to supporting not only the weight of the rotating element of the generator proper, all the shafting and the waterwheel runner, but also the unbalanced or downward force of the water which flows through the wheel when in service.

This necessitates an exceptionally sturdy frame and a heavy upper bracket having no appreciable deflection. A bracket with a number of I-beam section arms spaced equidistant around the periphery of the stator frame and bolted thereto has filled the requirements admirably and is now almost universally used (see headpiece and Fig. 3).

The bracket that supports the thrust bearing also carries a guide bearing, Fig. 1, whose function it is to center the rotor in the middle of the stationary part. This bearing is babbitt-lined. Immediately beneath the rotor a bracket similar to that used for supporting the thrust and upper-guide bearing is employed. This is also bolted to the stator frame, as in Fig. 1. Ordinarily, this bracket is employed only to house the lower-guide bearing, which is babbitt-lined, but in many cases, particularly with large-capacity units, it must be strong enough to support the rotor during dismantling, and in those cases where braking is necessary.

It has been found, particularly in many low-head installations, that the gates that shut off the water have sufficient leakage through them even when closed to cause the rotor to operate at a very slow speed and thus to endanger the thrust bearing. To prevent damage in such cases, suitably machined pad supports are provided on the lower-bracket arms to mount brakes or jacks. These brakes can be operated so as to bear upon a machined surface or circular plate on the rotor, to quickly bring the rotor to rest. To the lower bracket is also bolted an oil pan to catch the drain from the thrust bearing and from the two guide bearings.

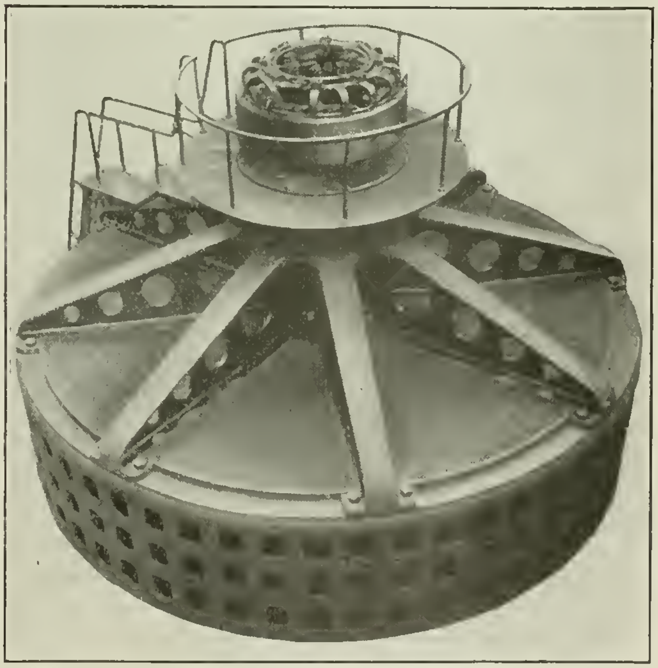


FIG. 3. VERTICAL ALTERNATOR, SHOWING I-BEAM METHOD OF SUPPORTING THRUST BEARING

Ordinarily, there is a break between the generator and the waterwheel shaft, as the mounting of the waterwheel runner on an extension of the generator shaft would involve considerably more headroom for installation and dismantling for repairs than would otherwise be required. The advantages to be gained by the use of a common shaft seldom compensate for the increased power-plant cost; therefore separate shafts are used. Connection between the two is made by either a "clamp" or "muff" type coupling, in which two machined pieces are bolted and keyed over the ends of the two shafts, or half-couplings forged directly on the generator and waterwheel shafts and the two connected rigidly together by bolts, are employed.

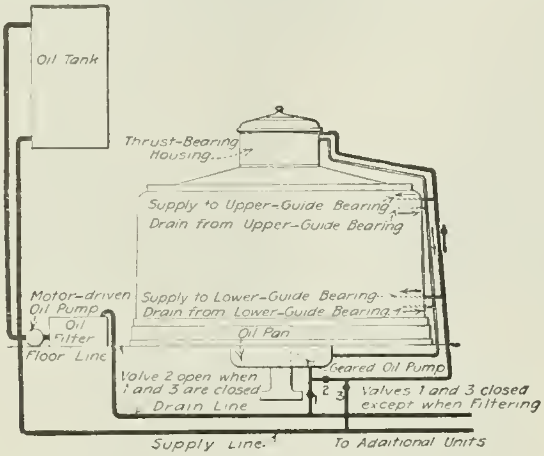


FIG 4.—DIAGRAM OF SEPARATE OILING SYSTEM

There are some cases, where the distance between the generator and the waterwheel runner is very small, in which the lower-guide bearing can readily be eliminated. Two different types of bearings are ordinarily used on the generator and on the waterwheel. The generator bearing is a babbitt-lined one, and any appreciable wear of the bearing surface is likely to cause vibration and trouble. The waterwheel bearing is ordinarily of lignum-vitæ blocks lubricated by water. These blocks are in a more or less inaccessible place and are rarely inspected or repaired. They can wear quite appreciably without causing serious trouble. When the generator has two bearings, these will often maintain true alignment even with considerable looseness around the waterwheel bearing. When only two bearings are employed, however, one on the generator and one on the waterwheel, any wear is found to immediately cause vibration and trouble. This, I believe, is the reason why it is so generally customary to employ the self-contained generator. It is somewhat questionable whether the danger has not been considerably exaggerated, since quite a number of installations have gone into service without a lower-guide bearing, and such installations are operating very satisfactorily.

Two general methods of lubrication for vertical machines are employed. On a machine where the flow of oil to the thrust and guide bearings does not exceed three or four gal. per min., a self-contained system, as shown in Fig. 1, is employed. The oil, from the pan bolted to the lower-guide-bearing bracket, is forced through brass piping by a small pump, gear driven from the main-generator shaft, as indicated. It flows through an oil strainer and then up into the housing holding the thrust bearing. Here provision for an adequate supply of oil for the guide bearings is made, and for the overflow. The drain from all bearings then flows back again into the lower oil pan. It is found that where the required amount of oil does not exceed the quantity specified, the oil is cooled sufficiently by radiation and no further means need be provided for cooling. As the system is an entirely closed one, there is little likelihood of dust or dirt getting into the oil, and operation for long periods of time without renewal is to be expected.

Where the weight carried by the thrust bearing is very heavy and where considerable quantities of oil are required, a separate oiling system is employed, the oil circulation through the machine proper being the same as that already described, except that instead of it returning and being pumped back into the system through a gear-driven pump on the main shaft, connections are made at the base of the generator for piping the oil into a common system. The oil flows from the pan at the base of the generator into a reservoir, from which it is pumped, usually through a filter, into a tank; from here the oil is returned to the various machines by means of gravity. Very considerable amounts of money can easily be spent on such a lubricating system. As the circuit is a closed one, it is not necessary to continuously filter all the oil from all the machines, and a filter having a much smaller continuous capacity can safely be installed. Cooling of the oil in the larger systems is usually accomplished by a flow of water through a coil of pipe placed in the reservoir or tank.

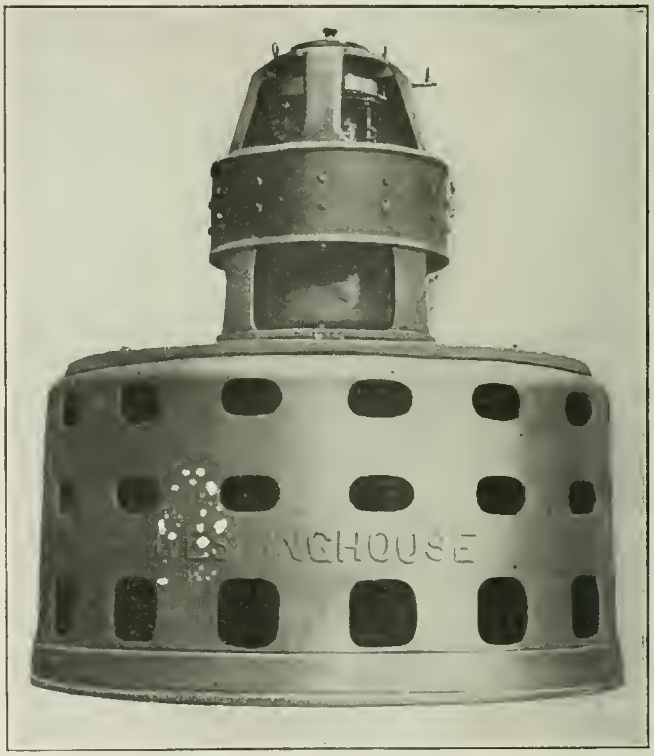


FIG. 5. VERTICAL WATERWHEEL ALTERNATOR WITH EXCITER MOUNTED ON TOP OF MACHINE

A system that is relatively inexpensive and that can be installed where several units of small capacity are employed, is shown in Fig. 4. Ordinarily, the oil flows through the closed system of each individual machine, but at intervals when it is desired to filter the oil from one unit, this is done by changing the valves shown and running the oil to be filtered through the filter into the supply tank. Brass piping throughout the entire supply system is preferable for the reason that such pipe does not corrode or rust.

By installing water-cooling coils in the thrust-bearing housing, very much the same effect can be gained as with the external-oiling system, as regards keeping the oil sufficiently cool for satisfactory service. While such methods are undoubtedly feasible, the water piping would necessarily take up a considerable space and therefore make the room normally available in the housing for inspection or repair very much congested. Furthermore, the carrying of water to the top of the generator, where a leak or break in the pipe during operation might result in considerable damage to the machine, is questionable.

The exciter problem, particularly with alternators that operate at slow speeds, is probably the most difficult of all the electrical ones in connection with the power-plant design, and the method that will combine maximum operating efficiency and minimum first cost and maintenance is found only after careful analysis.

Individual direct-connected exciters, as shown mounted on top of the machines, Figs. 3 and 5, should receive first consideration as giving the simplest and cheapest plan layout. In this consideration, however, certain fundamental facts concerning both alternating and direct-current generators appear: First, that the slower the speed of the alternator the greater is its percentage of excitation and the larger the exciter; second, that the slower the speed of the exciter the more expensive it is; third, that the slower the speed of the exciter the greater its field current and the more sluggish its operation, thus making the voltage regulator, now almost universally employed, both complicated and expensive. These factors may result in the direct-connected exciter being rejected on account of high first cost.

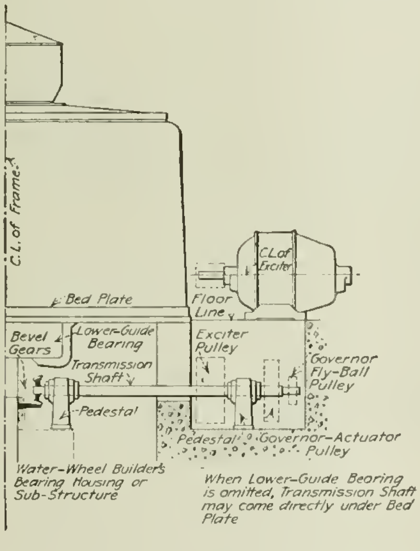


FIG 6 GEAR- AND BELT-DRIVEN EXCITER

Where generator capacities are relatively small, individual high-speed exciters may still be employed, as shown in Figs. 6 and 7. Both methods have certain disadvantages, one in the introduction of the gear and the other in a quarter-turn belt. Either method, however, is fairly inexpensive, and both seem to give fairly satisfactory results.

Next, separate waterwheel exciters may be considered. Such units ought not to be excessive in cost, but may introduce considerable expense in connection with building and wheel-pit costs. Also they may, because of the relatively small capacity of the wheel, require special and more expensive trash racks, etc.

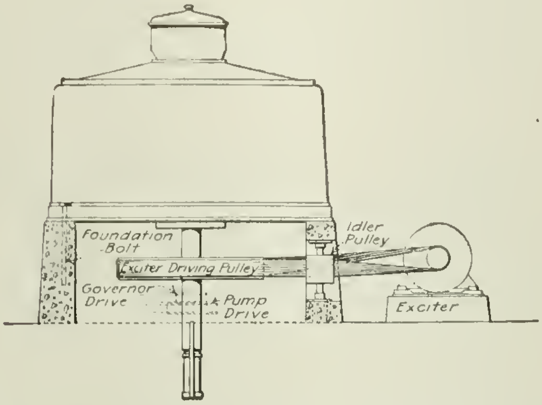


FIG. 7. QUARTER-TURN BELT-DRIVEN EXCITER

A method often used is a combination of waterwheel driven and motor-driven sets, the exciter driven by the waterwheel being used for starting the plant and as a spare, and high-speed motor-generator sets furnishing the excitation normally.

Any one of the foregoing methods may be considered as fairly standard, and the choice, of course, depends on the number of main units in the plant, relative costs of each method, conditions of operation more or less peculiar to the individual plant, etc. In general, it may be stated that the larger the capacity of the separate generating units and the higher their speed, the more favorable becomes the indivdual direct-connected exciter layout.

Heat Transfer

Radiation of heat takes place between bodies at all distances apart. Heat rays proceed in straight lines, and the intensity of the rays varies inversely as the square of their distance from the source.

Conduction is the transfer of heat between two bodies or parts of a body which touch each other. Internal conduction takes place between the parts of one continuous body and external conduction through the surface of contact of a pair of distinct bodies. The conduction of heat through a stagnant mass is very slow in liquids and almost, if not wholly, inappreciable in gases. It is only by the continual circulation and mixture of the particles of fluid that uniformity of temperature can be maintained in the fluid mass, or heat transferred between the fluid and a solid body.

Convection, conveying or carrying of heat means the transfer or diffusion of heat by means of the motion of the mass.

Where are the spendthrifts of yesteryear? Buying Liberty Bonds. The air of liberty, they find, is better than champagne, and the effect lasts longer.

Stoker Capacity vs. Boiler Forcing Rates

BY JOSEPH T. FOSTER*

This article suggests ways in which the plant owner can check his boiler performance against any well-defined standard and ascertain what improvements will result if certain changes are effected.

EVERY central station and plant operating boilers and prime movers is striving, or at least should strive to do two things: To get the maximum output from existing equipment without loss of time or expenditure of money for extensive rearrangement and to eliminate every possible item of waste, particularly the waste of coal, not only because of its present high price, but also because of the diminution in the available supply. From present indications the need for economy will not cease with the war, as the ensuing period will be one of readjustment and will probably be accompanied by high operating costs in every branch of industry.

Many companies have their boilers equipped with instruments to give data on boiler performance and conduct boiler tests at intervals for the purpose of showing up any abnormal conditions. The usual boiler test is susceptible of a certain amount of analysis, and it is possible to tell whether the boiler performance was good or only fair under the conditions of test, but it does not tell whether a boiler is doing its best day after day. There seems to be no way in which the plant owner can survey the whole situation, check his boiler performance against any well-defined standard and ascertain what improvement might be realized if certain changes were made. It is the purpose of this article to supply such a standard and to suggest ways to compare a given performance with the best. Predictions as to economical forcing rates for boilers have been based chiefly on the square feet of heating surface without sufficient regard to the square feet of grate surface or the pounds of coal burned per square foot.

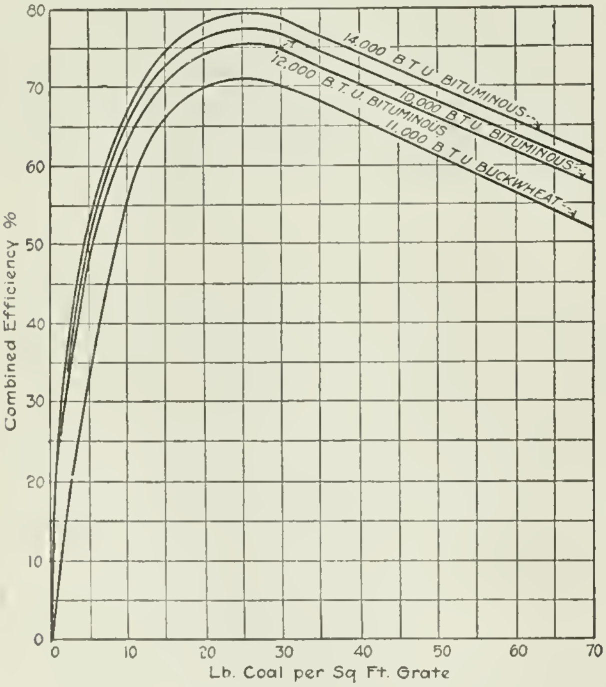


FIG. 1. RELATION BETWEEN COMBINED EFFICIENCY AND COAL BURNED PER SQUARE FOOT OF GRATE

It is difficult to see why variation in efficiency should be so commonly referred to square feet of heating surface or, what amounts to the same thing, to the percentage of the nominal rating. When a boiler is properly designed as regards heating surface, efficiency is a function of the furnace conditions only, and these are in turn dependent on the number of square feet of grate. Recently the tendency has been to give proper attention to this phase of the matter, and larger grate areas are becoming more common. A larger grate means a larger volume of hot gases and, by the moving back of the bridge-wall, a larger amount of tube surface exposed to the direct radiation from the fuel bed. The gain is therefore twofold.

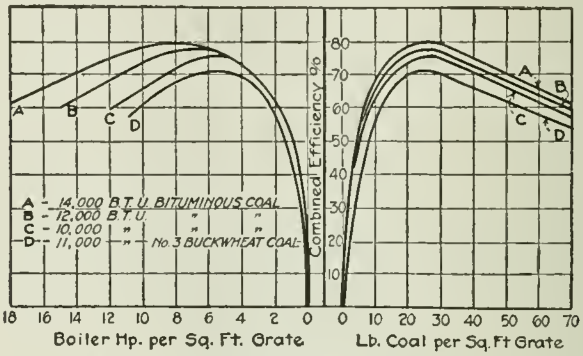


FIG 2. COMBINED EFFICIENCIES AT VARIOUS STOKER FORCING RATES

Formulas have been developed for computing combined efficiencies at various forcing rates, but such formulas are based on heating surface and the results obtained from them are empirical for a given size and type of grate. The efficiency formulas were of greater service some ten years ago, when there was a more definite relation between heating surface and grate surface. A definite relation existed then because with hand firing the depth of grate was limited by the ability of the fireman to handle the coal, and 6- or 6½-ft. grates were the rule. With a definite ratio between heating surface and grate surface the empirical formula developed for one set of conditions could be applied to other conditions with some degree of accuracy. B.t.u. input is certainly the governing factor in boiler output, and since the heat input is directly dependent on the amount of grate surface, this surface is the datum from which calculations should be made.

Boiler tests prove that the plotting of combined efficiency against the pounds of coal burned per square foot of grate surface shows a characteristic curve which has a definite form regardless of the character of the fuel or the size of the boiler. Fig. 1 shows the form of curves derived from actual tests. The curves for bituminous coal were obtained from tests on a battery

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*Public Service Electric Company, Newark, N. J.

of 1400 rated horsepower boilers and the curve for the buckwheat is a composite from numerous tests on boilers varying in capacity from 1000 to 250 hp. It will be noticed that the curves have the same general characteristics even though boiler capacities and kind of fuel varied widely. All grades show best efficiency at a rate of about 25 lb. of coal per square foot of grate surface per hour. Boiler-heating surface seems to have been pretty definitely fixed at 10 sq.ft. per nominal horsepower, and on this basis the curve will be of value in predicting efficiencies at various forcing rates.

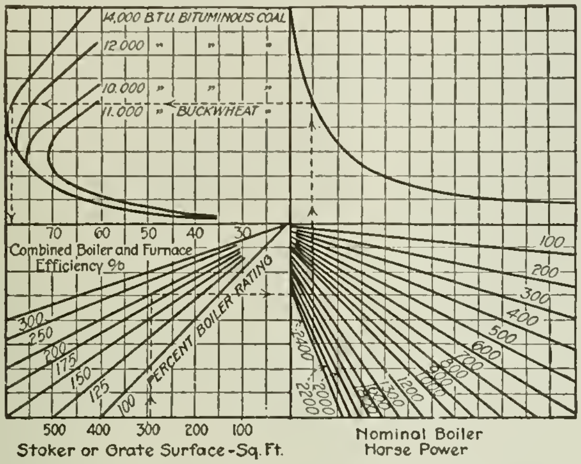


FIG. 3. RELATION OF BOILER HORSEPOWER PERCENTAGE RATING, GRATE SURFACE AND EFFICIENCY

Fig. 2 is a combined curve showing efficiencies plotted against pounds of coal per square foot of grate per hour and boiler horsepower per square foot of grate. The effect of the burning qualities of the fuel on the output is very marked. The most economical forcing rate for the 14,000-B.t.u. coal is 9 boiler horsepower per square foot of grate and for the buckwheat 6 hp. There is also a difference of approximately 10 per cent. between the best efficiencies realized.

Fig. 3 is a chart worked out on the basis of test results and shows the relation between combined efficiency and grate surface for various sizes of boilers under different operating conditions and with different kinds of fuel.

Example 1: What efficiency will be obtainable with a 1400-hp. boiler having 290 sq.ft. of grate surface when operated at 200 per cent. rating with 14,000 B.t.u. coal?

Solution: Project upward from 290 sq.ft. of grate surface to the 200 per cent. rating line, then horizontally to the right to the 1400 nominal horsepower line, then vertically to the curved transfer line and horizontally to the left to the point of intersection with the efficiency curve, thence vertically downward read the efficiency as 78.5 per cent.

Example 2: A boiler with a nominal rating of 1000 hp. and having 350 sq.ft. of grate surface is being operated at 150 per cent. rating on 12,000-B.t.u. coal. Is it developing its best efficiency, and if not, at what rating should it be run?

Solution: Following out the method outlined, it will be seen that the boiler is developing 73.5 per cent. efficiency. The best efficiency with this coal is 77.5 per cent. Reversing the operation by projecting horizontally from the point of best efficiency of the curve for 12,000-B.t.u. coal to the transfer line, downward to the nominal rating curve, horizontally to a vertical line from 350 sq.ft., read 230 per cent. as the rating at which to operate the boiler for maximum efficiency. Where a number of boilers are on the line operating under the conditions in the second example, it would be possible to cut out one or more boilers with a large fuel saving on account of the increased efficiency of the remaining boilers at the higher rate of steaming.

The practical use of this method will be recognized and the following instance is a case in point: The initial installation in a certain plant consisted of a battery of boilers with 221 sq.ft. of grate surface and rated at 1400 hp. and operated at 79 per cent. efficiency when developing 145 per cent. rating, burning 14,000-B.t.u. coal. Increased load on the plant required a second installation, and it was desirable that it should develop its best efficiency at a higher rating. It was therefore designed with a grate surface of 291 sq.ft. and will develop 79 per cent. efficiency at approximately 200 per cent. rating. It is much cheaper to develop greater horsepower by means of larger grates than by increasing the boiler-heating surface, for large heating surface involves high initial cost not only of the boilers themselves, but of all the other items entering into their erection. Where cubic feet of available space in the boiler house is limited, the question of grate surface is of importance because every unnecessary cubic foot taken up by the boilers means a higher plant cost. The question of grate area, however, is not limited to new plants, but is of equal importance where the boilers are already installed. Where the grate surface is found to be too small, it would be profitable in almost every instance to spend the money necessary to enlarge it.

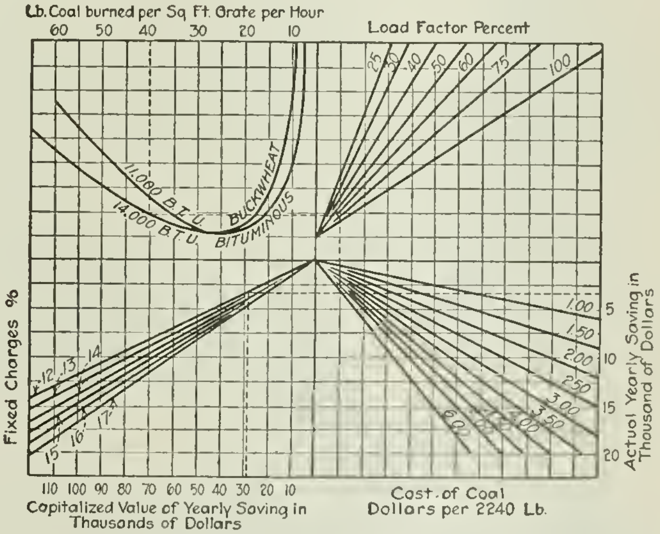


FIG. 4. CAPITALIZED VALUE OF SAVING REALIZED BY OPERATING AT BEST FORCING RATE

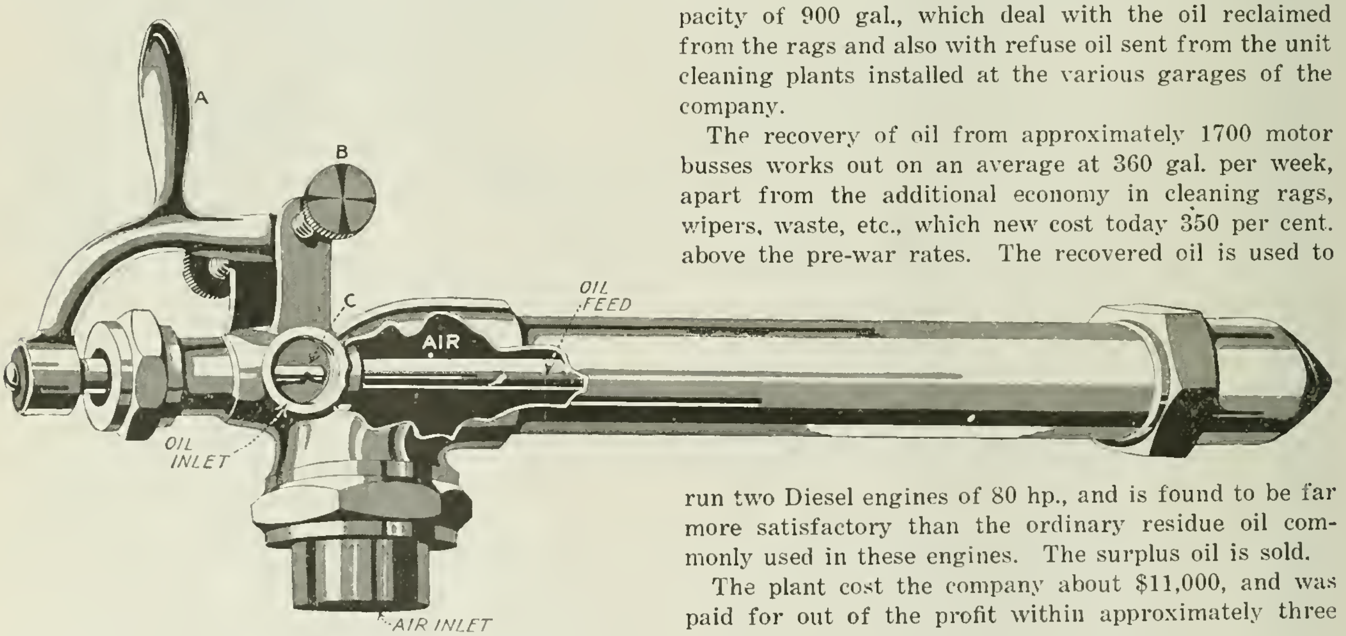
Fig. 4 is designed to show in dollars the saving which will result from changing from a given condition to the best condition, as shown in Fig. 1; namely, 25 lb. of coal burned per square foot of grate per hour, for various load factors and coal prices. The value of the annual saving, capitalized at from 12 to 17 per cent., is also given. All values are calculated for a 1000-hp. load, the data for other loads being proportionate. Only two grades of coal are shown in this chart, but other grades, since they fall between the two, can readily be interpolated. Example: A boiler is being forced so that 40 lb. of coal is burned per hour per square foot of grate. What saving would be realized yearly if the forcing rate were brought down to the foregoing standard, 25 lb. per sq.ft. per hour, or the most economical value? How much money could be profitably spent for additional boiler capacity to bring about this result if coal is $6 per ton and the saving is capitalized at 12 per cent., and 75 per cent. is the assumed load factor?

Solution: Project downward from 40 lb. the coal burned per hour per square foot of grate to intersect with the 14,000-B.t.u. curve, then horizontally to the right to the 75 per cent. load factor line, then vertically down to the cost of coal per ton, $6. From this point horizontally read on the right-hand scale the yearly saving, $3250, or horizontally to the left to the 12 per cent. line and vertically downward read the capitalized value, $28,000, the amount that could profitably be spent for additional boiler capacity.

The application of the curves is not confined to problems covering boilers already equipped, but can be used equally well for calculating the saving that would result in some cases from the use of stokers on hand-fired boilers. Assuming hand-fired boilers in which a rate of eight pounds of coal per square foot of grate per hour is maintained, the boiler efficiency would be approximately 60 per cent. With a stoker that will burn 25 lb. per sq.ft. per hour, the capitalized value of the stoker can be read from the curves in the same manner as described in the foregoing examples.

Johnson Crude Oil Burner

There are sections throughout the United States where crude oil is preferable to coal as a fuel under both heating and power boilers. In competition with coal 130 gal. of the cheapest grade of California fuel oil, containing about 18,500 B.t.u. per lb., is equal in heating value to one ton (2000 lb.) of the best grade of soft coal. In burning crude oil a burner of proper construction must be used.



SOME OF THE DETAILS OF CONSTRUCTION OF THE JOHNSON OIL BURNER

A low-pressure air crude-oil burner manufactured by the S. T. Johnson Co., Grace and Lowell Sts., San Francisco, Calif., has been developed to burn any kind of thick or thin oil, or oil containing water in emulsion.

Referring to the illustration, the burner is designed to vaporize heavy crude oil with an air pressure of between 1 and 5 lb. The burner has a 1-in. air connection and a ¾-in. oil connection and is furnished with an angle-ported valve *C*, which closely regulates the supply of oil to the furnace. The control of the flame is obtained by the adjustment of the lever *A*, which is locked into position by the two thumb-screws *B*. Oil is fed to the burner nozzle through the pipe opening shown, and the air supply going through the nozzle head surrounds the oil pipe. The oil and air are mixed at the head, and the flame is produced close to the tip of the burner.

Where air pressure is not available, a pressure blower is used, which furnishes the necessary air to atomize the oil without heating it before it reaches the burner.

Rag Washing and Oil Reclaiming

The London General Omnibus Co., Ltd., London, England, has, for about three years, been working a central recovery plant for reclaiming the oil and grease absorbed in rags, which so washes the cleaning material itself that it can be used over many times.

The depot is situated at Riley St., Chelsea, S. W., and the plant consists of a horizontal return-tubular boiler, three centrifugal steam-driven oil extractors, two hydro-extractors, three rotary washing machines and one rotary drying machine, together with a calender and an ironing machine to deal with the washing and pressing of women's overalls. The plant, in effect, is a typical laundry-machinery equipment.

In connection with this plant there are three steam-heated, oil-cleansing or settling tanks, each with a capacity of 900 gal., which deal with the oil reclaimed from the rags and also with refuse oil sent from the unit cleaning plants installed at the various garages of the company.

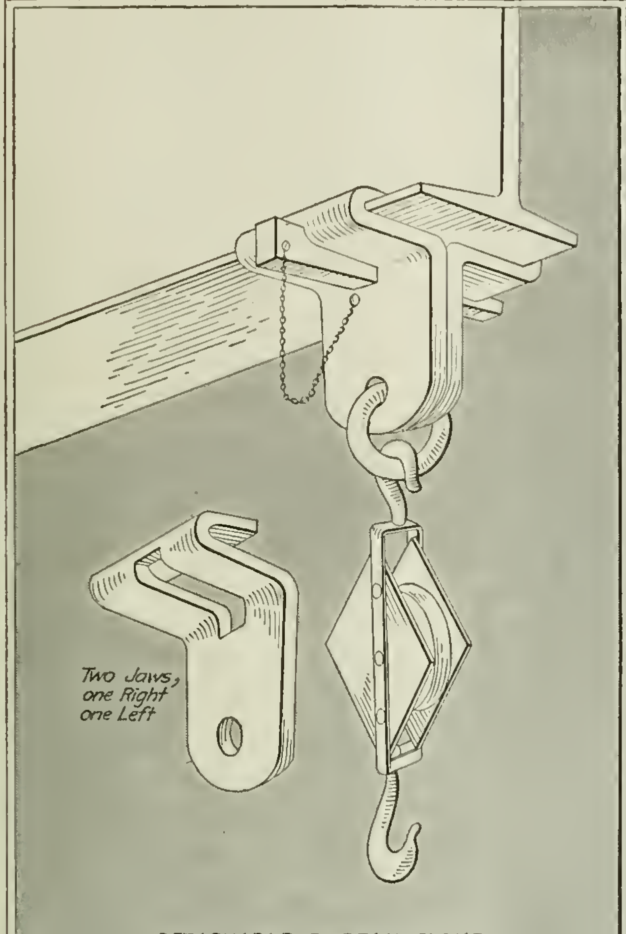
The recovery of oil from approximately 1700 motor busses works out on an average at 360 gal. per week, apart from the additional economy in cleaning rags, wipers, waste, etc., which now cost today 350 per cent. above the pre-war rates. The recovered oil is used to run two Diesel engines of 80 hp., and is found to be far more satisfactory than the ordinary residue oil commonly used in these engines. The surplus oil is sold.

The plant cost the company about $11,000, and was paid for out of the profit within approximately three years.

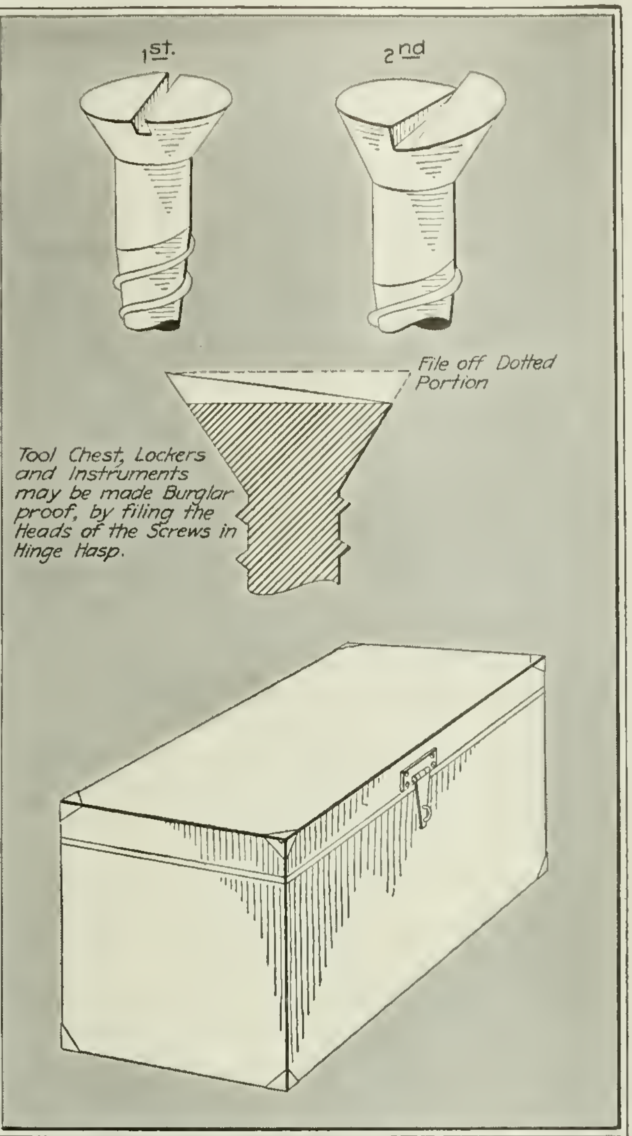
Liberty bondholders are justly another Grand Army of the Republic. You should lose no time in becoming a member of so glorious an army, even if you have purchased bonds in the other loans.

From an Engineer's Notebook

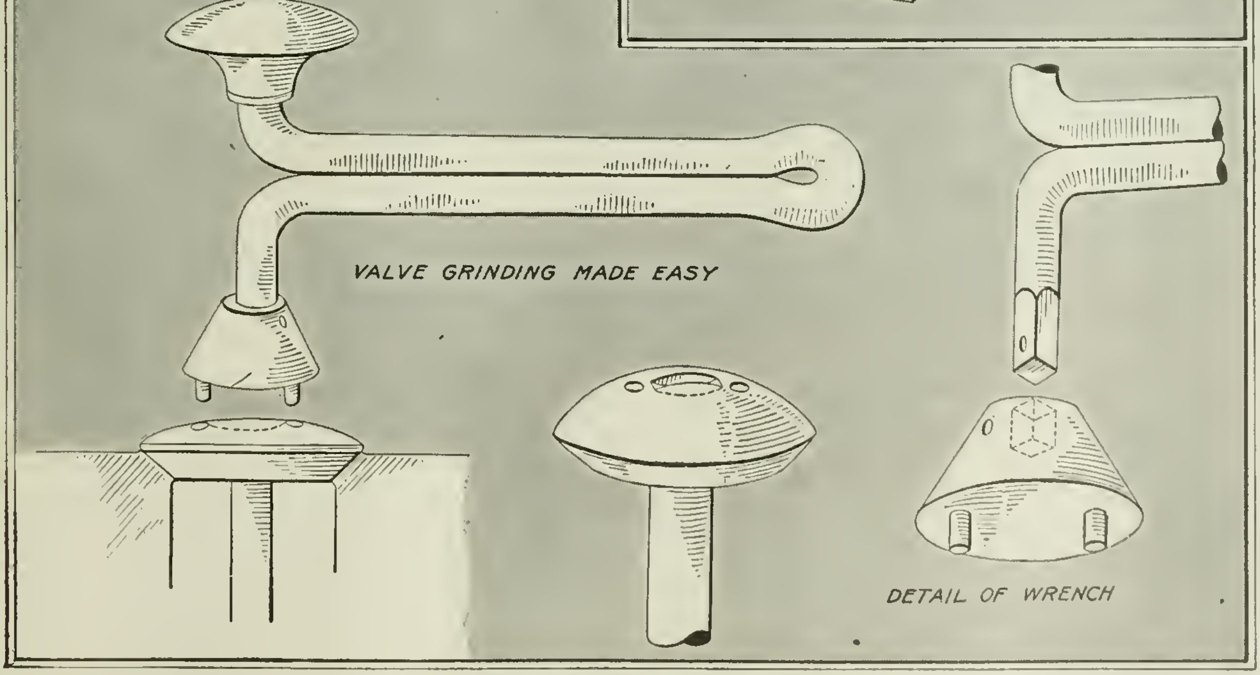
By M. P. Bertrande



DETACHABLE I-BEAM CLAMP



Tool Chest, Lockers and Instruments may be made Burglar proof, by filing the Heads of the Screws in Hinge Hasp.



VALVE GRINDING MADE EASY

DETAIL OF WRENCH

The Electrical Study Course—Series-Connected Generators

A comparison is made between the shunt and series type of direct-current generators, showing how the voltage of the shunt type remains practically constant with different load values, while the voltage of the series varies with the load.

IN THE previous lesson we saw how a shunt generator was capable of building up a voltage from the residual magnetism in the fieldpoles when the field coils are connected to the armature in the proper relation, as in Fig. 1. In this case the field coils are connected across the armature, therefore the latter is capable of causing a current to flow through the former whether the armature is supplying an external load or not. In Fig. 1 the field circuit is from the positive brush through the field coils back to the negative brush without passing through terminals M and N, which lead to the external load, hence it is evident that the field circuit is independent of the load circuit.

In the series-connected generator, as in Fig. 2, it will be seen by following around from the brush marked plus through the field coils that in order for the circuit through the armature and field coils to be completed an external load L must be connected between terminals M and N, as in Fig. 3. In other words, the series generator cannot build up its voltage unless it is connected to a load.

Since the field coils of the series generator are connected in series with the load and armature, it is at once evident that the cross-section of the conductors in the field coils must be large enough to take care of the full-load current of the machine. The field coils on the shunt generator are connected across the armature and are wound with wire of a size that will make the coils of such a proportion as to produce the flux in the polepieces with the minimum expenditure of energy. The power required to excite the field coils is generally from about 1 to 3 per cent. of the output of the machine.

To generate a given voltage, the armature must revolve at a certain speed and the magnetic field of the polepieces must have a definite value. To set up the lines of force in the magnetic circuit, it is necessary that a required number of ampere-turns in the field coils, say 6000, be supplied.

Ampere-turns is the number of turns in a coil of wire multiplied by the current in amperes that flows through it when connected to an electric circuit; that is, if a coil contains 2000 turns and when connected to a 110-volt circuit, 3 amperes flow through it, then the ampere-turns are $2000 \times 3 = 6000$.

If we assume the machine in Fig. 1 to require 6000 ampere-turns to excite the field coils sufficiently for the armature to generate 110 volts, and further assume that the full-load current of the machine is 100 amperes and requires 3 amperes to excite the field coils, then the number of turns in the field coils will be ampere-turns divided by amperes, or $6000 \div 3 = 2000$, and the resistance of the wire in the field coils is volts divided by current, or $110 \div 3 = 37$ ohms approximately.

If the series machine, Fig. 3, is assumed to have the same capacity as the shunt machine, Fig. 1, and requires the same number of ampere-turns to excite the field coils as the shunt machine to generate 110 volts, then the number of turns of wire required in the field coils, since the total current is flowing through the field winding, will be $6000 \div 100 = 60$ turns, or 30 turns on each coil. Since the total current flows through the field coils and load in series, the combined resistance of the field coils and load can only be volts $\div$ amperes, or in this case, $110 \div 100 = 1.1$ ohms.

Now if we are to keep the amount of power expended in the field coils on the series machine down to approximately that of the shunt machine, or 3 per cent., then the resistance of the field coils can be only 3 per cent. of the total resistance, or $1.1 \times 0.03 = 0.033$ ohm, or the resistance of the field coils in the shunt machine is $\frac{37}{0.033} = 1121$ times that of the series machine. Herein lies the most prominent structural difference between the shunt and series type of machines. The field coils on the shunt machine are wound with a large number of turns of small wire having a comparatively high resistance and are connected in parallel with the armature. The field coils of the series machine are wound with a small number of turns of large wire, consequently have a low resistance and are connected in series with the armature. However, the size of the conductors in either case varies with the size and the voltage of the machine.

The comparison of the field coils in the foregoing is not absolutely correct, because, in the first case we assume 110 volts at the brushes and in the series machine we have assumed that the total pressure generated is 110 volts. However, the comparison is close enough for all practical purposes and eliminates a lot of calculation.

It is evident that with the series generator if the field strength is to be maintained constant, consequently the voltage at the brushes at a constant value, the load also will have to be maintained at a constant value. This is generally a difficult thing to do, since the load on a generator is usually made up of a number of different devices used for different purposes and of different sizes and types, which are connected to the circuit when wanted and disconnected when not required. The devices also require approximately a constant voltage for their operation. Such a condition cannot be met very successfully by the series generator.

From what we have already seen of the shunt generator, it is evident that the load on the machine does not affect the field circuit. For example, in Fig. 4 is given a shunt generator supplying a load of four resistances, r_1, r_2, r_3 and r_4 each of 4 ohms, in parallel. If we assume that the armature develops 100 volts and neglecting the effect of the armature resistance, the current i flowing in each section of the load is $i = \frac{E}{r} =$

$\frac{100}{4} = 25$ amperes, or a total of 100 amperes in the four circuits. If one resistance is disconnected from the circuit, the current supplied to the load will be 25 × 3 = 75 amperes, and if only two are connected, the current delivered to the load by the armature is 50 amperes, and for one resistance, 25 amperes. Under any one of the conditions the current flowing in the field coils will remain practically constant since, as shown, this circuit is independent of the load. Consequently, the value of the field current is not affected by the load only as the voltage is caused to vary slightly by the load current and resistance of the armature. This latter factor will be considered in the next lesson.

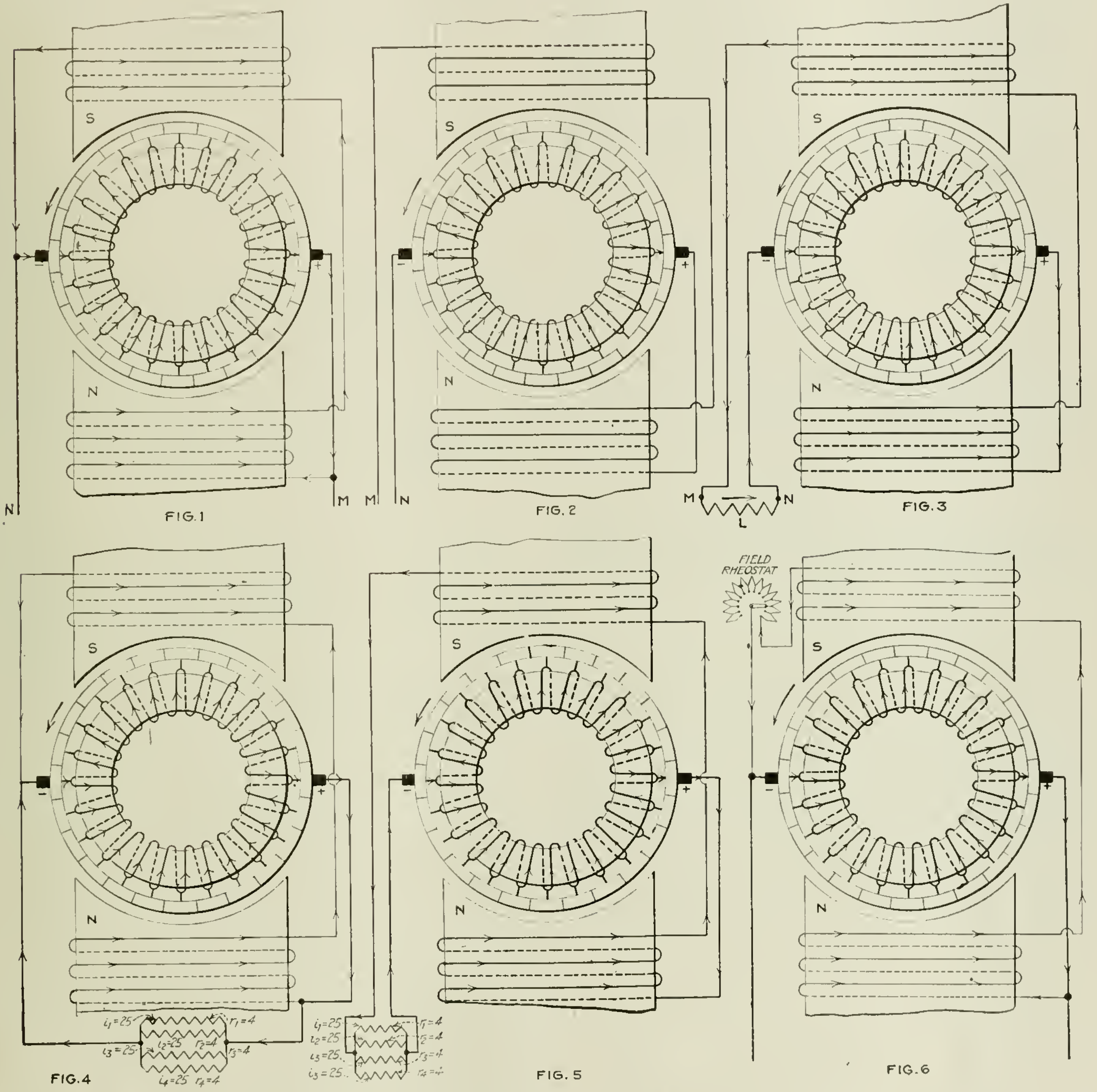


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 1 TO 6. DIAGRAMMATICAL REPRESENTATION OF SHUNT AND SERIES GENERATORS

Now consider what would happen if we varied the load on the series generator, Fig. 5, the way that it was changed on the shunt generator, Fig. 4. In Fig. 5, if we assume the machine to be generating 100 volts and that 100 amperes is flowing in the circuit, then 100 amperes is passing through the field coils. If one section of the load was taken off and if the voltage at the armature terminals remained constant at 100 volts, as was assumed in the shunt machine, 25 amperes would flow through each of the three resistance elements, as in Fig. 4. But with the series machine the pressure will decrease since the current has been decreased in the field coils, consequently the current will decrease in the different elements connected across the armature terminals. From this it is evident that as the load is decreased on the series machine the voltage is decreased and the current through each individual load also decreases; whereas, on the shunt generator the total load may be varied, but the current in the individual loads and the voltage remains practically constant.

What we have just seen has practically eliminated the series type of machine from commercial use in preference to the shunt type or modifications of this latter type.

Direct-current generators are generally designed so that, if the shunt-field winding is connected directly across the armature, as shown in Fig. 1, they will at rated speed develop about 120 per cent. normal volts, that is, a 110-volt machine will generate about 125 or 130 volts. The voltage is then adjusted to normal by connecting an adjustable resistance in series with the field circuit, as in Fig. 6. The current through the field coils is adjusted by means of this resistance so as to produce normal volts. Then any slight variation in the voltage, due to changes in load or otherwise, can be taken care of by varying the resistance in the field circuit. The resistance connected in series with the field coils is called a field rheostat.

Fig. 7 is a layout of problem 1 in the last lesson. The joint resistance of the circuit is

$$R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2}}$$

In the problem the joint resistance R is known and r_2, one of the individual resistances, is to be determined. This may be found by transposing the joint-resistance formula around to read

$$r_2 = \frac{1}{\frac{1}{R} - \frac{1}{r_1}} = \frac{1}{\frac{1}{3.75} - \frac{1}{6}} = \frac{1}{\frac{6}{22.5} - \frac{3.75}{22.5}} = \frac{22.5}{2.25} = 10 \ ohms$$

The correctness of this answer may be checked by substituting the values in the joint-resistance formula; then

$$R = \frac{1}{\frac{1}{6} + \frac{1}{10}} = \frac{1}{\frac{8}{30}} = \frac{30}{8} = 3.75 \ ohms$$

In Fig. 8 is problem 2 of the previous lesson. The resistance of each lamp is 220 ohms and that of the voltmeter 10,956 ohms. The joint resistance of the five lamps is equal to the resistance of one lamp divided by the number of lamps in parallel, or 220 ÷ 5 = 44 ohms. Since the group of lamps is in series with the voltmeter, the total resistance of the circuit is $R = 44 + 10{,}956 = 11{,}000$ ohms, and the current $I = \frac{E}{R} = \frac{110}{11{,}000} = 0.01$ ampere. If the voltmeter is properly calibrated, its reading will be equal to its resistance times the current flowing through it, in this case 10,956 × 0.01 = 109.56 volts, or a difference of only 0.44 of a volt less than line voltage. This 0.44 volt is expended in the lamps, consequently it is evident that the effect that the lamps would have upon the reading of the instrument could scarcely be detected on the scale. On the other hand, each lamp has 220 ohms resistance and when connected across a 110-volt circuit would take 110 ÷ 220 = 0.5 ampere, or 0.5 × 5 = 2.5 amperes total current for the group to make them burn at their normal brilliancy; but when connected in series with the voltmeter, only 0.01 ampere flows through the lamps, therefore they will remain dark, on account of the high resistance of the instrument being in series with them.

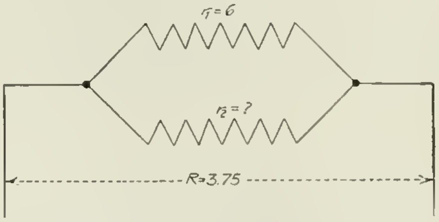


FIG. 7. TWO RESISTANCES CONNECTED IN PARALLEL

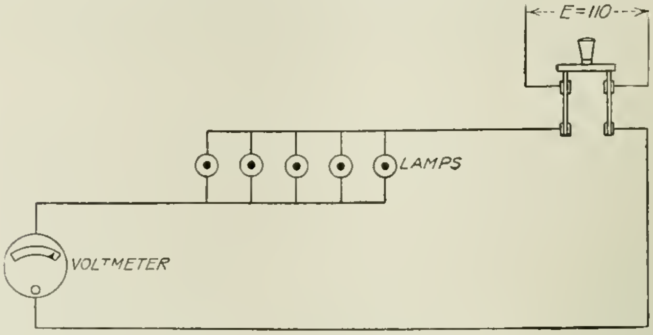


FIG. 8. GROUP OF LAMPS CONNECTED IN SERIES WITH A VOLTMETER

1. Find the resistance of 1500 ft. of stranded copper cable made up of 37 wires 90 mils in diameter.

2. A 250-volt 350-kw. two-wire direct-current generator is located 75 ft. from its switchboard; allowing 0.5 per cent. drop, find the size of the conductors required to make the connections between the machine and switchboard.

Ancient Conception of Heat

The early-day theory regarding heat was that it was a material substance, a "subtle imponderable fluid" that was named "caloric." One of the chief constituents of any substance that would burn was supposed to be "phlogiston," and therefore if a substance burned completely or nearly so, it was said to be a pure or nearly pure "phlogistate," and when burned it became "phlogistated."

This theory was proved by melting a given weight of lead and keeping it in a molten state, skimming the surface as fast as a film appeared on it. When all the lead had been so converted into what we now call lead oxide, it was found that its weight was greater than the original lead—therefore phlogiston (heat or fire) had entered the metal, the weight of which was the increase in the weight of the substance. To further prove this theory, it was found that heating this phlogiston-impregnated substance in the presence of or mixed with powdered charcoal reconverted it into metallic lead—the phlogiston was driven out. We now know that it is oxygen from the air that attacks the lead when melted and forms lead oxide, and that when the lead oxide is heated with charcoal (carbon), the charcoal will rob the lead of the oxygen, because of the greater affinity of carbon and oxygen than lead and oxygen, leaving metallic lead again.

Conscription limits the age of the fighting man to thirty years, but there is no age limit for buying Liberty Bonds.

You must buy or pay—buy a Liberty Bond or pay Germany. The $100 Bond is the cornerstone of Liberty.

Coöperation of Public-Service and Isolated Plants

By IRA N. EVANS

A solution of universal application of the old problem of "buying vs. producing current." Coöperation will bring mutual profit, conserve coal and reduce investment for equipment.

THE generation of power in conjunction with heating by exhaust steam has become less profitable in many localities, due to the effort of public-service companies by low rates to control the business at a questionable return to themselves. Making the generation of current seemingly unprofitable for the isolated plant and in some cases taking over the business, still leaves the heating. In numerous instances these heating plants have grown to large proportions. Whether large or small they duplicate to a great extent the power requirements of fuel, labor and unavoidable boiler wastes.

It is a well-known fact that with the most improved methods and equipment only about 15 to 20 per cent. of the heat of the fuel is recovered in current when generated by steam, and 85 per cent. passes up the chimney or into the condenser cooling water. On the other hand, the isolated plant uses 60 to 70 per cent. of the heat of the fuel in the heating system and could easily recover the relatively small percentage convertible into power with practically little or no increase in the total fuel used, provided the functions were properly coördinated.

MUTUAL PROFIT IN COÖPERATION

In large industrial plants it is possible to recover all power convertible from the heating fuel by coöperation with the public-service company. There would be mutual profit, conservation of fuel to the community, and the central station would maintain control of the business.

Suppose an industrial plant used 1000 hp. in high-pressure boilers for heating in zero weather and purchased all power used from the public-service company at a flat rate of approximately 1c. per kw.-hr. The heating system would have a condensing capacity of 34,000 lb. of steam per hour in zero weather, and at least 3400 lb. of coal per hour would be burned and paid for in any case. Suppose a turbo-generator of, say, 1000-kw. capacity were installed between the heating system and the boilers and the current metered back continuously night and day into the public-service mains during the period that heating was required. The heating system would be hot water under forced circulation with the exhaust heater of the heating system functioning as a condenser for the turbo-generator.

At about 34 lb. per kw.-hr. and atmospheric exhaust, 900 kw. could be recovered from the fuel burned under the heating boilers, and by varying the vacuum on the heater, the steam rate on the turbine could be lowered as the requirements of the heating system were reduced by the rising outdoor temperature. In this event there would be a constant power-load recovery throughout the heating season, night and day, at a maximum power factor. If 100 kw. were deducted for circulating pumps and plant apparatus, the remaining 800 kw. could be delivered continuously into the public-service mains by utilizing the isolated plant's heating boilers and fuel.

Records of the Weather Bureau show 3782 hours during nights, Sundays and holidays when, in the average plant, heating is required and the power is inoperative. There are 2050 hours during days in the heating season when power is required, making a total of 5832 hours. Consequently, if a turbo-generator of proper size were installed in the heating plant previously mentioned, there would be a net power recovery of 5832 hours × 800 kw. = 4,665,600 kw.-hr. At 1c. per kw.-hr this would amount to $46,656 for the season. Allowing $100 per kilowatt as a war-time price to cover the installation of superheaters, generating and heating equipment, interest and depreciation aggregating 10 per cent. would amount to $10,000. Extra coal over heating requirements at $5 per ton would cost $7125 and supervision and supplies should not exceed $2500, leaving a balance of $46,656—($10,000+$7125+$2500)=$27,031 to be divided as mutually agreed.

If the isolated plant were supplying its own power independently of the public-service company, it would have to expend from one-half more to double the amount for equipment to guard against breakdown, and during day periods in the heating season would operate only 2050 hours, which would mean a net recovery of 800 × 2050 = 1,640,000 kw.-hr. This is less than one-half of the previous saving.

FUEL CONSERVATION EFFECTED

If the public-service company generated current on 2 lb. of fuel per kilowatt-hour, the conservation of fuel to the community in the heating season would be 4,665,600 × 2 ÷ 2000 = 4665 tons. It is anticipated that the plant would purchase current on the same basis as before, depending on the rebate from current returned to the mains for its profit. It would depend on circumstances and the relative economy of the public-service plant and the turbine under vacuum, whether the machine would be operated during the summer months. No duplicate machinery would be necessary in the isolated plant, as in case of accident the load could be carried for the time being by the central plant, as the unit in the plant would function as part of the public-service company's equipment.

This method of operation would reduce the load on the central station at night and would add to the idle equipment. It will be found, however, that the number of plants available in any one district would be comparatively few and their capacities aggregate a small portion of the night load of the public-service station. They would furnish a source of cheap current during those periods, and as the public-service company has the mains and the only market for the current at these hours, it would have control of the situation.

The period of operation of the turbo-generator, 5832 hours per year, would be greater than that of the large public-service machines operating on a typical industrial-load curve. Where the load on the public-service station is heavier in winter than summer, it would be an advantageous arrangement if the isolated-plant turbine were discontinued during the summer.

It is the writer's belief that this is the most economical and efficient method of handling the isolated-plant problem, and it is applicable to any part of the country for heating plants having over 500 hp. in boilers.

For the assumed case, Table I gives the hours for each 10-deg. period of outside temperature, the steam required for heating, the vacua that would be possible with the water temperatures required and the corresponding steam rates for the turbine. With these data it is easy to figure the total steam and the kilowatt-hours recoverable. The column heads indicate the method. As an interesting comparison Column X gives the electrical energy recoverable from the heating steam by means of a noncondensing reciprocating engine. In moderate weather the noncondensing unit is outdistanced in the ratio of two to one.

The boilers and fuel are purchased and operated in any case by the owner of the heating plant, and no change in this arrangement is contemplated. As will be shown from concrete cases, a saving of fuel will be effected for the owner over the previous method of heating by low-pressure steam sufficient to pay for the changes and modifications of the heating system to successfully operate as a condenser for the turbo-generator.

TABLE I. POWER RECOVERABLE FROM HEATING FUEL IN INDUSTRIAL PLANT WITH 1,000 BOILER HORSEPOWER FOR HEATING IN ZERO WEATHER

I Outside Temp. Periods Deg. F	II Hours Nights, Holidays	III Hours Work Days	IV Total Hours Each Period	V Steam per Hour Lb.	VI Vac., In. Hg.	VII Av. Water Temp., Deg. F.	VIII Turbine Rate, Lb per Kw.-Hr.	IX Recov. Power Heating Steam Kw.	X Recov. Power Non-Cond. Engine Kw.	XI Turbine Rate Const. Load 900 Kw. Lb.	XII Gross Load Carried Kw.	XIII Net Load Carried Kw.	XIV Evap. Factor 175 Lb. 100 Deg. F. & A. 212 Deg.	XV Steam per Hour Power Heating F. & A. 212 Deg.	XVI Total Steam Power and Heating F. & A. 212 Deg.	XVII Total Steam for Heating
0–10	211	97	308	30,000	3	194	31.4	956	857	31.4	956	856	1.134	34,041	10,484,628	9,240,00
10–20	566	251	817	26,600	9	182	28.4	937	760	28.4	937	837	1.134	30,176	24,653,792	21,732,200
20–30	719	423	1,142	23,300	14	170	26.2	889	665	26.2	900	800	1.134	26,740	30,537,080	26,608,600
30–40	766	354	1,120	19,800	20	154	22.8	870	565	22.6	900	800	1.134	23,065	25,832,800	22,176,000
40–50	622	290	912	16,200	24	135	20.2	802	463	19.8	900	800	1.134	20,208	18,429,696	14,774,400
50–60	475	271	746	14,100	26	115	18.8	750	403	18.0	900	800	1.134	18,371	13,704,766	10,518,600
60–70	423	364	787	12,000	27	110	18.8	638	343	17.0	900	800	1.134	17,350	13,654,450	9,444,000
	3,782	2,050	5,832												137,297,212	114,493,800
														Tons of Coal (Evap. 8 Lb.) .	8,581	7,156
														Cost of Power 1,425 Tons ..		

Note—Column IX = Col. V ÷ Col. VIII; Col. X = Col. V ÷ 35; Col. XIII = Col. XII − 100; Col. XV = Col. XII × Col. XI × Col. XIV; Col. XVI = Col. XV × Col. IV; Col. XVII = Col. V × Col. IV

The ordinary low-pressure steam system is a good condenser of steam, but at pressures at the source all above atmosphere, and this makes it inefficient as an adjunct to power generation. The hot-water system is adapted to use steam at pressures above and below atmosphere. At 3 lb. back pressure it will give an average water temperature of about 200 deg. for zero weather. With a range of about 80 to 120 deg. in moderate weather it will do the heating and still allow a vacuum of 26 in. on the turbine. The arbitrary control of the vacuum regulates the temperature of the heating medium and determines the steam rate on the turbo-generator. When the power and heating loads balance in zero weather it is a fortunate coincidence that the saturated steam used by a turbine decreases with the improving vacuum in almost exact proportion as the heating demand is reduced by the rising temperature. Use of superheated steam upsets the equilibrium somewhat, and it is advisable to use a little additional coal in moderate weather to keep up the power output.

As the turbo-generator uses 100 per cent. more steam under atmospheric pressure than under high vacuum, it is uneconomical to operate in conjunction with a steam-heating system utilizing the exhaust steam for heating. In most cases, therefore, when the question of combining power and heating in the isolated plant arises, a low-pressure vacuum steam system is assumed, which compels the use of reciprocating engines, slow-speed generators and noncondensing conditions the year around, with the result that the space occupied and first cost are excessive and the financial return less favorable. The constant steam rate on the noncondensing reciprocating engine with the widely varying heating requirements causes the recovered power load to range from 100 per cent. in zero weather to less than 50 per cent. in warmer periods, while the variation in the turbine steam rate permits greater recovery. This is shown in Table I.

In a new plant the hot-water system can be installed at no greater cost than a steam system and with no more heating surface if properly designed. The regulation of the vacuum for maximum power will at the same time compel regulation of the heating medium with the outside weather, giving a constant interior temperature. There will be a saving of 25 to 30 per cent. in the heating steam over the constant-temperature low-pressure steam-heating system, or more than sufficient to allow for additional fuel to raise the steam pressure for power purposes. The power operation will give an opportunity to utilize for feed-water purposes all steam from auxiliary pumps of the heating plant, which is generally wasted due to the high temperature of the return condensation.

In ordinary low-pressure steam plants using steam at 5 lb. pressure, the boilers are operated at from 100 to 140 lb. pressure and steam is supplied through a reducing valve. The total heat per pound at 140 lb. pressure is 1194 B.t.u., and the temperature 361 deg. F. If the steam is reduced to 5 lb. pressure, the temperature is actually 308 deg., showing that at this pressure the steam is superheated 80 deg. The corresponding pressure for the temperature is nearly 61 lb. gage. As the loss of heat from pipe surfaces is proportional to the temperatures and not the pressures, the heating system is actually operating at a temperature corresponding to 61 lb. pressure instead of 5 lb. and will use more steam. This accounts for the frequent statement of many engineers that they find little difference in fuel if they operate the engines and heat with exhaust steam or heat by live steam at reduced pressures, the power costing nothing. No one would wonder at an increase in fuel if told the system was operated at 60 lb. instead of 5 lb. pressure, and this is virtually what happens. The heat all goes into the building, but is generally lost in mains and nonessential places.

This is obviated with the hot-water system owing to the use of the heaters: one for live steam with gravity return to the boilers for use when the engines are inoperative, and an exhaust heater that utilizes the exhaust steam at atmospheric pressure and below. The water is passed through both heaters in series, and all steam at whatever pressure is converted to water temperatures always the same for the same outside temperature. The steam is piped a comparatively short distance.

A CONCRETE CASE IN POINT

In substantiation of the previous statements the writer has a concrete case and approximate conditions in two other plants to offer. The plant first mentioned is heated by live steam reduced to 5 lb. pressure and the others already have forced hot-water heating systems and purchase current. The steam-heated plant operates 1600 hp. in Stirling boilers at 150 lb. pressure. The second plant is shut down in summer, but during the heating season operates 800 hp. in boilers. The third plant will have 2000 hp. in boilers, a portion to be operated throughout the year. Table I will serve to show the possibilities in the first plant if the steam system were changed to hot-water heating and the plant operated as previously suggested. Inasmuch as there are turbine feed pumps and engines to drive the forced-draft fans, the additional fuel for the higher pressure and for heating the feed water will be practically nothing, although the factor of evaporation is taken from the temperature of 212 deg. in each case to 175 lb. and 100 deg. superheat. Table II summarizes the possible saving in each of the three plants.

In the three plants there is recovered from heating steam 11,078,600 kw.-hr. At 2 lb. of coal per kilowatt-hour in the central station, this represents 11,078 tons of coal per season. In the first plant there is a net saving of 2000 tons of coal for power and heating combined over heating alone, and in the other two plants an addition of 1250 tons is required for power over heating. The net saving to the community is 11,828 tons of coal, which at $5 per ton amounts to $59,140. At 0.95c. per kw.-hr. the recovered current is valued at $105,247, which is nearly 60 per cent. of the total expenditure.

In plant No. 1 the actual fuel purchased for heating in 1915-16 was 9000 tons, or 2000 tons more than required to heat by hot water and recover 4,665,600 kw.-hr. The difference in fuel pays a large return on the investment required for changing the heating system. In this plant two large air compressors are operated the year around and only part of the exhaust is used for heating on a near-by building. High-pressure steam for heating is reduced from 140 to 5 lb. through a reducing valve. In summer 20 tons per 24 hours is used to operate the plant Sundays and holidays when no work is accomplished. The turbine feed pump and forced-draft fan engine practically exhaust to atmosphere, as all condensation is returned to the boiler room at a comparatively high temperature. If vacuum were carried on a turbine unit for power, there would be ample exhaust from auxiliaries to heat the feed water to 200 deg. at least.

Plant No. 2 has a hot-water plant and would require only a 350-kw. machine and the heaters changed to carry a vacuum on the turbine. The coal is not weighed and the boilers are operated below rating under less than 100 lb. steam pressure. Plant No. 3 has a hot-water heating system, 2000-hp. in boilers and a large noncondensing air-compressor plant operated throughout the year. Current is purchased for power and lighting and there is probably a total consumption of four to five million kilowatt-hours per year.

TABLE II. TYPICAL ILLUSTRATION WHERE LARGE SAVINGS ARE POSSIBLE

Plant No. 1		
Steam Heating, 1600 Hp. in Boilers		
Heating fuel as per record, 1915-16, 9,000 tons at $5		$45,000
Power purchased, 3,336,225 kw.-hr. at 0.95c.		31,694
Operating cost		$76,694
Cost changing heating to hot water	$60,000	
Cost generating equipment, 1,000 kw.	75,000	
Int. and dep., at 10 per cent. on	$135,000	$13,500
Power and heating fuel, 7,000 tons at $5		35,000
Attendance and supplies for 6 months		3,000
Gross cost		$51,500
Kw.-hr. recovered 800 × 5,832 = 4,665,600		
Surplus kw.-hr. 4,665,600 — 3,336,225 = 1,329,375 at 0 95c		$12,629
Net operating cost		$38,871
Net saving ($76,694 — $38,871)		**$37,823**
Plant No 2		
Hot-Water Heating, 800 Hp. in Boilers		
Int. and dep. on gen. equipment and heaters (10 per cent. on $21,000)		$2,100
Extra fuel for power over heating, 350 tons at $5.		1,750
Attendance and supplies, 6 months		2,000
		$5,850
Kw.-hr. recovered, 250 × 5,830 = 1,457,500 at 0.95c		$13,846
Net saving ($13,846 — $5,850)		**$7,996**
Plant No. 3		
Hot-Water Heating, 2,000 Hp. in Boilers		
Int. and dep. on gen. equipment (10 per cent. on $75,000)		$7,500
Extra fuel for power over heating, 1,100 tons at $5		5,500
Attendance and supplies, 6 months		3,000
		$16,000
Kw.-hr. recovered 850 × 5,830 = 4,955,500 at 0.95c.		$47,077
Net saving ($47,077 — $16,000)		**$31,077**

In plants Nos. 1 and 3 it would pay the owners to generate their own power independently, but the installation would have to be at least 1500 kw. instead of 1000 kw., with a corresponding expenditure and with little greater saving than would be attained by operating the heating boilers for power in conjunction with the public-service company.

The foregoing outline, if adopted in some form, will make the public-service plant stronger and more profitable and solve the question of unprofitable rates to large consumers who are shirking the responsibility of generating their own power and are actually wasting the community's fuel. The system could be adapted to office buildings having over 500 hp. in boilers by operating a turbine during the heating season to recover the electrical energy from the heating fuel, purchasing all current required above this amount in winter and buying all current during the summer months. This would also help solve the district-heating tangle, due to the high cost of fuel, but with this difficulty—the changing from steam to hot-water heating.

Exhaust Pits for Low-Compression Oil Engines

By L. H. MORRISON

Forms of exhaust pits are described, together with means for preventing accumulations of discharged oil and avoiding damage by explosions.

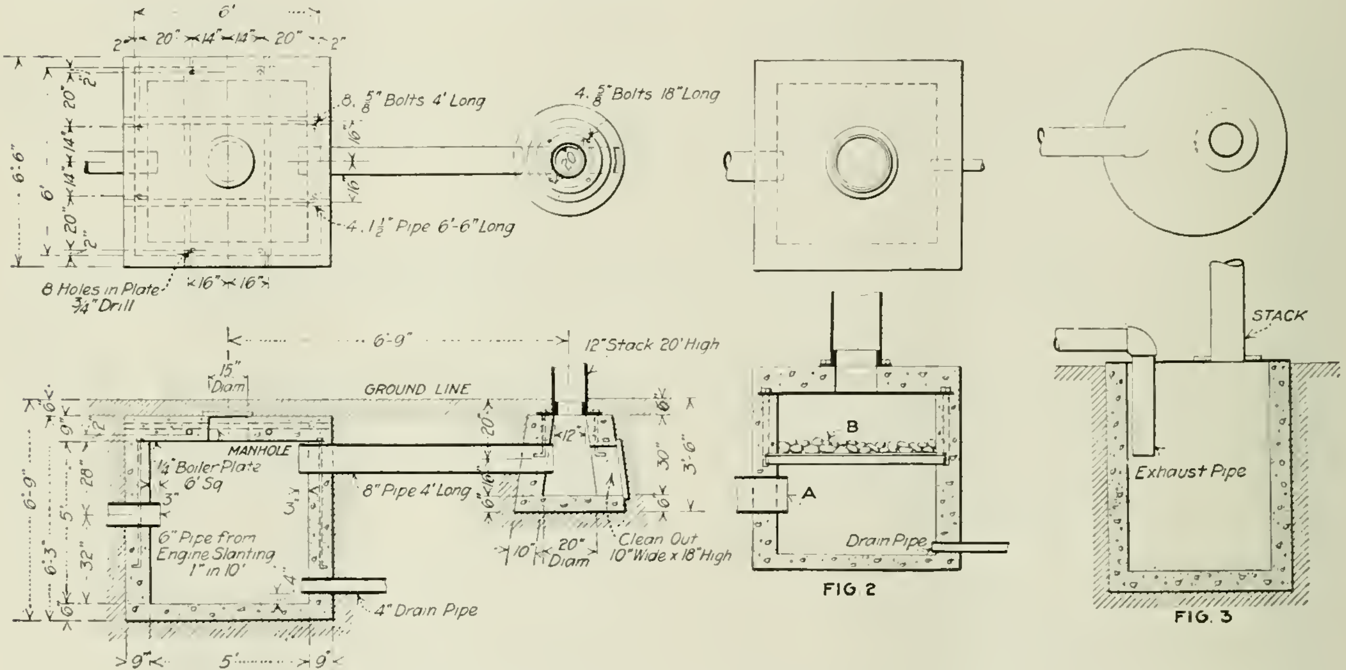
EVERY low-compression oil engine, no matter where it is installed, should be provided with an exhaust pit. It is the practice of some manufacturers to furnish a cast-iron exhaust pot, which is located close to the engine. While this assists in dampening the noise of the exhaust, it does not, by any means, take the place of a pit.

Low-compression engines, regardless of make, display a tendency to allow part of the fuel charge to blow out through the exhaust ports while it is in a liquid condition. This is especially noticeable when an oil having a heavy asphaltum base is used, because the cylinder temperature is not high enough to vaporize the heavier portion of the oil. The same objection frequently is raised against heavy fuel when the engine is operating on low loads. On low loads the temperature of the bulb or hot ignition device falls so low that it is unable to vaporize completely any of the fuel oils ordinarily used. As a consequence, some oil must enter the exhaust pipe. The same condition is often encountered when the governor and the injection nozzle fail to cut off the oil supply at the proper point.

If the discharged oil is trapped in an exhaust pot located close to the engine, it will accumulate until it is set afire. The exhaust is always at a high temperature, and frequently a flame blows through the exhaust ports and ignites this residue. Many fires, some of them serious, have resulted from the use of the exhaust pot or muffler.

To overcome the objection to the pot, a concrete exhaust pit should be constructed outside the building. It is a good plan to place the pit at least five feet from the building wall. Means should be provided for draining away the residue that accumulates in the pit. If the contour of the land permits, the drain should have an open end. If not, it should be run to a smaller pit and a bucket should be placed in this pit below the drain. In this way the residue will collect in the bucket and can be removed.

Fig. 1 shows a form of exhaust pit much used. It is provided with an extra exhaust-stack pit leading from the pit proper. While this is of assistance in deadening the noise, it is a refinement not actually required. Note should be taken of the reinforcement of the concrete. This will resist the ordinary strains to which the walls are subjected. It is necessary to use a manhole, both for access to the pit and for safety in case a violent explosion occurs.



FIGS 1 TO 3. FORMS OF EXHAUST PITS FOR OIL ENGINES

Another good form of pit is shown in Fig. 2. Here the exhaust pipe *A* enters below the layer of rock *B*, which is supported by old rails or iron bars and serves to deaden the sound of the explosions. Such a pit is well-nigh noiseless. It should be provided with a manhole in the side, below the layer of rock. This manhole can be fitted with a thin cover held in place by two small studs, so that, if a heavy explosion should occur, the cover will blow off and prevent damage to the pit.

Frequently a cylindrical exhaust pit like that shown in Fig. 3 is used. This, however, is not of good design, as it does not even deaden the noise of the exhaust. Furthermore, as it has no drain, the residue cannot be removed readily.

The pit should be so located that its top will be a few inches below the ground level. The exhaust pipe should be a size larger than the flange on the engine, in order to provide a free exhaust, and the pipe from the engine should slope down toward the pit, in order to drain well.

The exhaust stack from the pit should be considerably larger than the exhaust piping; for instance, if an exhaust pipe 8 in. in diameter is used, the stack should be at least 12 in. in diameter. Owing to initial cost it is customary to use a sheet-steel stack of from No. 8 to No. 16 gage. Corrosion in the stack is generally severe, and as a consequence the heavy gage is cheapest in the long run.

Large Single-Phase Transformers

Four of the largest single-phase transformers ever built were recently shipped by the Westinghouse Electric and Manufacturing Co. from East Pittsburgh, Penn., to a Southern power company. These units, one of which is shown in Fig. 1, are rated at 14,000 kv.-a. 60 cycles, and since they have a 25 per cent. overload rating, they have practically a 17,500-kv.-a. maximum capacity.

They will form a 42,000-kv.-a. bank, which, together with a spare unit, will make the preliminary installation to step up the voltage of the waterwheel-driven generators from 13,200 to 150,000, the highest transmission voltage used today. Power will be transmitted about 25 miles to an industrial plant, where it will be stepped down by means of a number of 7000-kv.-a. single-phase transformers of similar characteristics, ten of which have recently been built by the Westinghouse company.

Owing to the large size of the 14,000-kv.-a. units and the great amount of generating capacity that will ultimately be concentrated behind them and their need to be able to withstand the effects of momentary short-circuits, the shell type with the special end frames and bracing arrangement shown in Fig. 2 was selected. Structural steel for these parts was used throughout, because the strength of the various members can be depended upon to a much greater degree of certainty than with castings. The top and bottom ends of the coils are held against distortion by two heavy steel plates, each reinforced by four lengths of angle iron riveted to them and held together by four heavy tie-rods.

The tanks are made of heavy boiler plate, all seams being oxyacetylene-welded. A structural-steel base with wheels supports the tank. The high-tension terminals are of the condenser type protected by means of a number of porcelain rain shields to adapt them to outdoor service.

Some idea of the size of these units may be gained from the fact that their height measures 23 ft. 6 in. from the top of the high-tension terminals to the base, and each unit weighs complete with oil and fittings approximately 110,000 pounds.

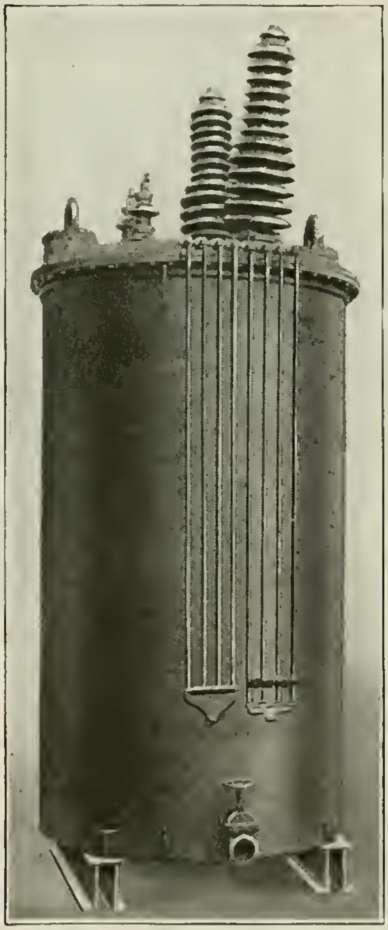


FIG. 1. TRANSFORMER COMPLETE

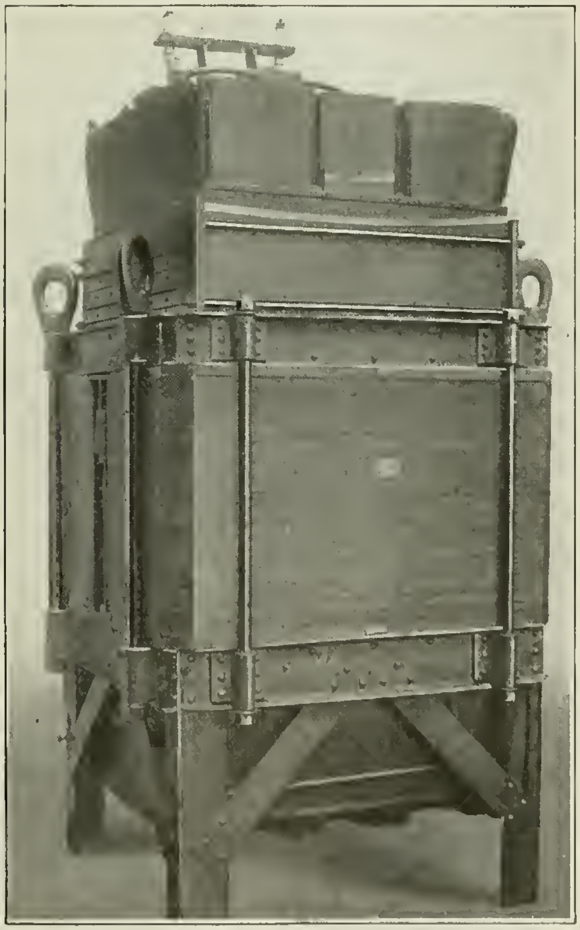


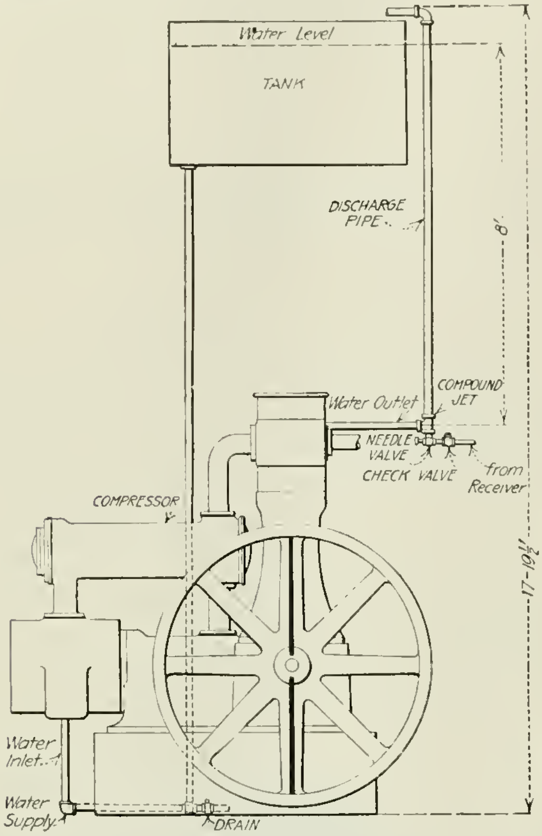
FIG. 2. CORE AND COILS OF TRANSFORMER ASSEMBLED

White Power in Italy

According to P. Lanino, an Italian authority who has recently published four volumes on "La Nuova Italia Industriale" (The New Industrial Italy), Italians in general have cause to be optimistic on the question of the utilization of water power. In 20 years, he points out, about 1,000,000 hp. of water has been harnessed, and it is estimated that from 2,000,000 to 6,000,000 hp. is readily available, while the potential horsepower ranges as high as 20,000,000. Within ten years 300 kilometers (186.5 miles) of railroad have been electrified, and plans have been prepared calling for the electrification of 2000 kilometers (1243 miles) more—one-seventh of the total mileage in Italy.

Air Lift for Compressor-Jacket Water

The accompanying illustration shows how the air-lift system of pumping can be utilized to form a simple and effective method of supplying cooling water to air-compressor cylinder jackets. A small tank is placed about eight feet above the compressor, which gives sufficient height to permit the water to flow by gravity through the jackets. Instead of using a pump for this purpose or for elevating the water to the gravity tank again, a needle valve or, still better, an air-lift mixing tube controlled by means of a pin valve, is placed at the base of the riser, just outside of the water-jacket discharge. This valve is connected by a small pipe with the air receiver, and a small amount of air is thus forced into the riser pipe, acting to carry the water from the cylinder jacket back to the elevated tank.



PIPING OF AIR-LIFT SYSTEM

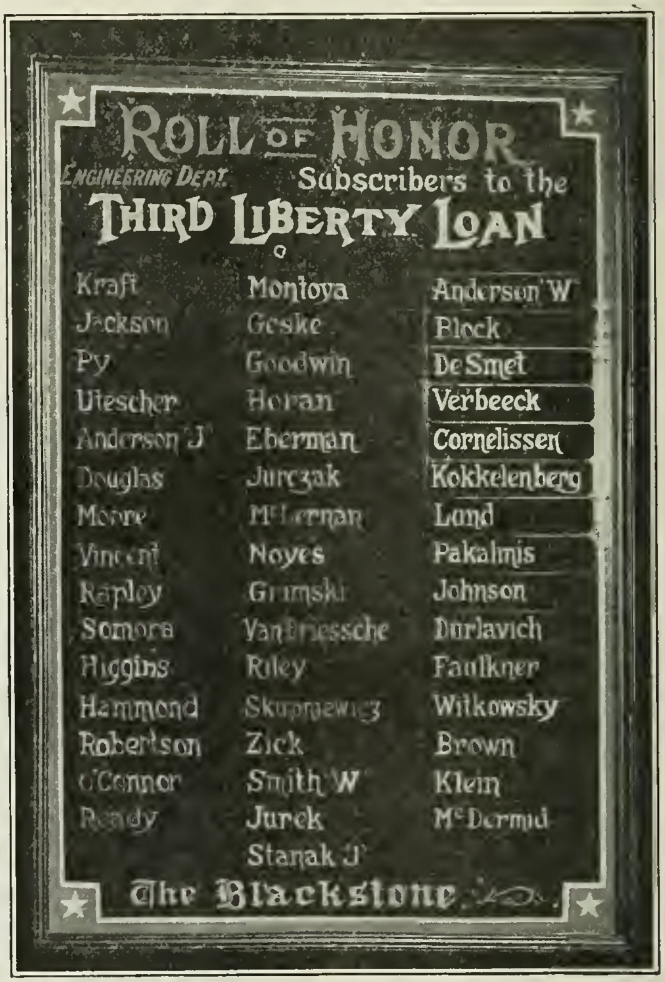
The amount of water required depends, of course, on the size of the compressor. A 10 x 10-in. single-stage machine, having a capacity of 213 cu.ft. per min., would require about 5 gal. per min., and for this a 1-in. pipe would be sufficient.

This plan of automatic cooling water circulation, says *Mine* and *Quarry*, was worked out by George H. Richey, one of the engineers of the Sullivan Machinery Co. at Boston, who has placed it at several installations in New England, as a substitute for a small centrifugal pump driven by an electric motor. Excellent results are obtained, and the heat in the water is reduced to a considerable extent by the expansion of air in the riser or eduction pipe. The sketch shows the system as installed for a two-stage angle-compound compressor. It is, of course, even simpler with a single-stage machine. In the installations referred to, no trouble has arisen, and the system has kept the compressors properly cooled.

Blackstone's Roll of Honor

W. A. Eberman, chief engineer of the Blackstone Hotel, Chicago, has been a patriotic worker in the campaigns for the three Liberty Loans. To further subscriptions among employees of the engineering department of the hotel, he has instituted a Roll of Honor. As soon as a man signs up for a bond his name is entered in gilt letters on the board shown in the accompanying illustration. Its dimensions are about 4 x 6 ft., and it is mounted in the engine room in plain sight of the force. There is a border of red, white and blue; the frame is gilt and the roll is golden literally and in spirit as well, for 48 of the 50 men in the department have subscribed to the Third Loan and the other two have agreed to invest a definite sum in Thrift Stamps. The efficiency is 100 per cent.

In looking over the names there is a cosmopolitan variety of nationalities represented: German, Bohemian, Austrian, Belgian, Swedish, Russian, English, Irish and Scotch. All have shown their patriotism. Not one has failed to subscribe. It is a gratifying example of what can be done and is a leading suggestion to other large plants.



ROLL OF HONOR
ENGINEERING DEPT.
Subscribers to the
THIRD LIBERTY LOAN

Kraft
Jackson
Py
Utescher
Anderson J
Douglas
Moore
Vincent
Rapley
Somora
Higgins
Hammond
Robertson
O'Connor
Ready

Montoya
Geske
Goodwin
Horan
Eberman
Jurczak
McLernan
Noyes
Grimski
VanDriessche
Riley
Skupniewicz
Zick
Smith W
Jurek
Stanak J

Anderson W
Block
DeSmet
Verbeeck
Cornelissen
Kokkelenberg
Lund
Pakalmis
Johnson
Durlavich
Faulkner
Witkowsky
Brown
Klein
McDermid

The Blackstone

At times nails and pegs are found extending from walls at face level to hold tools and clothing. Such projections make dangerous hazards when not in use, and they should be removed. Clothing should be hung in lockers, and firing tools should preferably be kept in racks.

Editorials

The Ultimate B.t.u.

THE central-station folks have been raising a considerable hullabaloo of late—to be particular, since the Fuel Administration has begun to ferret out the places where coal is going to waste—about the terrible inefficiency of the isolated plant in the generation of power. In the same breath they have been making considerable fuss over the wonderful efficiency of the central station as a power producer.

The point at issue between the two types of plants, so far as the Fuel Administration is concerned, is simply one of coal conservation, which may be expressed in another way as making a pound of fuel go just as far as possible in producing useful effects. Under this broader interpretation of the problem, the isolated plant has a strong case against its powerful opponent.

Observe what happens to a pound of coal in the central station. It goes majestically to the furnace on a chain-grate chariot, flares up in one swift burst of incandescence, and gives all its latent energy to a swirl of gases that sweep the boiler, caress the tubes of the superheater and are whisked away through the economizer to the chimney, while from the boiler flows that aristocrat of heat mediums—superheated steam.

The steam—thermal offspring of that pound of black, prosaic coal—rushes lightly through the main, enters the turbine, flirts daintily with the flying blades, and leaves, with its energy only slightly diminished, to give up all its remaining heat to the condensing water; and that condensing water, carrying with it about eight-tenths of the heat liberated from the stodgy pound of coal, goes merrily seaward to warm the fishes, who don't need warming and are totally ungrateful for the favor so graciously bestowed.

By contrast, see what happens in the isolated plant. The pound of coal is heaved unceremoniously through the fire-door by a member of the strong-arm squad, breathes its last on an old-fashioned herringbone grate, and passes its heat into a boiler that produces a slug of plain, ordinary wet saturated steam—the common garden variety discovered by Watt some decades ago.

That slug of steam eventually finds its way into the cylinder of an old-fashioned reciprocating engine, where it churns to and fro, spends a small fraction of its energy in generating power, and escapes clumsily and soddenly into the exhaust pipe, still holding in its keeping about nine-tenths of the heat it received from the pound of coal.

But no condenser yawns invitingly to receive it. That little trip through the engine was mere play. The real work is about to begin. A houseful of radiators waits to claim some of that exhaust steam for heating; some of it goes to a hotel kitchen to aid in cooking; some of it goes to a laundry, where it helps to heat water and dry clothes; a part of it enters the generator of an absorption plant and furnishes refrigeration for cooling and ice-making; and after all these varied interests are served, if there is anything left of that slug of wet steam—which there usually isn't—it escapes through an exhaust stack, a mere ghostly wraith, scarcely visible to the naked eye. Meanwhile, the steam that has done this work is a collection of streams of hot water that are collected, drained into a trap, and sent back to the boiler, carrying with them the last B.t.u. that can be reclaimed.

When it comes to utilizing the last heat unit in a pound of coal, the isolated plant for combined lighting and heating need not take off its chimney cap to any central station.

Launch a Blow in Defense of Liberty

ALL newspaper readers are familiar with the reports from Washington which interpret the weather map. We read, for example, that an area of high pressure is static over the Middle Atlantic States, or we learn that a "disturbance," originating in the far Southwest and centering for the moment over northern Texas, is moving rapidly northeastward and within forty-eight or sixty hours should bring us a violent and sustained storm.

From the German point of view our Liberty Loan campaign is just such a "disturbance," collecting the elements of its future fury thousands of miles away. Through the mysterious channels by which their arrogant leaders are kept informed of the activities of this land, the Germans learn of the gathering storm, and they watch its development with an anxious intensity second only to their keenness for word of the tide of battle in France. They know that as fast as these Liberty Bonds are converted into guns and munitions and put into the hands of American soldiers, the "disturbance" will move upon them with the inexorable force of a cyclone traversing a continent. And they know also that when it arrives it will beat against them, uprooting and sweeping away their defenses, with just that degree of violence which is imparted to it in the beginning by the will of its originators.

That is to say, it is the initial impulse which places limits to the force of any drive, and in the case of such an offensive as that just described the initial impulse comes from the patriotic hearts and pocketbooks of one hundred million Americans. If they respond to the challenge, each to the limit of his ability, eagerly, passionately, completely, the Germans will know that they are in for a cyclone such as only America can breed.

There is not an American among us who can afford to stand by and watch the launching of this tremendous blow for liberty without contributing to it his full share of patriotic frenzy expressed in cold cash. The money will come back increased with a bountiful interest, but that is not the main point for the investor; this lies in the opportunity it will give him to get in his particular jab against the barbaric enemy which, with all the vicious ferocity of desperation, is seeking to trample under foot our boys "over there," our Allies' boys, our Allies' fair lands and homes and liberties and, beyond them, our own. There isn't a man with a single minim of American blood in his veins today who wouldn't give his all to check the freshet of Boches on the western front. Here is his opportunity. Let him join the storm that sooner or later will set that appalling flood rushing the other way. Specifically, let him invest as much of his money in bonds of the Third Liberty Loan as he can spare from the necessary daily expenses of his existence.

Combustion and Furnace Design

WHAT is perhaps the most valuable bulletin on the subject of combustion and its influence upon the design of furnaces has been issued recently by the Bureau of Mines. A full review, together with remarks on this bulletin, appears elsewhere in this issue. Experience has taught that high boiler settings with great furnace volume have greatly improved combustion, but it is safe to say that most of us have not known fully the reasons why. We have known that stoker-fired furnaces of large volume have given far better mixtures of the air for combustion and the combustible gases than is obtained in the ordinary hand-fired setting. The bulletin corroborates experience which tends to show that, although engineers have carried the ordinary water-tube boiler settings to a height of twelve feet from the bottom of the front tube headers to the floor line, even this height, great as it is compared with practice of a few years ago, is not sufficient with ordinary settings to insure the most desirable conditions for commercially perfect combustion. It is interesting to note that the investigations of the authors of the bulletin show that there is a definite relation for each coal between the excess of air supply and CO_2.

The percentage of excess air that gives the best results in any steam-generating apparatus varies with the size of the furnace and the kind of fuel. In two furnaces burning the same fuel but having different sizes of combustion space, the one with the smaller space may receive more excess air for the best results than the one with the larger combustion space. Also, of two furnaces exactly alike in size but burning different coals, the one burning coal lower in volatile matter and oxygen gives better results with lower excess of air than is necessary for the best results in a furnace burning the coal higher in volatile matter and oxygen. This explains why in one plant the highest efficiency may be obtained with fourteen per cent. of CO_2 in the gases, and in another plant with only ten per cent. of CO_2. In other words, the investigation brings us much nearer to a general understanding of the reasons why the statement which claims that efficiency is always highest with the higher CO_2 may be questioned when applied to the usual boiler setting. It is likely true that if one could design a furnace to give a thorough mixture of the air for combustion and the combustible gases, maximum furnace efficiency would occur when the CO_2 was at a maximum; but in the usual boiler furnace we must depend in great measure upon an excess of air to obtain the best mixture of air and combustible gases under the local conditions. We direct particular attention to the pages of the bulletin which deal with the subject of soot formation. The authors point out that soot is formed at the surface of the fuel bed by heating the hydrocarbons distilled off from the volatile in the coal in the absence of air; it is not formed by the hydrocarbon gases striking the cooler surfaces of the boiler. It is pointed out that only a very small trace of the hydrocarbon gases ever reaches the surface of the boiler. In other words, the cooling surfaces do not cause or promote the formation of soot, but they merely act as collectors of it.

Pages 134 to 137, the last in the bulletin, are especially interesting. In these pages the authors point out that the volatile matter in soft coal may be distilled off and converted into liquid fuel for motor purposes, in which form it has a value from twenty to thirty times as great as that in the form of coal. As the supply of bituminous coal is enormous, the uses of the oil are practically unlimited and the margin of profit in the conversion is large. It would seem that the development of highly productive methods would be rapid. By itself the coke residue from such reduction plants would have considerable commercial value, and if its price were made equivalent to coal, it would doubtless find a wide market for house heating and steaming purposes. The authors say that vague reports from Europe indicate that after the war the world will be informed of some extraordinary developments in the utilization of bituminous coals in certain countries, and that these developments will be of pressing importance to American manufacturers. One notices that two or three different companies have been formed recently for the purpose of distilling the highly volatile matter out of bituminous coal, using the residue for steaming purposes, while the distillates are to be used for chemical and motor fuel purposes. *Power* has, from time to time, pointed out that some day it would be the chemist who would reveal to the public the wasteful manner in which the engineer uses coal by giving the people a truer conception of the intrinsic value of bituminous coal. This seems to be the beginning.

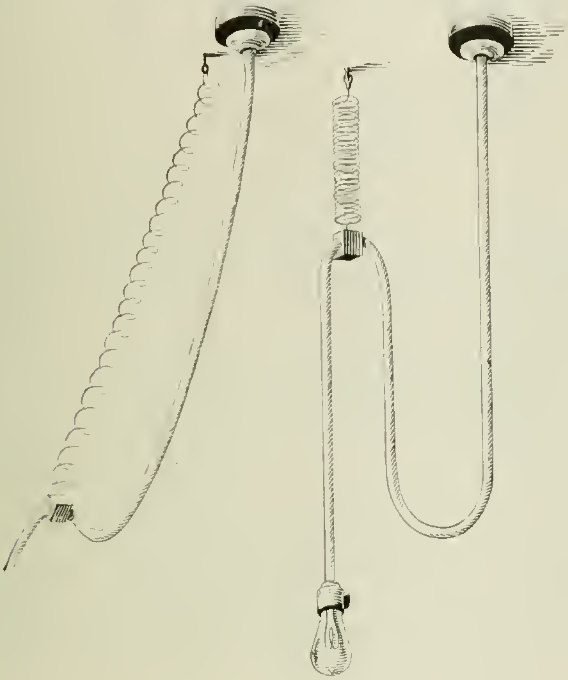
There is no doubt that the Fuel Administration's zone system for the distribution of bituminous coal will effect considerable saving in transportation and will, if entered into in the right spirit by the mine owners, dealers and the people, help to avoid such deplorable shortages as occurred last winter. That the country as a whole may be benefited some consumers must be inconvenienced. Many plants in Illinois, for example, long accustomed to the West Virginia low-ash, low-volatile coal, must now use the high-ash, high-volatile coals of Illinois. Consumers in Iowa, Kansas, Missouri and Nebraska, particularly, can no longer get the West Virginia coals, but must use the coals produced in their own districts. The whole Middle West and Northwest is thus affected. For these people many new combustion problems will arise. *Power* hopes soon to begin the publication of articles written especially to help these consumers solve such problems.

The engineering world is still waiting for the report of the committee of scientists who were to determine whether the Garabed should receive a laurel crown or merely a casket bouquet.

Correspondence

Handy Extension Lamp Cord

The illustration shows a drop-light arrangement that I have found very convenient for use in places where a light is needed for inspecting the interior of ice tanks and the like, and that at other times is available for general illumination. It consists of a spring taken from a shade roller fastened to a drop-light cord, which should be of suitable length so that the light will be lifted out of the way when not in use within the tank.



SPRING SUPPORT OR HOLDER FOR DROP LIGHT

St. Louis, Mo. **Arnold James.**

Fatal Explosion of Home-Made Boiler

In the local morning paper several days ago I saw in large headlines, "Boiler Explodes, Frozen, Kills One Man." Anxious to learn the details of the case, I went, in company with another inspector, to the scene of the accident. How the writer of the article knew that the boiler was frozen still puzzles me, for we could not obtain enough information from our investigation to arrive at such a conclusion, as not a particle of the boiler proper could be found. The fire-door frame was found about a block away, and there was no one about the plant at the time of the accident except one young man who, unfortunately, was instantly killed.

A boy about 16 told us he had seen the boiler installed, and upon questioning him regarding its design, he said that they had taken an ordinary kitchen hot-water tank suspended it with iron bars, built a furnace of rock under it and used it to produce steam to sterilize milk cans and for other cleaning about the dairy. As to whether there was a steam gage, water column or safety valve, no one knew, but I doubt it. Judging from the damage done, there was a tremendous pressure on the boiler at the time of the explosion. The building was completely wrecked, and rock from the setting was scattered over a radius of five hundred yards; and one of the fireman's feet was found two hundred yards from the plant and in almost the opposite direction from that in which the body was hurled.

This boiler was within the city limits and should have been inspected by the city inspector. It is stated on good authority that it had been in service for several years, but the city had no record whatever of it or it probably would have been eliminated. It appears to me that the life of this promising, able-bodied young man was lost because the people of the State of Washington have not seen to it that laws under which steam boilers must be properly designed and operated are enacted and enforced.

By far too many of us say nothing until after such an accident and then jump at the conclusion that the boiler was frozen or that the fireman was to blame for various reasons.

I have inspected boilers in eight states, some of them having no boiler laws, and the probability, in my opinion, is that more lives will be lost if all states do not promptly wake up to the fact that there should be standard boiler designs, compulsory inspection and licensing of engineers and firemen. **R. S. Hart.**

Spokane, Wash.

Alternating Current Cannot Cause Corrosion

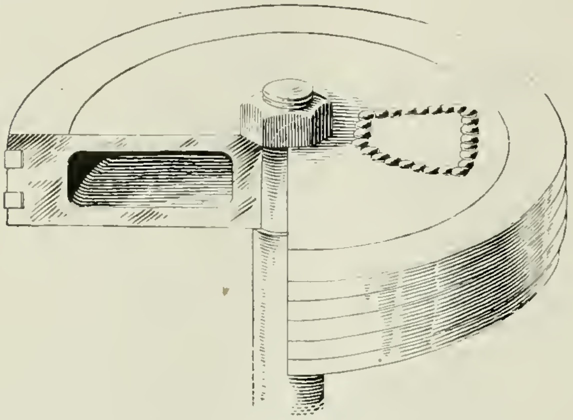
The only effect of eddy currents that would cause the water-pipe joint to corrode as mentioned in the article "Lighting Circuit Caused Water-Pipe Joint to Corrode," in *Power*, Feb. 5, would be of a thermal nature. Such effects require that a large current be induced in the pipe, which in turn requires that the inducing circuit have considerable ampere turns and high frequency. This is true since the induced currents are proportional to the induced potential and the pipe resistance, the former being dependent on the flux changes.

The small amount of energy involved in a lighting circuit would at once eliminate it as a cause of corrosion. It is highly probable that stray direct current from a railway is entering the building through the water line and that the trouble is due to a high resistance joint at the point of corrosion. If electrolytic action is due to an electric current, then it must be direct current since an alternating current will not cause such action. (See Bureau of Standards "Technologic Paper" No. 72.) **H. E. Weightman.**

Chicago, Ill.

Broken Cast Piston Repaired

The piston of a large vertical engine had a hole "punched" in it when the "keeper" key, holding the nut in place on the rod broke and got over into the clearance space. The engine was urgently needed and had to be repaired as quickly as possible. Welding would necessitate heating the entire piston to some extent and might distort it. It was therefore decided to "sew" the piece back in. We drilled and tapped holes along the crack and put in ½-in. cap bolts and sawed the heads off. One bolt overlapped the other so that they could not unscrew and work out. The job was completed in a short time and was entirely satisfactory. **George H. Diman.**


HOW A BROKEN PISTON WAS REPAIRED

Lawrence, Mass.

Static Electricity from Gasoline

In the issue of Jan. 22, page 130, D. R. Gibbs states that gasoline flowing from a spigot into an ungrounded can will produce sufficient static electricity to ignite itself. This will also occur if the liquid used under the same conditions is benzine or naphtha.

In the manufacture of paints and the grinding of pigments, where the solvent or vehicle is naphtha, gasoline or turpentine, the ignition of the liquid is liable to occur, especially with high-speed apparatus, and I have known fires to be caused by an operator touching the metal tank sides with a steel scraping knife. Grounding the apparatus is not always a preventive for if the tank be of considerable size its entire area may become charged and act as a storage of low potential, and there may not be sufficient difference of potential between it and the earth to cause discharge. Grounding is, as a rule, satisfactory in conducting to earth a static discharge where a considerable difference of potential exists; as, for example, in a fast-traveling belt.

In theory the earth is regarded as at zero potential, but in practice it is claimed that with a difference of less than 4000 volts potential grounding static discharges is ineffective, and other means are resorted to, as follows: Humidification will so dissipate the static charges that they will not build up sufficiently to produce sparks hot enough to raise even inflammable gases to the ignition point. Humidification may be produced by a steam jet, or in the absence of steam, water sprinkled around will produce enough moisture to secure relief. If humidification is objectionable, and it is in many of the processes of manufacture, circulating currents of air, preferably hot, will be found advantageous.

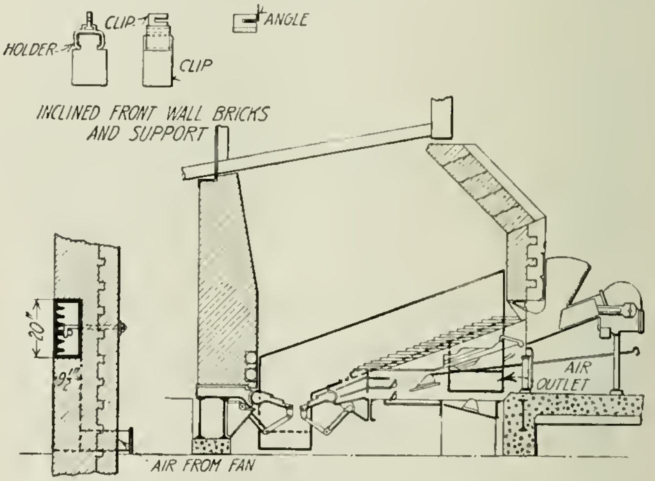
In printing-press work and where heavy, fast-moving machinery is employed, it is sometimes necessary to install a static neutralizer. This is a device that produces an alternating-current field, therefore having both positive and negative impulses. A static charge of positive sign is thereby neutralized by an impulse of opposite sign as generated by the neutralizer, consequently a static charge of negative sign is neutralized by one of positive value. This device is on the market and is used by many industries. **Mathew King.**

Passaic, N. J.

Ventilating the Side Wall Was Unsuccessful

One of the principal sources of annoyance to all stoker operators is the tendency of the clinker to stick to the side walls, which cuts down the available grate area and causes injury to the bricks when cleaning the fires.

The method illustrated was tried in conjunction with the Westinghouse stoker under a 250-hp. B. & W. type boiler, the setting being arranged as shown in the illustration. The total air for combustion was brought in from the outside of the setting underneath the boiler-room floor and conducted up along the side walls in the box as shown and finally discharged underneath the stoker. The three sides of this box were made in one casting, while the cover was made in three sections. To increase the heat-absorbing surface of the cover it was constructed as shown. The covers on the box were made of a good grade of cast iron.



HOW THE SIDE WALLS WERE COOLED

When this method was applied and the boiler put in operation, trouble was discovered almost immediately with the cover plates burning through. Increasing the velocity of air through the boxes did not remove this difficulty, and finally the whole plan was abandoned.

The method of supporting the brick in the inclined front wall is also shown. This method was satisfactory.

Pittsburgh, Penn. **L. B. Breed Love.**

Material for Dump-Plate Bearing Bar

I have noticed, in articles in recent issues of *Power*, several references to the operation of inclined underfeed stokers. One thing essential to the successful operation of these stokers, or in fact any of the ram-type stokers, is the removal of the clinker that forms on the side wall of the furnaces.

Some of the coal shipped these days contains a high percentage of ash and clinker-forming material which accumulates on the side walls of the furnace. This formation is sometimes so hard that it is necessary to let out the fires and to cut the clinker loose with pickaxes and bars. If it is allowed to accumulate, great strain is thrown on the ram-feeding mechanism, causing breaks and compelling frequent repairs.

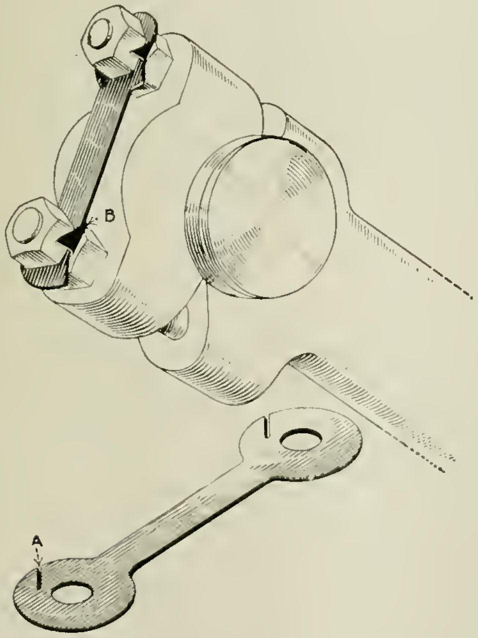
The bearing bar under the dumping grates, which supports the grate sections, is regularly supplied in $\frac{3}{4}$ x $2\frac{1}{2}$-in. wrought iron, which sometimes bends under the heat coming from the recently dumped ashes. I have been using sleigh-shoe steel for making these bars, as it is slightly higher in carbon than the stock bars, making it stiffer under heat.

I think these bars should be made of cast iron about $1\frac{1}{8}$ in. thick and 6 or 7 in. wide with holes properly spaced cast in for the cotter pins which hold each grate bar. It also pays to watch the hand-operated shaking extension grates to see that no ashes or clinkers get under them to make them unhook the supporting shaft and burn the ends in the fire. H. G. **Burrill.**

Herkimer, N. Y.

Nut-Lock Plate

There are many ways to lock or secure nuts against slacking back, and the "lock plate" shown in the illustration is submitted, adding to the collection. The slot at *A* should be cut to within one-fourth inch of the bolt hole, and when the plate is on and the nuts up solid, the ear or tab is bent up, as shown at *B*, with a blunt chisel and a hammer. C. H. **Willey.**

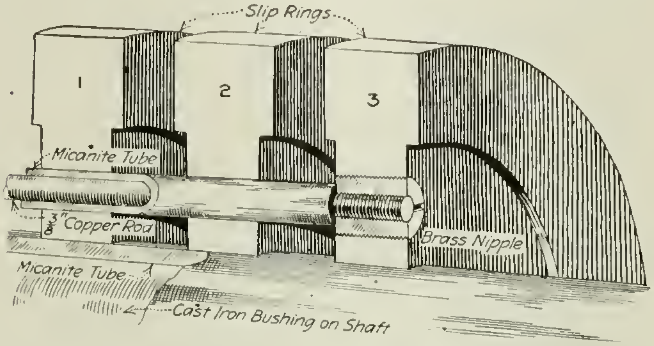


SPECIAL PLATE TO SECURE NUTS

Concord, N. H.

Slip-Ring Insulation Repair

The micanite insulating tube around one of the conductors to the outer slip, or collector, ring on one of our 250-kw. Westinghouse rotary converters in a traction substation broke down under the edge of the middle slip ring, resulting in a dead short-circuit across the two rings. The rings and conductors were not damaged much as the high-tension oil switch had only a small time lag, but the insulating tube was practically destroyed.



INSULATION ON CONDUCTOR TO SLIP RING RENEWED

To remove the rings and replace the insulating tube is a big job as the cast-iron bush with all three slip rings and the conductors are assembled together before being placed on the shaft; besides, outside of the bearing on this machine there is a small rotor and slip rings for the synchronous booster which forms part of the combined set. It looked as if there was no other way but to send the armature back to the makers for repair, but this would have been a difficult job in any event and unusually so in this case since the machine is installed under a gallery with very little headroom. Besides, conditions due to the war make the smallest repair take six months or more to get through the shops, so we decided to undertake the job ourselves.

The copper conductors, four to each ring, are screwed tightly from the inside into their respective rings, and there is just room enough to screw them out clear of the ring before they foul the armature spider. As the insulation in the rings 1 and 2 and around all four conductors to the outer ring (3) was badly charred, they were screwed out and the holes in ring 3 were enlarged by means of an adjustable reamer until the regular insulating tube would just pass through and into rings 2 and 1. The holes in 3 were then tapped out with a taper pipe tap that happened to be the right size, four brass nipples were turned, threaded and screwed in and the inside bore was a good fit on their respective rods. New lengths of insulating tube were then cut and placed in position and the rods and nipples screwed tightly home. The whole connection was as solid as when new. No special tools were made for the job except a piece of flat steel cut to fit the slots cut in the nipples, across the outer end, by means of which they were screwed in, as an ordinary screwdriver was too narrow.

The job was finished and the machine on the line again the next day at noon, being out of commission 27 hours—and the repair shop was two miles away from the substation at that. D. S. **Regan.**

Yorkshire, England.

An Electrical Phenomenon

I have read with much interest the article by H. S. Whiteley, "An Electrical Phenomenon," published in *Power*, Feb. 12. Similar phenomena may frequently happen, but it is not so often that they are observed, and it is very seldom they are reported and described.

The electrical effect observed was a discharge of blue sparks of static electricity produced by the friction of dry steam slightly superheated, passing through cold dry air at a high velocity, this discharge taking place where the expansion of steam was visible. Considering these phenomena from the viewpoint of the electron theory, which ascribes an atomic structure to all electrical charges, may be of interest.

When a very fine spray of water is directed on the plate of an electroscope, the leaves diverge, showing that the plate is electrified by the spray. The charge on the plate is positive and the air around the spray negatively electrified. In fact, whenever there is a splashing of water, electrification results, the two kinds of electricity being separated. Such electrical conditions can exist, for instance, at the foot of a waterfall, and it can be shown that the water is positively electrified and the air negatively. However, the kind of water and certain impurities it may contain have a decided influence upon the amount of electrification produced. It has been shown that when a drop of water is broken up into a spray while suspended in the air, the water becomes positively electrified and the surrounding air negatively. Hence, any process by which drops of water are broken up into a spray, whether by clashing against one another or in other ways, constitutes a potential source of electricity, and as soon as the strength of the field is large enough, a discharge takes place.

A few words regarding the separation of the electricities, namely, the positive electrification of the water and the negative electrification of the air:

A water molecule consists of a nucleus around which electrons are rotating. There is only one kind of electron, and this has a mass of $\frac{1}{1800}$ that of a hydrogen atom and carries a constant charge of negative electricity. The water nucleus, on the other hand, is positively charged. The two charges are equal in magnitude but opposite in sign, so that a water molecule is electrically neutral. To charge a water molecule positively means, therefore, that one of the electrons which it contains is taken out of it.

Now, when water or vapor molecules collide with the molecules of the air, electrons are pushed away from the water molecules, which by loosing electrons keep only their positive charge; namely, the charge of their nucleus. A detached electron, on the other hand, unites with a molecule of the air and then revolves about this air molecule. But when such an air molecule, which has taken on another electron, comes into contact with or near to a water molecule that has lost an electron, the formerly detached electron goes back to the water nucleus, thus establishing electrical neutrality. It is just this establishing of the electrical neutrality that we see in the form of a spark or a silent electric discharge.

A molecule that has lost or gained an electron is called an ion. A gaseous ion, in our case a water-vapor ion and an air ion, has the power of attraction through which a number of molecules that are not in the ionic state are collected around an ionic or electronic center. This fact corresponds to the observation of Mr. Whiteley that the discharge took place where the expansion of steam was visible.

By velocity measurements it has been shown that the ions in air at atmospheric pressure consist of single charges (electrons) associated with about 20 to 30 molecules of oxygen or nitrogen.

Discussion of Turbine Wreck

Allow me to comment on the wreck of the 35,000-kw. turbine of the Boston Elevated Ry., an account of which appeared in the issue of Mar. 19, page 390. At the outset let me give due and generous credit to the maker and his engineers for the prompt and frank publication of some of the details. It is just ten years ago that a 10,000-kv.-a. waterwheel generator, designed by the writer, who was then chief engineer of the electrical department of Allis-Chalmers Co., was destroyed during an overspeed test at Niagara Falls. The experience served as a most remarkable object lesson, with the result that no accident of a similar nature has occurred during the last ten years on machines with which he has had anything to do. This justifies an optimistic view in regard to the future of single-cylinder turbines of the impulse type, if the lessons from this accident are properly utilized.

The editorial remarks are judicious and fair. The disks are not the weak element. A disk construction for the largest types of turbo-generators has been developed that has marked an important advance in electric-generator design. The weakness lies in the method of holding the blades and in the distortion of the diaphragm. The use of cast steel would diminish distortion, but rotation of the diaphragm due to seizing on the shaft must be forestalled, as no material at these high speeds could resist the stresses in a disk shaped as the diaphragm is. This leads to the consideration of the advisability of greater clearance with this type of construction.

Power has rendered a public service by the publication of this accident; let us hope that this policy of frankness will find imitation in other quarters.

B. A. Behrend.

Boston, Mass.

Tamarack Mills Power Plant

I have read with much interest the article in the Mar. 26 issue of *Power* on the Tamarack Mills power plant, and would like to call attention to an error which I think should be corrected. It is stated that "the management got a price of 92c. per barrel of 42 gal. of oil delivered." This is not correct, the price actually being $1.15 per barrel delivered.

The price you give is near that which this company is paying on their fuel-oil contract for the Jenckes Spinning Co. mill, which contract was made in 1915, and it is worthy of note that after operating with oil for a year and a half, they were willing to pay over 20 per cent. more for their oil on the new contract.

New York City. Frederic Ewing,
Engineer, Mexican Petroleum Corp.

Inquiries of General Interest

Small Bypass Around Main Stop Valve—How can water-hammer shocks be prevented in a 6-in. steam line when the stop valve is opened very slowly and the line is drained at the discharge end through a 1¼-in. drip connection? T. P.

The line should be warmed up by means of a small bypass to control admission of steam more gradually. This will also permit of easier and safer opening of the main valve by equalizing pressure on its opposite sides.

Effect of Rocker Out of Plumb—If the rocker-arm of a Corliss valve gear oscillates ¾ in. more to one side than the other of a vertical position, what effect would it have on the operation of the steam valves? J. L.

With a rocker-arm and connections of usual length, the difference of oscillation would make no appreciable difference in adjustment or operation of the valves, provided the oscillation of the wristplate was the same on each side of the center.

Blistering of Boiler Shell—What causes blistering of a boiler shell? W. R. B.

Blistering is separation and puffing out of layers of the material that have not been thoroughly welded in the process of manufacture. When the shell is heated or cooled, the different rate of expansion or contraction causes the layers to separate. When blistering is confined to a very thin surface skin, its effect on the strength of the plate may be unimportant, but if the scaling-off process continues after the outside skin has been removed, it is an indication of defective structure of the material that may seriously impair the safety of the boiler.

Required Size of Steam Header—What should be the size of a main steam header where the sizes of pipes from five boilers are respectively 4, 5, 6, 6 and 8 in.? B. F. S.

Ordinarily, the size would be taken of an area equal to the sum of the areas of the feeders or the size of header would be

$$\sqrt{4^2 + 5^2 + (2 \times 6^2) + 8^2} = 13.3$$

or, nominally, a 14-in. pipe would be used. But for the same pressure the flow of steam in pipes of different diameters is as the square root of the fifth power of the diameters and, calling the required diameter d,

$$\sqrt{d^5} = \sqrt{4^5} + \sqrt{5^5} + 2\sqrt{6^5} + \sqrt{8^5} \text{ or } d =$$
$$\sqrt[2.5]{4^{2.5} + 5^{2.5} + (2 \times 6^{2.5}) + 8^{2.5}} = 11.47 \textit{ in. diameter}$$

and a header of 12-in. pipe would answer.

Valve Travel Unaffected by Diameter of Eccentric—Will the valve travel of a slide-valve engine be affected by reducing or enlarging the diameter of the eccentric? J. B.

It would not, because the eccentric is the exact equivalent of a common crank arm in which the crankpin is sufficiently enlarged to include the shaft, so it may be placed anywhere along the shaft. The valve travel depends on the length of the arm or the distance from the center of the shaft to the center of the eccentric, commonly called its eccentricity; and just as the length of stroke with a crank is independent of the diameter of the crankpin, the length of valve travel is independent of the diameter of the eccentric.

Kilovolt-Amperes and Kilowatts—What is the difference between kilovolt-amperes (kv.-a.) and kilowatts (kw.)? W. C. L.

Alternating-current machinery and systems, excepting induction-motors, are usually rated in kilovolt-amperes (kv.-a.) and not kilowatts (kw.). In a single-phase system kv.-a. = volts × amperes ÷ 1000; in a two-phase system kv.-a. = volts × amperes × 2 ÷ 1000; and in a three-phase system kv.-a. = volts × amperes × 1.732 ÷ 1000. In all cases, kw. = kv.-a. × power factor. Kilovolt = amperes is frequently termed the apparent power, and kilowatts is called the true power, or load on an alternating-current machine or circuit. The term kilovolt-ampere is never used in reference to the rating of direct-current systems.

Wetting Down Fine Coal—In hand-firing is there advantage or disadvantage in wetting down fine sizes of bituminous coal? C. R

Wetting down makes cleaner handling, permits of better spreading and is accompanied by much less annoyance from back draft, and less combustible material is carried over by the draft into the combustion chamber. The tendency of fine coal to pack in the furnace is overcome by wetting the coal; as the steam thus generated opens the mass, the coal is burned more uniformly and more completely and with fewer cracks and large holes in the fire. The principal disadvantage is that the water used for wetting down the fuel requires heat for its evaporation into steam which is discharged to the chimney as superheated steam at atmospheric pressure; but with good spreading of the moistened fine fuel this loss will generally be more than offset by the requirement of less excess air to burn the coal on account of the more uniform distribution of draft passages through the fuel bed.

Density and Volume of Steam—What is the meaning of the density and volume of steam? A. H.

The density of a body is its mass per unit of volume, and the customary unit is pounds per cubic foot. The density of steam, therefore, is its weight in pounds per cubic foot. The density of steam or weight per cubic foot varies with the pressure. Thus, as shown by tables of properties of steam, the density of dry saturated steam at 0 gage or atmospheric pressure (taken at 14.7 lb. per sq.in. absolute) is 0.3732 lb., at 50 lb. gage (or about 65 lb. absolute) it is 0.1503 lb., and at 100 lb. gage (or about 115 lb. absolute) it is 0.2577 lb. per cu.ft. The specific volume is the number of cubic feet per pound. Therefore the specific volume is the reciprocal of the density. Thus if the weight of 1 cu.ft. of steam at 100 lb. gage is 0.2577 lb., then the volume, or space occupied by a pound, is $\frac{1}{0.2577} = 3.88$ cu.ft. per lb. Steam tables generally give both specific volume and density for different pressures.

Induction-Motor Winding Connections—Why is the secondary winding of a wound-rotor induction motor generally connected in star instead of delta? R. A.

What is true of the rotor winding may also be applied to the stator winding. Where possible both windings are connected in star. The reason for this is, that with a given weight of copper in the winding the star-connected winding is 173 per cent. as effective as the delta-connected winding. Expressing this another way, the star-connected machine requires only 58 per cent. of the copper of a delta-connected machine of the same type and capacity. The voltage generated in the secondary winding when star connected will be 1.73 times as great as that generated in the same winding when delta-connected, and the current will be in inverse proportion to the voltage. This lower current for the star connection will generally simplify the design of the controller. There are also other factors in favor of the star-connected winding such as, the coil requires a smaller number of turns, less time to place the winding on the core and the winding can be more easily insulated.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Combustion of Coal and Design of Furnaces

A review of Bureau of Mines Bulletin No. 135, which deals with the combustion of coal and the influence of furnace design upon combustion. The bulletin is one of a number issued by the Bureau and dealing with the economical utilization of the nation's fuel resources. The tests with which the bulletin deals were made in a Murphy stoker furnace of special design, at the end of which was a Heine boiler. The fuels used were Pocahontas, Pittsburgh and Illinois coal. Exceedingly interesting data relative to the combustion space or volume required for the different coals and different rates of combustion are given. Different furnaces and different fuels require different percentages of excess air to give the best results; some furnaces and some fuels may give the best results with high percentages of CO_2, whereas others may have to operate with a comparative low CO_2 content.

ABOUT a year ago, the Bureau of Mines issued a technical paper of considerable importance under the title, "Combustion in the Fuel Bed of Hand-Fired Furnaces." This was practically a virgin field, inasmuch as little or no experiments or investigations of the behavior of gases in the fuel bed of a furnace had been made. The astonishing fact revealed was that the CO_2 reached its maximum at about 4 in. above the grate in a 6-in. fuel bed, the fuel bed being presumably free of ash. All the free oxygen in the air admitted under the grate was shown to be consumed in the 6-in. fuel bed 4 in. above the grate, or 2 in. below the surface of the fuel bed. This paper was fully reviewed in *Power* for May 8, 1917, p. 640. The Bureau in carrying out its investigations made its next step the investigation of the behavior of the gases in the combustion space of the boiler furnace, and the results of these investigations are presented in Bulletin 135 by Henry Kreisinger, C. E. Augustine and S. K. Ovitz, who are the authors also of the Technical Paper No. 137.

The present bulletin, No. 135, is, we believe, the most valuable publication the Bureau has yet issued on the subject of combustion. Certainly no publication contains a similar wealth of data for the man who designs furnaces or who must operate them economically. The tests were made with Pocahontas, Pittsburgh and Illinois coals burned in a Murphy stoker (side-feed) furnace of special design. The furnace was exceedingly long, being 43 ft. 4 in. in length from the boiler to the front wall of the furnace. The firebox itself is 5 ft. wide by 5 ft. deep. The furnace is essentially a brick tunnel 3 x 3 ft. in cross-section, the stoker having 25 sq.ft. of projected grate area. The arch over the grate surface contains an air space through which air is delivered to the tuyeres supplying air over the fuel bed. Observation holes were placed every 5 ft. apart along the length of the furnace. Although the data were obtained from experiments with a Murphy furnace and are therefore particularly applicable to furnaces of that type, it is believed that they may be of value as a guide in the proportioning of other furnaces. When applying the data to other furnaces, the designer should give full consideration to the method of introducing secondary air and the facility for mixing it with the combustible rising from the fuel bed. For best results the secondary air should be introduced as near to the fuel bed as practicable, and the air should be supplied in a large number of streams at high velocity.

The gases rising from the fuel bed of a Murphy stoker contain 10 to 28 per cent. by volume of combustible. If the gases flowed through the combustion space, they mixed with the air added over the fuel bed and burned. Because of this combustion, the percentage of combustible decreases along the path of the gases, the rate of decrease being rapid at first, but slowing down as the gases move farther from the fuel bed. Inasmuch as the gases rising from the fuel bed contain 10 to 28 per cent. of combustible and practically no free oxygen, additional air must be supplied over the fuel bed to insure complete combustion. That this additional air may flow into the furnace, the pressure of gases in the furnace must be below that of the outside air. The composition of the furnace gases at various distances from the fuel bed is shown in Fig. 2. The rate of combustion in this case was 35.6 lb. of coal per sq.ft. of grate; the coal was Pittsburgh screenings. The curves show that the gases leaving the fuel bed contain over 25 per cent. of combustible gases, about 1 per cent.

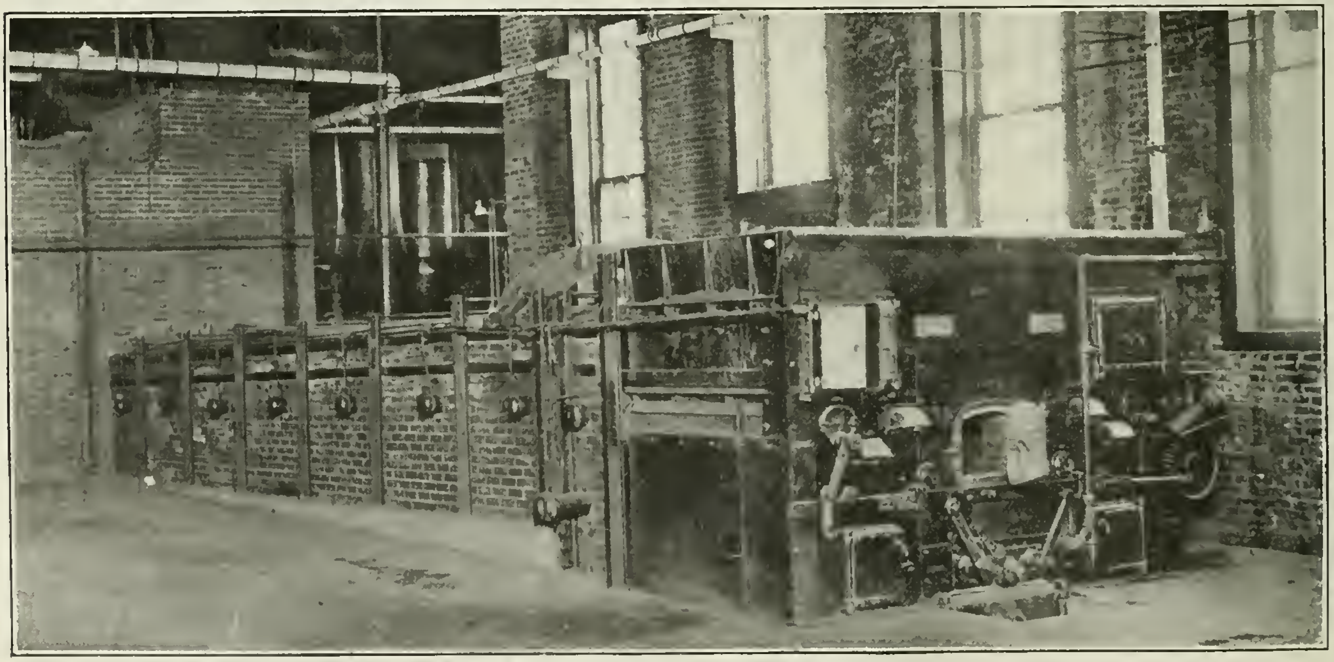


FIG. 1. EXPERIMENTAL FURNACE, SIDE-FEED STOKER; FURNACE 45 FT. BY 5 FT. SECTION

of O_2 and 7 per cent. of CO_2. Before these gases reached section *A* of the furnace, which is a point about 6 ft. from the inside front furnace wall or a point about 1 ft. beyond the firebox proper, enough air was added to make the total air supply exceed the amount theoretically required by 19 per cent. Most of this air was added through the tuyeres near the surface of the fuel bed and in a way that facilitated its mixing with the combustible gases rising from the fuel bed. In view of all that has been said about the value of high boiler settings and great furnace volume, it is interesting to note that in this figure little combustible gas is left after a distance of 13½ ft. from the grate is traveled through and by the gases. If we refer to commercial practice in furnace design, we observe that engineers have been increasing the height of boiler settings or increasing the furnace volume. Those who, five to six years ago, allowed but 8 ft. from the bottom front header of an ordinary B & W boiler to the floor line allowed 10 ft. in later design, and in still later design they have allowed as much as 12 ft. It would seem, from the experiments told of in this bulletin that inasmuch as the combustion rate greatly influences the furnace volume required, and inasmuch as high rates of combustion are required to carry peak loads, the 12 ft., which probably represents the maximum in modern practice, is still short of the most desirable height. Of course, volume alone is not sufficient in commercial boilers, and the authors mention this fact. There also should be provisions for mixing the combustible gases and the air for combustion.

In the most recent installations of the "W" type Stirling boilers by the Detroit Edison Co., the distance from the bottom of the middle drum to the dump plate is 33 ft. It is 28 ft. in the old Delray boilers. Vertically baffled boilers are now being set 12 ft. from floor to front headers.

The authors say that the length or volume of the combustion space required for practically complete combustion seems to depend chiefly upon the percentage of excess air, the rate of combustion and the kind of coal.

INFLUENCE OF EXCESS AIR

Comparison of different curves plotted by the authors show that for the same rate of combustion when the excess air is large, the proportion of combustible gases is less at any given cross-section (distance from the firebox) of the furnace and the combustion is practically complete in a smaller combustion space than when the excess air is small. Investigations show that as the size of combustion space increases, the minimum losses are obtained with a lower excess of air and a higher percentage of CO_2 in the furnace gases. The minimum losses in the furnace having a small combustion space are much larger than the minimum losses in the furnace equipped with a large combustion space. However, with a large combustion space the minimum losses extend over a much smaller range of excess air than they would with a smaller combustion space. This means that with a furnace having a large combustion space, more skill is required to keep its performance within the narrow range of minimum losses or maximum efficiency than to operate a small furnace at its best. With the furnace having a small combustion space a variation of 50 to 100 per cent. in the excess of air makes little difference in the performance of the furnace. However, the maximum efficiency of the furnace having the large combustion space is so much higher than that of the furnace with the small space that there is little doubt left as to which is preferable.

It is interesting to note that at the surface of the fuel bed the combustible gases represent 35 to 65 per cent. of the total heat value of the coal. This means that under ordinary operation of the side-feed furnace about one-half of the total heat in the coal is developed in the fuel bed, the other half being developed in the combustion space. Among other factors, it depends upon the size of the combustion space how much of the 50 per cent. of heat left in the combustible rising from the fuel bed is developed. There then follow in the bulletin a number of curves showing the relation between the completeness of combustion and the length and volume of the combustion space; also the effect of the excess of air and the rate of firing on the completeness of combustion at the various sections of the combustion space.

Figs. 3 and 4 (Figs. 29 and 30 of the bulletin) may be used for determining the size of the combustion space required for given conditions in the following manner: Suppose that it is desired to design a furnace that will burn Illinois coal at the rate of 40 lb. per sq.ft. of grate per hour with 50 per cent. excess of air, and with an incomplete combustion of only 2 per cent. of the heat in the coal as fired. For the solution of this problem the left half of Fig. 3 can be used. Refer to the group of curves designated by 2 per cent. (undeveloped heat) at the left margin. From the intersection point of the horizontal line of 40 lb. rate of combustion with the curve of 50 per cent. excess of air, a vertical line is followed to the bottom of the figure, where, in the second scale, the size of the combustion space is found to be 5.8 cu.ft. to every square foot of grate. The first scale indicates that the length of gas traveled for this condition should be about 18 ft. The first scale at the bottom indicates that, with the experimental furnace, about 145 cu.ft. of combustion space was needed to satisfy the given conditions, the space extending to within 1 ft. of section *B* of the furnace, which is at a distance approximately 10 ft. from the front wall of the furnace or firebox.

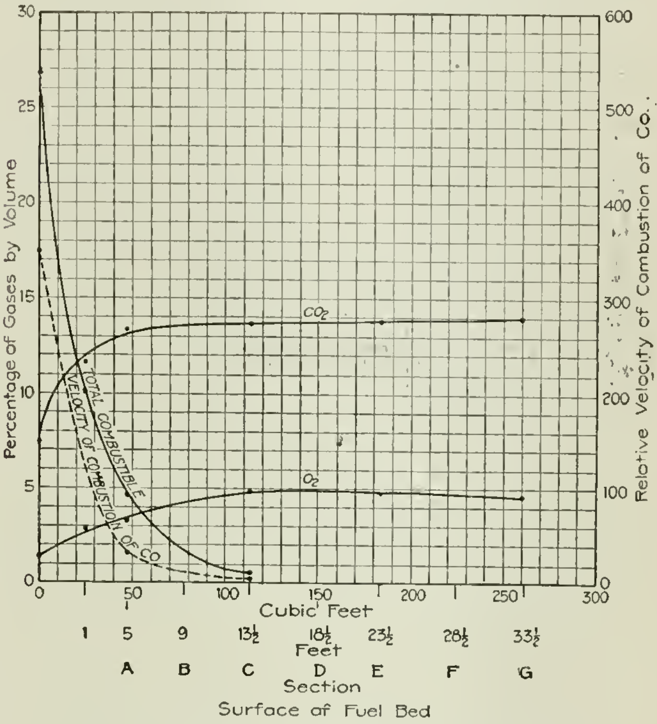


FIG. 2. PROGRESS OF COMPOSITION OF GASES AT VARIOUS DISTANCES FROM THE FUEL BED

If Pocahontas coal is to be burned under the same conditions, the required size of the combustion space is obtained from the group of curves designated by 2 per cent. undeveloped heat in the right half of the same figure. From the intersection point of the horizontal line a rate of combustion of 40 lb. with the curve of 50 per cent. of excess air in the vertical line is followed to the bottom of the figure, where the second scale indicates that about 3.2 cu.ft. of combustion space is needed for every square foot of grate area and that the length of the gas path should be about 10 feet.

When Pittsburgh run-of-mine coal is to be burned, it is found in the same manner from the left half of Fig. 4 that the best results can be obtained with a rate of volume to grate area of about 3.9 to 1 and an average length of gas travel of about 12 feet.

Thus, the three coals, Pocahontas, Pittsburgh and Illinois, require 3.2, 3.9 and 5.8 cu.ft. of space per square foot of grate, respectively, to burn 40 lb. of coal per square foot of grate per hour, 50 per cent. excess of air and incomplete combustion of 2 per cent. of the total heat in the coal as fired. According to the right half of Fig. 4, when burning Pittsburgh screenings, only about 3.1 cu.ft. of combustion space is required per square foot of grate to burn the coal with the same results. This is about the same combustion space required per square foot of grate to burn Pocahontas coal.

When considering the volume of combustion space, it is well to add that the length of the gas travel is probably an important factor. It seems that a long narrow combustion space is more efficient in burning the gases than a short wide one having the same cubical space. In the long narrow space, the gases travel with a higher velocity, which promotes mixing and therefore quickens the combustion. In the short wide space, the gases remain the same length of time, but travel slower. On account of this slower movement, the gases are less agitated and tend to travel in stratified streams. Therefore, there is less mixing and the combustion is slower. It is advisable that in using the data of Figs. 3 and 4 in designing a furnace, the path of the gases be made nearly as long as in the experimental furnace as practicable.

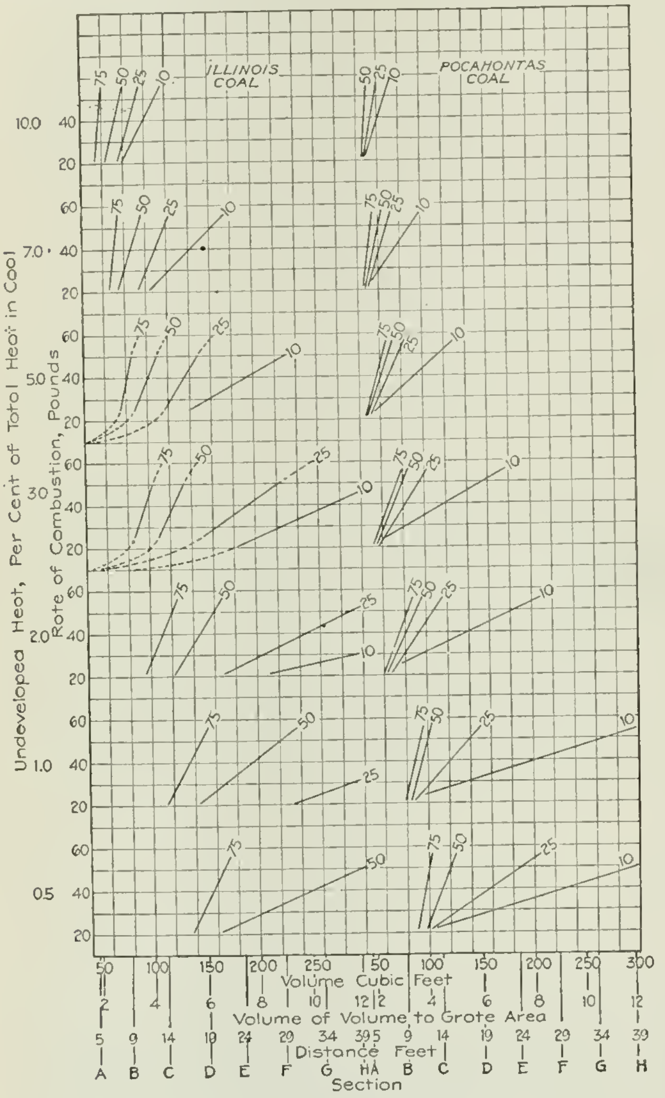


FIG. 3. COMBUSTION VOLUME REQUIRED FOR ILLINOIS AND POCAHONTAS COALS

Shows the relation between the required combustion volume, given completeness of combustion, rate of firing and excess air. Figure on each curve indicates percentage of excess air.

Table V of the bulletin (here Table I) is one which undoubtedly should be of practical value to the designer of furnaces or to the man responsible for furnace alterations. The table gives the size of the required combustion space for the three coals and several sets of conditions indicated by columns 1, 2 and 3 of the table. Examination of the values in columns 4, 5 and 6 shows that the size of the combustion space does not increase in direct proportion to the percentage of volatile matter in the coal. The increase in the combustion space from Pittsburgh to Illinois coal is much larger than the increase from Pocahontas to Pittsburgh coal. Roughly speaking, under the same conditions Pittsburgh coal requires about 20 per cent. larger combustion space than Pocahontas coal, while Illinois coal requires about 40 per cent. larger combustion space than Pittsburgh coal. That the size of the combustion space does not increase in direct proportion to the percentage of volatile matter in the coal is shown graphically in another curve of the bulletin designated as Fig. 31, which curve does not appear here. If the relation of the size of the combustion space to the percentage of volatile matter were a direct proportion, the relation would be represented by a straight line. The curves are far from straight lines and become more and more curved as conditions of less complete combustion are considered and the combustion space becomes smaller. However, in the opposite direction toward complete combustion the curves seem to approach a straight line.

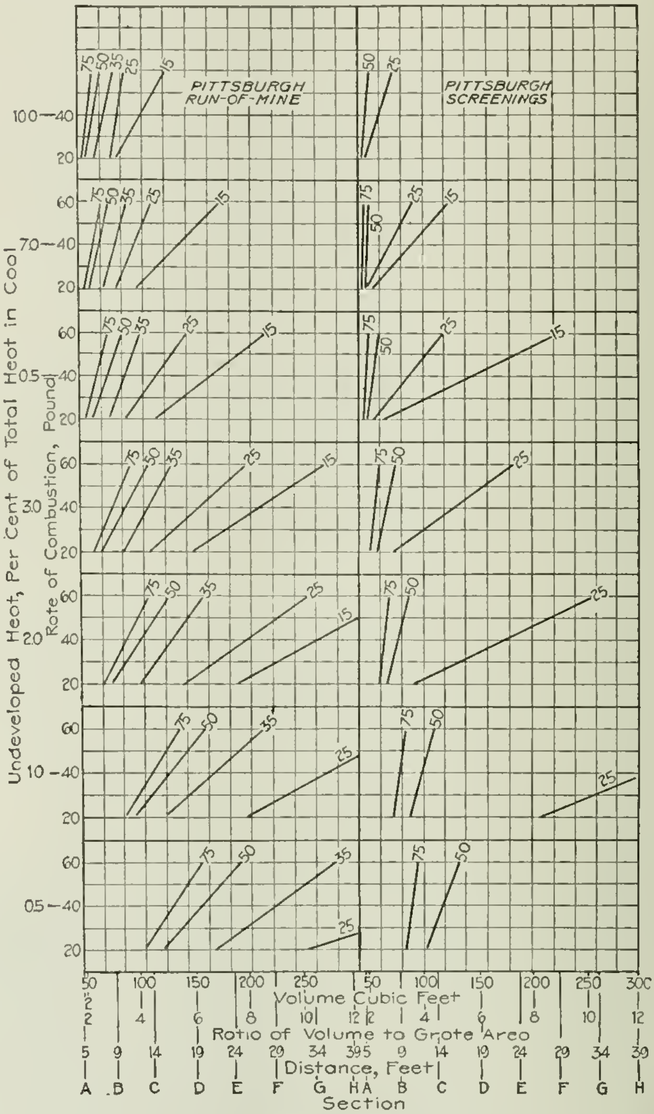


FIG. 4. COMBUSTION VOLUME REQUIRED FOR PITTSBURGH COALS

Figures on curves denote excess air

That the size of the required combustion space under ordinary degrees of completeness of combustion does not vary in direct proportion as the quantity of volatile matter even if the quality of the latter remains constant can be deduced from Table V by comparing the two rates of combustion of the same coal. Thus, when the rate of combustion is doubled, the quantity of the volatile matter distilled per unit of time is doubled. However, to burn this double quantity of volatile matter with the same excess of air to the same completeness, the combustion space is increased only about 20 per cent.

The following paragraph is quite significant in view of the experience that we have had in the burning of coal in a practical way. It explains why some settings fail in one place and succeed in another.

The quality of the volatile combustible, as far as the ease of burning is concerned, is perhaps best expressed by item 6 in Table I, showing the ratio of volatile carbon to available hydrogen. These values were obtained by dividing the volatile carbon by the available hydrogen and are probably fair indicators of the burning qualities of the coals. The amount of volatile carbon was computed by subtracting the amount of fixed carbon from that of the total carbon. The available hydrogen is equal to the hydrogen content on a moisture and ash-free basis minus one-eighth of the oxygen content. The ratio shows that the volatile matter of the Pittsburgh coal contains nearly twice as much carbon, and that of the Illinois coal three times as much carbon, as the Pocahontas coal. These ratios indicate the probability that in burning Pocahontas coal, the volatile combustible is distilled mostly as light gases which are easily burned in the diluted furnace atmosphere, whereas, in burning Illinois coal the volatile combustible leaves the fuel bed mostly as heavy hydrocarbons in the form of tars, which, in the diluted oxygen of the furnace atmosphere, are first decomposed into the lighter hydrocarbons and carbons, the latter being precipitated as soot. This mixture of soot, tar and gases burns slowly and requires a large combustion space for its complete combustion.

TABLE I. COMBUSTION SPACE REQUIRED FOR POCAHONTAS, PITTSBURGH AND ILLINOIS COALS

Completeness of Combustion, per Cent. of Undeveloped Heat	Rate of Combustion, Lb. per Sq. Ft. of Grate per Hr.	Excess of Air, per Cent	Cubic Feet of Combustion Space per Sq.Ft Grate		
			Pocahontas	Pittsburgh	Illinois
1	2	3	4	5	6.
5	50	50	2 7	2 9	4 3
3	50	50	3 2	3 7	5 3
2	50	50	3 6	4 4	6 3
1	50	50	4 0	5 6	8 9
0.5	50	50	4 8	6 8	11 9
5	25	50	2 0	2 2	3 5
3	25	50	2 3	2 7	4 35
2	25	50	2 7	3 1	5.1
1	25	50	3 4	4 0	6 2
0.5	25	50	4.0	5.0	7 1

In general, the higher the carbon content in the carbon-hydrogen compound the more time is required for their combustion. Therefore, it may be expected that as the ratio of volatile carbon to available hydrogen increases, the size of the combustion space required for a given degree of completeness also increases. In a rough way, when nearly complete combustion is desired, the size of combustion space varies directly as the product of the quantity and quality of the volatile matter as the two are given in items 1 and 6 of Table IV (here Table I). As the combustion becomes less complete, the curve showing the relation between this product and the size of the combustion space is farther from a straight line. Distillation at low temperatures favors the formation of light hydrocarbons of the paraffin series, which contain more hydrogen and less carbon than the hydrocarbon of the aromatic group, which are distilled at high temperature. The hydrocarbons of the paraffin series are more stable at high temperatures and, on account of their higher hydrogen content, are more likely to burn completely without depositing soot. It requires one molecule of oxygen to burn completely one atom of carbon, whereas one molecule of oxygen burns completely four atoms of hydrogen. Thus, of two compounds having the same number of atoms in a molecule, the one having more hydrogen requires less oxygen for its combustion, and therefore, in the same concentration of oxygen, will burn more readily. The authors here go into quite a detailed statement relative to the composition of the various hydrocarbons, and the discussion shows the advantage of distilling volatile matter at low temperatures, producing mostly paraffin or other hydrocarbons of this group. The furnace should be so designed that distillation takes place at low temperature. After the volatile matter is distilled, air should be added and the mixture thus passed through a hot chamber, especially with the smoky coal, for the reason that slow and uniform heating of the coal occurs when the coal is highest in volatile contents, or in other words, when it is admitted to the furnace distillation taking place in a low temperature and in the presence of oxygen. With most of the common types of mechanical stokers the distillation of volatile matter occurs in the presence of oxygen, whereas in hand-fired furnaces distillation is almost in entire absence of oxygen, all of the latter being consumed as it passes through the fuel bed. Even if there should be some tendency to decomposition with the mechanical stokers, the presence of large percentages of oxygen at the point of distillation makes it possible for the hydrocarbons to react with oxygen before the deposition of carbon can really take place. High temperatures, such as exist in boiler furnaces and in the absence of oxygen, promote the decomposition of all hydrocarbons, including methane, the lightest of the paraffin series, one of the products of decomposition being soot. When methane is burned with insufficient air supply, it burns with a yellow flame and deposits soot. It should, therefore, be burned with some excess of air and with provision for obtaining a good burning mixture, otherwise soot will be deposited.

The authors devote considerable space to a discussion of soot and its formation. The subject is interesting and important enough to warrant mention here. Tests show that the combustible matter rising from the fuel bed was roughly 12 per cent. in the form of tar and soot. The coal was Pittsburgh screening. Immediately at the surface of the fuel bed the quantity of tar is largest, but decreases rapidly as the gases pass through the combustion space. On the other hand, the soot increases during the first foot of gas travel. In general, an increase in the rate of combustion and in the excess of air is accompanied by a decrease in the quantity of soot, particularly in the quantity of tar. With all rates of combustion and all excess of air, there is a large decrease in the quantity of tar and a moderate increase in the quantity of soot, during the first foot of the length of gas travel.

This decrease in the quantity of tar and increase in the quantity of soot seems to indicate that the volatile matter leaves the fuel bed as heavy hydrocarbon mostly in the form of tar. These tars are decomposed by the high furnace temperature and in the absence of oxygen into soot and lighter, more gaseous hydrocarbons. The process of the decomposition of the hydrocarbons very likely consists of a number of consecutive reactions each step of which is accompanied by the deposition of soot and formation of lighter hydrocarbons. This process of decomposition is complicated by the presence of CO_2, which reacts with the soot and combustible gases and is itself reduced to CO. The decomposition and reduction proceed toward the simple gases CO and H_2.

TABLE II. CHEMICAL CHARACTERISTICS OF THREE COALS TESTED

	Pocahontas Coal	Pittsburgh Coal	Illinois Coal
1. Volatile matter in moisture and ash-free coal, per cent	18 05	34.77	46 52
2. Fixed carbon in moisture and ash-free coal, per cent	81 95	65.23	53.48
3. Carbon in moisture and ash-free coal, per cent	90 50	85 7	79.7
4. Volatile carbon in moisture and ash-free coal, per cent	8 55	20 47	26 22
5. Available hydrogen in moisture and ash-free coal, per cent.	3 96	4 70	3.96
6. Ratio of volatile carbon to available hydrogen, per cent	2.16	4.35	6.6
7. Oxygen in moisture and ash-free coal, per cent	3.32	5.59	10 93
8. Nitrogen in moisture and ash-free coal, per cent	1 19	1 73	1.70
9. Moisture accompanying 100 per cent. of moisture and ash-free coal, per cent	2.53	2 88	22.07
10. Volatile matter times ratio of volatile carbon to available hydrogen (product of items 1 and 6)	39 0	151 00	307 00
11. Ratio of oxygen to total carbon, in moisture and ash-free coal	0 0367	0.0652	0 137
12. Total moisture in furnace per lb. of coal reduced to moisture and ash-free basis, lb	0 409	0 501	0 70

The length of time in which the tars are decomposed into soot and gases is short. At the rate of combustion of 30 lb. per sq.ft. of grate per hour, the gases travel with a velocity of about 10 ft. per second. As most of the tar disappears during the first foot of the gas travel from the fuel bed, the time taken for the decomposition of the tar is about one-tenth of a second. This high rate of decomposition is undoubtedly due to the high temperature near the fuel bed, which in the test was probably not less than 1500 deg. C., or 2732 deg. F. This is a dazzling white heat. In the light of the preceding discussion it appears that soot, which is the main constituent of visible smoke, is formed at or very near the surface of the fuel bed and not at the place where the furnace gases strike the heating surface of the boiler. The heating surfaces merely cool the gases surrounding the soot, thereby preventing its combustion. The formation of soot at the surface of the fuel bed is caused by the high furnace temperature and absence of oxygen. It is possible that if oxygen was present in sufficient quantity at the time of distillation of volatile matter, the heavy hydrocarbons would burn directly to products of complete combustion, CO_2 and H_2O, without first decomposing and depositing soot. After the soot has once been formed, it is difficult to burn it in the atmosphere of the furnace. This fact has been observed by many investigators, and some of the early writers on combustion even considered soot as noncombustible. At present no support can be found for this extreme view. As a matter of fact all combustible substances burn slowly in an atmosphere of highly diluted oxygen, but in the case of soot this slowness is much more pronounced. The reason for the very slow combustion of soot in highly diluted oxygen probably lies in its complex molecular structure. The chances of the molecule of soot finding the 12 molecules of oxygen presumably required to burn it are small.

CRACKING OF TAR IN THE FURNACE

Tar exists in the furnace in the form of vapor, an ideal condition for cracking. The small globules present a large surface for absorption of heat from the gases and hot furnace walls and are quickly heated to a high temperature which favors the formation of carbon.

On account of the complex nature of tar, a great many reactions are involved in its decomposition. In general, the cracking is similar to that of hydrocarbon gases, but many more compounds are involved, and the result is a complicated equilibrium among a large number of hydrocarbons. Little experimental data are available on equilibrium and the velocity of these reactions; however, the high temperature in the furnace and the fact that the tar is in a state of subdivision favor rapid cracking and the formation of large amounts of carbon. This view is supported by the results shown in Fig. 44 of the bulletin, but not given here. The greatest amount of tar is found with a larger proportion of soot. The amount of tar and the gases decreases rapidly as the distance from the fuel beds increases; at an average distance of 5 ft., the tar has nearly disappeared. The velocity of combustion of hydrocarbon is faster than the velocity of decomposition; therefore, combustion will take precedence over decomposition for this reason. Air supplied over the fuel bed should be admitted as near to the surface of the bed as possible and mixed with the hydrocarbons so that they will be burned before they are decomposed by heat and form smoke, which is difficult to burn in the diluted oxygen of the furnace.

Pages 125 to 134 are devoted to an interesting explanation of the chemistry of combustion as carried on in a boiler furnace. These pages are omitted in this review.

What the authors have to say relative to the future method of using bituminous coal is interesting. Difficulty in burning bituminous coal in industrial furnaces is due almost entirely to the volatile matter because this leaves the fuel bed as gases and tars and must be burned in the combustion space of the furnace. Unless enough air is introduced immediately at the surface of the fuel bed and thoroughly mixed with the volatile combustible, the tars and more complex combustible gases are quickly decomposed or cracked into soot and simple gases. The soot thus formed is difficult to burn in a dilute furnace atmosphere and is likely to pass out of the furnace as black smoke, particularly if the furnace is hand-fired. The fixed carbon is easy to burn because it stays on the grate. It burns partly to CO_2, partly to CO, which in turn can be burned to CO_2 with additional air introduced above the fuel bed. The authors here point out that the various measures tried by individuals and cities to prevent smoke have, on the whole, done but little to solve the problem. In view of what is known of the chemistry of fuels and the possible advancement of such knowledge in the near future, it is questionable whether the method used in attacking the smoke problem was the best as regards fuel economy, the authors say. The persistence of smokiness in burning bituminous coal shows that there is room for improvement in methods of burning. The volatile matter of bituminous coal would have greater economic value if converted into gas or liquid fuel than if burned under steam boilers. Under present market conditions heat in the form of coal gas brings eight to sixteen times the price of an equivalent amount of heat in the form of coal. Gas is an extremely convenient fuel and can be used to advantage for many purposes, such as cooking, lighting and heating buildings, municipal lighting and in some industrial plants for obtaining a uniformly high temperature and clean products of combustion. The residue from the coking coals should find a ready market for househeating and for steaming purposes.

By the application of proper processes, it seems possible to reduce a large part of the volatile matter to liquid, of which an appreciable percentage could be obtained in the form of light oils suitable for motor fuels. Benzol has been obtained at byproduct plants for many years without any special effort to produce it. There is no doubt that with well-developed methods the yield of benzol and similar oils could be greatly increased. The value of heat in the form of motor fuel is twenty to thirty times as great as that of heat in the form of coal.

As the supply of bituminous coal is enormous, the uses of the oil are practically unlimited and the margin of profit in the conversion is large, it would seem that the development of highly productive methods would be rapid. By itself, the coke residue from such plants would have considerable commercial value, and if its price were made equivalent to that of coal, it would doubtless find a wide margin for house-heating and steaming purposes. The higher the percentage of volatile combustible the higher will be the commercial value of the coal. The time may come when our views of the relative values of different coals will change, and we shall consider anthracite as of minor importance as compared with the high-volatile bituminous coals.

The authors say that reports from Europe indicate that after the war the world will be informed of some extraordinary developments in the utilization of bituminous coal in certain countries, and that these developments will be of striking importance to the manufacturers of the United States.

The bulletin is one that every engineer concerned with furnaces, stokers and combustion should include in his library. It may be had free by addressing the Director, Bureau of Mines, Washington, D. C.

Engine Wreck from Unusual Cause

An item in the Swiss engineering journal, *Schweizerische Bauzeitung*, tells of the breakage of a cylinder head due to an unusual cause, bad lubricating oil.

The rear cylinder cover of a 500-hp. uniflow steam engine was forced out during operation but not by waterhammer, the usual cause. The cause of the break was found to be in the bad quality of the cylinder oil (tar oil). The deposit from this very thick oil, which also contained various mechanical impurities, accumulated on the piston and cylinder-head surfaces in a continually thickening crust which finally filled the entire clearance space at the back end of the cylinder and in time began to strike, compressing the substance more and more solidly and finally forcing the cylinder head out.

A saving of 25 per cent. in ammonia consumption by ice and refrigeration plants will mean several million pounds annually for munitions. A pound of ammonia will make 20 hand grenades. Ice cream and refrigeration concerns are asked to do everything in their power to stop waste and leakage of ammonia, and report on the first of each month what is being done to conserve it.

Steam-Electric Power-Plant Design*

By A. S. Loizeaux

IN THIS lecture the speaker generalizes on principles that may be used as a guide in power-plant design. It is most important for an engineer to consider and understand principles rather than individual facts, because every engineer's work presents problems of its own, which can be best solved only by applying general principles to decide the best design for the case.

It is necessary to pass the circulating water through screens located in the intake tunnel, to eliminate foreign materials. Friction through the screens will be a considerable item. The drop in head should be modest, perhaps not more than one or two feet, in order to reduce the lift required by the circulating pump. Stationary screens may be satisfactory where the water is exceptionally good, but where any considerable amount of foreign matter exists, revolving screens are required. Stationary screens were used at Westport, but they became clogged at frequent intervals. In some cases clogging resulted in a three-foot drop of head through the screen. This would take place in a few hours, the resultant pressure damaging the screens by bending. On raising the screens they would be found stopped with foreign matter and, in some cases, several wheelbarrow loads of fish and crabs. Revolving screens have eliminated these difficulties and give entire satisfaction. They are not operated continuously, but only at such intervals as the conditions require. The washing of these screens is automatically done by means of a pipe with high-pressure water impinging on the screen after it turns over the top guide.

Bunker Capacity Needed

The coal bunker should have a storage capacity for at least 48 hours' operation or more to provide for interruption of the coal supply. Automatic coal scales are now generally used to feed all stokers. Boiler-house records can then readily check the coal used by the plant, the duty of each boiler, and an efficiency test can be made on any boiler when desired.

The water-tube boiler practically holds the entire field in large power-plant work. Both straight-tube and curved-tube boilers are used.

Boiler horsepower has been by common agreement taken to be 10 sq.ft. of heating surface, this being approximately the heating surface required in old designs to produce one boiler horsepower of 34.5 lb. of water evaporated from and at 212 deg. F.

It has been found, however, that boiler capacity has been limited only by furnace capacity under the boiler and that with modern types of stokers the boiler capacity can be increased to double or even three times its normal rating. For the sake of uniformity, the normal boiler horsepower remains as before.

Economical boiler-house design today must provide for stokers, as may be readily seen by considering the investment required for a definite output. A hand-fired boiler will develop rated boiler capacity continuously, and under the best conditions may reach 150 per cent. A good stoker will deliver continuously twice rated boiler capacity and over peaks three times rated capacity, thus producing with the same boiler twice the output of the hand-fired boiler. It is evident that this is equivalent to cutting boiler-house investment nearly in half by the use of stokers.

The boiler setting required for underfed stokers must be higher than for hand-fired boilers, a space of ten feet from the stoker surface to the tubes being required for thorough combustion.

Draft through the fuel bed is provided by blowers in connection with stokers as before mentioned. It is not feasible to provide sufficient draft by this means, however, to carry the gases through the boilers, because a positive pressure in the furnace as compared with the atmosphere would produce a movement of the heated gases through the boiler setting to the outside and would soon destroy even the best firebrick. A slight negative pressure should be maintained in the combustion chamber, and this negative pressure or suction will therefore be increased throughout the several passes of the boiler and through the breechings to the stack. To provide this draft or negative pressure a chimney must be provided.

The draft available with given stack temperature is roughly proportional to the height of the chimney except that friction cuts down this proportion. The capacity in cubic feet per minute is roughly proportional to the cross-section of the chimney. Steel chimneys are sometimes used, but their upkeep is greater than for brick chimneys. A steel chimney should be lined all the way to the top to prevent corrosion on the inside, and it requires frequent painting on the outside. Masonry chimneys are made of perforated radial tile to conserve heat and material, and they are designed to be stable at various sections throughout their height. Their upkeep is negligible.

Mechanical Exhausters Unsatisfactory

Mechanical exhausters have been tried in lieu of chimneys, but have been unsatisfactory owing to the lack of reliability of fans working in high temperature. In designing breechings three points should be kept in mind: (1) Connections to stack should be as short as possible; (2) as few as possible changes in direction and use bends where this is unavoidable; (3) practically uniform speed of gas, requiring cross-section proportional to the gas carried.

A three-pass boiler has a distinct advantage in draft connections as compared with four-pass boilers because of lower friction and larger passes available.

Superheat of 100 to 200 deg. F. is used to improve the economy of generation. This also avoids water in the steam delivered to the turbine. The use of superheated steam requires the use of cast steel for all valve bodies and fittings, as cast iron under the greater heat will expand or grow until sometimes rupture occurs.

Pipes for high-pressure steam are made of wrought steel of about the same grade as boiler steel. The size of piping is determined by the speed of steam through piping to supply normally a maximum load. A few years ago engineers were using velocities of 10,000 ft. per min. and higher for normal load. It was found that these velocities produced a greater drop in pressure than was expected, the loss occurring possibly to a large extent in bends and fittings. Our present practice is to allow 8000 ft. per min. for normal load. When overloads are carried higher velocities may be produced, but as these periods are of short duration, they will not be serious.

Heaters Should Be Well Above Pumps

The use of a feed-water heater with water carrying solid matter in solution often acts as a purifier in causing this solid matter to separate out and be deposited, in the heater, as its temperature is raised. Heaters should be located well above boiler-feed pumps to provide positive heads. This requirement is due to the fact that hot water cannot be lifted by suction without breaking the water column due to liberation of steam. The temperature of water vapor at different negative pressures as compared with atmospheric pressure determines the critical point for any condition of suction with hot water.

The day when an engineer designs his own engine is passed. Today manufacturers are asked for bids and specifications on units of specified size. Alternative designs are often available, some being more efficient and costly than others. The choice of proper equipment then is determined by the cost of output when fixed cost as well as operating cost is included. In general the choice between high-efficiency, high-cost apparatus and low-cost, low-efficiency equipment is determined by the load factor, or hours of service per year. The higher the load factor on apparatus or plant the more will the effect of higher efficiency make itself felt. A plant that is held simply as stand-by in case of emergency and may operate only a few hours per year is evidently a case where lower cost would justify the use of low-efficiency apparatus.

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*Abstract from a lecture delivered at the Johns Hopkins University, Baltimore, Md., Mar. 13, 1918, as one of the J. E. Aldred Lectures on Engineering Practice.

It is important that apparatus should be uniform in any plant to reduce the necessary stock of repair parts and make it simpler for the operating forces. There is a temptation in adding to a power plant to use apparatus, such as boilers, stokers and pumps, and different things, because of some slight advantage in design or cost. Some plants might almost be termed museums, due to the variety of apparatus. The designer should use the utmost care in first choosing type and make of equipment and then adhere to the standard set throughout the plant unless some great advantage unquestionably makes it wise to change. One advantage of standardizing is the greatly reduced engineering cost of adding to a plant by using additional duplicate units.

One of the fundamental lessons of practical power-house experience is the imperative need of spare equipment. One boiler in every five or six should be spare to provide for cleaning and repair and also for repairing the stokers. A spare turbo-generating unit is required in a power house whether the load calls for one or more units. The practical capacity of a plant is therefore its continuous capacity with one unit out of service. Thus a plant designed to carry 100,000 kw. should have the following number of units:

Each Unit	Number of Units	Total Rating, Kw.	Safe Capacity One Unit Out of Service, Kw.
10,000 kw	11	110,000	100,000
15,000 kw	8	120,000	105,000
20,000 kw.	6	120,000	100,000
25,000 kw	5	125,000	100,000

It will be seen that the larger the individual unit the greater capacity must be provided for spare, unless the number of units becomes large, and then more than one would be required for spare. The same principle of spare equipment is applied to the use of auxiliaries, the common design being to provide for two circulating pumps with each generating unit, also two air pumps and two condensate pumps. These auxiliaries are frequently supplied with both steam and electric drive for the double purpose of insuring reliability and also of controlling at will the amount of exhaust steam available for feed-water heating.

Those Damaged German Ships

When the history of this audacious war is fully written, there should be no more interesting chapter than that which deals with the interned German ships and their reappearance in a few months as auxiliary transports of the United States Navy. And this notwithstanding the damage inflicted upon them by Prussian orders was such as was calculated to keep them out of service for two years or what the Germans had figured as the period within which the war would terminate.

Thirty-seven German ships of 700,000 aggregate tons had their 74 engine cylinders so broken that repairs within any reasonable time seemed out of the question. The biggest ships appeared to call for new castings entirely beyond the capacity of any foundry works in the United States.

When the Shipping Board got down to close estimates, it figured the repair bill at $2,600,000 and time required 18 to 24 months. But American enterprise, combined with American invention, concentrated capital and industrial organization in large units accomplished the job in six to eight months at an expense of only $273,000. Every one of these ships has been for many weeks most effectively in Uncle Sam's service except possibly the "Armenia," lost off the Irish coast.

The Navy Department, says the Boston *News Bureau*, has figured that the saving in time at the going rate of tonnage had a value of not less than $240,000,000. One of the first ships tackled had four cylinders broken and it was estimated that 18 months would be required for repairs. In two months the engines were turning over, and in less than three months the ship was finished and ready for sea.

Indeed, the striking feature of the whole situation is the fact that the repairs on all the ships were made within the time required to overhaul the ships, clean their bottoms and otherwise make them ready for sea. The Germans had all their labor for their pains. What is also well-nigh incredible, the ships are stronger than before and the largest of them are more economically operated and are actually working better in the American than in the German hands.

Take the "Vaterland" for example. She is the biggest and most beautiful thing afloat. Stood up on Broadway, she would tower 200 feet above the Woolworth Building. She has 18 decks, 18 elevators, 5 kitchens, 530 clocks all timed from the main bridge, hot and cold water in every room, and many miles of piping, wiring and electric controls. This vessel was damaged as directed by the government to insure her being out of commission for at least two years. There were no foundries on this side of the ocean that could give the "Vaterland" new cylinder castings of 70 tons each, and no drydock that could receive her on this side of the ocean except at the Panama Canal.

It was found that the United States Steel Corporation had developed just the right wire soldering with the proper mixture of manganese and that the railroad repair shops around New York had developed the electric welding process of the General Electric Co. to a higher efficiency than anywhere else in the world. The railroad shops and the General Electric Co. were able to furnish the apparatus and the crews to repair the machinery of the "Vaterland" within the time required for general overhauling and cleaning of the ship's bottom by a half-dozen submarine divers who, among other things, took 280 bushels of oysters off the "Vaterland's" bottom.

The "Vaterland" was equipped with both Curtis and Parsons turbine engines, but the Germans have never been able to work them to full efficiency. Indeed, on the last trip to this country under German engineers, the "Vaterland" was able to use only part of her machinery. The American engineers adjusted everything, improved the machinery and the draft to her 46 boilers, improved the piping and valves and sent the giant forth in a few months at above a 21-knot speed and using 200 tons of coal a day less than before.

The Germans had figured that the "Vaterland" could never be repaired in the United States and if repaired was such a complicated piece of mechanism that it could never be operated by Americans or any new official staff. The officers of the big German ships have to be in training at least a year with their ships during construction. Now on the "Vaterland" in place of five German captains of the unlimited license class, there is but one American captain; and instead of a chief engineer and five assistant engineers, there is just one American chief engineer, and he is only 32 years of age.

The General Electric Co., the New York Central and the Erie Railroads all coöperated with electric workers and electric welding devices and what it was estimated would require five months on this ship was done in ten days. Thirteen breaks or cracks in the "Vaterland's" cylinders were mechanically patched by the electric welding system and made stronger than before, yet without a single rivet having to be put through the 3½ inches of metal.

It is said that Indian coal is the cheapest in the world. The coal now being worked is comparatively near the surface and labor is cheap. One of the difficulties in mining seems to be that a sufficient supply of labor is not always available when wanted, as the majority of the workmen follow the vocation of agriculture as well as mining and return to their homes during the periods of sowing and reaping. During the last 10 years the use of machinery has been rapidly extending, especially at the larger collieries. About 145,000 persons are employed in coal mining.—*Gas and Oil Power.*

The War-Savings Stamps project is, in reality, a two-billion dollar loan launched among the masses of the people and is intended for the benefit of those who cannot afford to buy the larger bond issues. It is a most democratic plan in that it reaches the entire population from coast to coast, men, women and children, rich and poor alike, and there certainly is not a person in this prosperous land so humbly placed that he or she cannot buy a 25c. Thrift Stamp as a tribute of loyalty toward Uncle Sam.

A. I. E. E. Discusses Single-Phase Induction Motors

The American Institute of Electrical Engineers held its 339th meeting in the Chamber of Commerce Building, Pittsburgh, Penn., Tuesday evening, Apr. 9, and in the Engineering Societies Building, New York City, Friday evening, Apr. 12, 1918. At New York a buffet dinner was served prior to the meeting, under the auspices of the New York Membership Acquaintance Committee.

The New York meeting was called to order at 8:15 by Vice President B. A. Behrend. Two papers were presented: "No Load Conditions of Single-Phase Induction Motors and Phase Converters," by R. E. Hellmund; and "A Physical Conception of the Operation of the Single-Phase Induction Motor," by B. G. Lamme. Mr. Lamme presented his paper in abstract and illustrated his remarks by diagrams on the blackboard. The paper covers a method of studying the action of the single-phase induction motor, which the author has found to be very convenient from the educational standpoint. It is based on the assumption of two equal and opposite rotating primary magnetomotive forces combined with a synchronously rotating secondary magnetomotive force, such as would be produced by direct-current excitation. A comparison is made between a two-motor unit consisting of two similar polyphase motors coupled together and connected for opposite rotation and the straight single-phase induction motor.

In the absence of the author Mr. Hellmund's paper was presented in abstract by A. M. Dudley, who explained its important details by the use of a number of lantern slides. In this paper methods are shown and formulas derived for the determination of the fields, the stator and rotor magnetizing currents, and tertiary voltages for phase converters and single-phase induction motors. The paper is of considerable length, occupying some 85 pages of the proceedings, and involves considerable mathematical analysis. However, it is arranged so that it can be read to good advantage without going through the major portion of the mathematics. The importance of the subject was demonstrated by the large number of prominent engineers who took part in the discussion. These were B. A. Behrend, Dr. Michael I. Pupin, E. F. W. Alexanderson, L. W. Chubb, Alexander M. Gray, C. A. M. Weber, Prof. C. F. Scott and Selby D. Harr.

One of the most prominent features brought out at the meeting was the lack of some simple method of presenting the action of the single-phase induction motor. The discussion of the paper was closed by B. G. Lamme.

Test of World's Largest Turbine a Success

Electrification of the Coast section of the Chicago, Milwaukee & St. Paul Ry. took a long step forward recently with the turning over for the first time of its big turbine generator, the largest in the world, at the White River, or Lake Tapps, generating station of the Puget Sound Traction, Light and Power Co., which has the contract for furnishing the power.

The turbine into which water was turned recently is one of 25,000-hp. capacity, and it constitutes the third unit in the White River plant. This plant is on the east side of Stuck River valley, five miles from Auburn, Wash., between Seattle and Tacoma, and is the largest and most important of the hydro-electric plants of the Puget Sound Traction, Light and Power Co. and one of the most remarkable in the world. It is built at the base of a high plateau between the Stuck and White Rivers, on which Lake Tapps is situated. White River was diverted above Buckley and emptied into the series of lakes of which Lake Tapps is the largest, and which form the natural storage reservoir. The water is taken from this reservoir through penstocks of inch steel 8 ft. in diameter at the intake and 6½ ft. at the power house. The penstocks are 2500 ft. long, and the water is fed to the turbines at a head of 465 feet. There are three units, each of one turbine, directly connected by shaft to the generator it drives. The first two turbines are of 20,000 hp. each. The new turbine is of 25,000 hp. and is the largest in the world. The total capacity of the plant with the added unit is 65,000 hp. This gives the traction company a combined capacity of all its plants supplying Seattle of 110,000 horsepower.

The Milwaukee road will require a little more than 50 per cent. of the additional power. The current will be delivered to the railroad at a voltage of 100,000, alternating current, and transformed into direct current at a voltage of 3000 for use on the motors of the Milwaukee electric locomotives. The traction company's contract with the railroad calls for the delivery of 10,000 kw. of 100,000 volts, alternating current. The railroad has yet to install substations and overhead trolley wires on the division between Othello and Tacoma. The trolley poles are now being placed in position, though operation electrically will be delayed for some time owing to a shortage in some classes of equipment. When this section of the Milwaukee electrification is completed, the road will be operated by electricity between Tacoma and eastern Montana.

War Convention of the Machinery, Tool and Supply Industry

The enormous problem of manufacturing and supplying machinery and tools sufficient for the carrying out of the Government program for the production of ships, shells, guns and aircraft will be the subject considered at the great "War Convention" of the machinery, tool and supply industry of the country to be held in Cleveland the week of May 13.

One thousand men who are bearing the brunt of the unprecedented demand for machinery will gather from all parts of the country to lay out a plan, with the aid of Government officials, to keep the great munition program going at top speed. The big war convention will be a joint meeting of four great national associations—the American Supply and Machinery Manufacturers' Association, the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the National Pipe and Supplies Association—which will meet together in order to coördinate their efforts toward one goal—"more ships, more shells."

"No industry has a greater responsibility at this moment than the machinery men," said H. W. Strong, president of the National Supply and Machinery Dealers' Association. "We must have men, but behind the men must be ships and munitions, and behind the ships and munitions, machinery —more machinery—still more machinery. We are in this fight to a finish. The Germans have convinced us that the only way out of the war is straight through, and the American machinery industry is ready to carry on to a knockout."

The part played by drills in the game of war is shown by the computation that 70 drilled holes are required in every 3-inch shrapnel shell, in every rifle 90, machine gun 350, torpedo 3466, war plane 4089, war truck 5946, war ambulance 1500, 3-inch field gun 1280, gun caisson 594, and anti-aircraft gun 1200.

"'Carry on' will be the watchword of the convention," said R. F. Valentine, president of the Maufacturers' Association.

New Power Development in Pennsylvania

Public-utility companies at Philadelphia, Penn., and vicinity are conferring with Government representatives for the development of the electric generating stations in the Lehigh Valley section of the state, supplemented by the construction of new transmission lines to connect with existing high-tension systems in Pennsylvania, New Jersey, New York and Delaware.

The proposed project, devised as a war measure and arranged with an idea of fuel conservation, will place the resources and ability of the different companies at the disposal of the Government. The Philadelphia Electric Co., Philadelphia, and the Electric Bond and Share Co., New York, the latter operating electric plants at Harwood Mines, Penn., and neighboring sections in this mining district for light and power service, are the two principal utility companies interested.

It is proposed to build extensions to a number of the existing generating stations to provide an increased output of at least 100,000 hp. Following this two or three new plants will be constructed, with total generating capacity of about 100,000 kw. The different stations will be tied in with a network of transmission lines, and a new high-tension system will be constructed to Philadelphia. Here it is planned to connect with the present lines of the Philadelphia Electric Co. and those of the Public Service Electric Co., operating in New Jersey, as well as with the system of the American Railways Co., which operates lighting and power properties in Pennsylvania, South Jersey and Delaware. The plan also includes a proposition to connect the new system with the lines of the Public Service Electric Co. at Newark and vicinity, and with New York City power lines.

Estimates of cost are now being made and different phases of the work investigated. While it is possible that the cost of the enterprise will be financed by the Government, this has not as yet been decided. The entire plan is designed to be of mutual benefit and not to the individual interest of any of the particular companies. William Potter, Pennsylvania State Fuel Administrator, and Charles E. Stuart, public-utility engineer for the Fuel Administration in the state, are representing the Government in the development plans.

Rights in Waters of Streams

A late decision of the North Dakota Supreme Court, handed down in the case of McDonough vs. Russell-Miller Milling Co., 165 Northwestern Reporter, 504, shows that an owner of land bordering a river has no unqualified right to object to use of waters of the stream by an upper landowner for manufacturing purposes.

Plaintiff complained that defendant's use of the stream by returning waters to it somewhat contaminated in their use rendered plaintiff's use less valuable, especially for the purposes of harvesting ice. But the court found that his rights, as governed by the following stated legal principles, had not been invaded:

The right of a riparian owner to have a natural stream continue to flow through or by his premises in its natural quantity and quality is subject to the right of each riparian owner to make reasonable use of the waters of the stream while remaining on his land. "Manifestly, running streams cannot be used for commercial, manufacturing or agricultural purposes and retain their pristine clearness and purity."

The question whether a reasonable or unreasonable use of the water is being made, having regard to the common rights of others, is to be determined by the circumstances of each particular case, due consideration being given to the character and size of the water course, its location and the uses to which it may be applied, as well as the general usage of the country in similar cases. . . Upon the question of reasonableness of the use by the upper proprietor, the character and extent of his business, as well as the use to which the lower proprietor is putting the water, may be taken into consideration.

Waste from Water Leakage

Water wasters cause unnecessary pumping that requires the use of 100,000 tons of coal annually in Chicago, in pumping and sterilizing 2½ times as much water as the consumers actually use, the waste and leakage amounting to more than the combined consumption of Milwaukee, Boston, Cleveland and St. Louis. The coal required for pumping this waste during one year amounts to more than enough to heat all its public schools during the winter. This useless pumping adds about half a million dollars a year to the operating expenses. Furthermore, three and a half million dollars is spent annually in an attempt to keep the plant adequate for the extravagantly excessive service, and even this amount is not sufficient. If the waste could be stopped, no further additions need be made for more than thirty years to come. The waste of water so reduces the pressure in the mains that for more than three-fourths of the area of the city it is less than half of that recommended by the National Board of Fire Underwriters, and in only one of the 35 wards does it equal the recommended pressure. With approximately 2,500,000 population, Chicago is pumping into its water mains 14 per cent. more water than New York receives by gravity (with no pumping costs) for the use of a population of 5,500,000. It supplies more water than any other water-works system in the world.

The startling facts here given are derived from a report entitled "The Water-Works System of the City of Chicago," that has just been published by the Chicago Bureau of Public Efficiency. The purpose of the report is to make public, and emphasize the enormous waste, and the undoubted increase in this waste of public funds which will occur unless radical methods are carried out for greatly reducing it.—*Municipal Journal.*

Thrift-Stamp Selling Machine

The War Savings Committee of Greater New York recently announced the placing of an order for 1500 Thrift Banks. These are really Thrift-Stamp selling machines which not only sell stamps for 25 cents but also register each sale.

The New York committee feels that this machine will greatly increase the sale of Thrift Stamps, and facilitate the handling of the stamps by merchants. The machines are meeting with great popularity everywhere. Frank Vanderlip, chairman of the National War Savings Committee, recently placed his stamp of approval upon them, expressing his hope that they would be adopted generally by the committees all over the country. Closely following Mr. Vanderlip's approval, the Treasury Department was so greatly impressed that it decided to put up the stamps in rolls of one hundred each at a little less than one cent per roll, in order to facilitate the feeding of the machine.

These machines are ideal for factories on payday or for any place where money changes hands or people congregate. Their use does not eliminate the personal solicitations, which are necessary if the War Savings Stamp campaign is to be a success. The first shipment of the New York Committee's order has already been started, and it is expected that within a few days everyone in New York will be able to purchase Thrift Stamps from this automatic salesman of Uncle Sam.

Full particulars regarding the machine will be furnished on application to the New York War Savings Committee, 51 Chambers St., New York City.

Conflicting Water Claims

In view of the fact that practically all Connecticut streams available for municipal water supply were long ago utilized for water power, either directly or through connecting waters, it must be supposed that a municipal charter, amended in 1901 and reaffirmed in 1909, empowering the municipality to condemn the waters of certain streams, contemplated appropriation of waters of streams that might already be used for water-power purposes at least when such water powers are not already employed in some other public use at the time of the proposed taking by the municipality. Respondent power company, although authorized to exercise the flowage rights of individuals and to use a brook to generate electricity, and although possessed of rights in the stream acquired for that purpose, is not entitled to defeat condemnation of waters of the stream by a municipality for water-supply purposes under statutory authority; the power company's property not being presently devoted, nor about to be devoted, to public use, within the general principle of law that property already appropriated to one public use cannot thereafter be condemned for an inconsistent public use. (Connecticut Supreme Court of Errors, East Hartford Fire District vs. Glastonbury Power Co., 102 Atlantic Reporter, 592.)

New Publications

FINDING AND STOPPING WASTE IN MODERN BOILER ROOMS. By Engineers of the Harrison Safety Boiler Works, Philadelphia, Penn. Cloth; 4¾ x 7 in.; 270 pages; 213 illustrations. Price $1.

The material contained in this book is both informative and timely. It is not original, but is a compilation of statements, tables and charts from various sources, the references being given in the majority of cases. Taken as a whole, it forms an authoritative treatment of the entire range of subjects relating to combustion and the economical management of steam-boiler plants, and is of value to owners, managers, engineers and firemen. The work is divided into five sections, the first of which deals with coal, its classification, analysis, heating value, purchase by specification, washing, storage and weathering, together with a brief notice of oil and gas as fuels. The second section takes up the chemistry of combustion, air required, grates, hand-firing methods, stokers and their operation, clinker, draft, stack proportions, draft gages, dampers, flue-gas analyses, excess air and smoke prevention. The third section treats of heat transmission, economizers, air heaters and superheaters, relation between heating surface and boiler capacity, boiler setting, firebrick, soot, scale, softening feed water and feed-water heating. The fourth section covers heat absorbed by boiler, heat losses, efficiencies, boiler capacity and boiler trials. The fifth section discusses various arrangements of auxiliaries with regard to their effect upon feed heating and also describes the Polakov functional system of boiler-room management.

Personals

Robert S. Blake, formerly representing the Condit Electric and Manufacturing Co., of Boston, in Pittsburgh, is now district manager of the Chicago office of the Duquesne Electric and Manufacturing Co., at 230 So. LaSalle St.

Engineering Affairs

The Bridgeport (Conn.) Section of the A. S. M. E. will meet on Apr. 24, and the New Haven Branch will meet on May 10.

The American Water-Works Association will hold its annual convention at the Planters Hotel, St. Louis, Mo., May 13, 1918.

George A. Orrok talked on Tuesday evening, Apr. 17, to the Student Branch of the American Society of Mechanical Engineers at Yale, on Internal Combustion Engines.

The Association of Iron and Steel Electrical Engineers announces the following meetings: The Cleveland Section on Apr. 27 at the Union League Rooms of the Statler Hotel. T. F. Bailey, president of The Electric Furnace Co., will present a paper on "Electric Soaking Pits, Annealing and Heat-Treating Furnaces and Furnaces for Melting Nonferrous Metals." The Philadelphia Section, at the Majestic Hotel, on May 4, at which H. A. Lewis and W. H. Burr will present a paper on "Electrically Operated Door Hoists for Openhearth Furnaces." In addition to this Major William A. Garret will address the meeting on "Some of My Observations in France." The Pittsburgh and Cleveland District Sections will hold a joint technical session at Youngstown, Ohio, on May 18, and make an inspection of McDonald and Ohio Works, Carnegie Steel Co.

Miscellaneous News

The Commercial and Industrial Museum of Montreal, Canada, has been established as an annex to the Faculty of Commerce, to furnish Canadian manufacturers and dealers information of interest to them in their business, and as a medium of advertising to Canadian and American customers. Manufacturers and exporters may get free space to exhibit their goods by communicating with the Museum at 399 Viger Ave., Montreal, Canada.

Concrete Ships—Edward N. Hurley, chairman of the United States Shipping Board, has recommended to the Secretary of the Treasury that the sum of $50,000,000 be authorized, of which some $15,000,000 shall be appropriated for the acquisition or establishment of plants suitable for concrete shipbuilding, or of materials essential thereto, or for the enlargement or extension of such plants as are now or may hereafter be acquired or established, and for the cost of constructing, purchasing, requisitioning or otherwise acquiring such concrete ships.

The House Naval Appropriation Bill for the year ending June 30, 1919, as reported from the Committee on Naval Affairs, contains numerous large appropriations for improvements and extensions to central power plants and distributing systems as follows: Navy Yard, Portsmouth, N. H., $150,000; Boston, Mass., $75,000; New York, $200,000; Philadelphia, Penn., $300,000; Norfolk, Va., $300,000; Naval Academy, $325,000; Naval Station, New Orleans, La., $280,000; Mare Island, Calif., $100,000; Puget Sound, Wash., $200,000; Marine Barracks, Peking, China (power plant), $25,000. Other items of general interest are as follows: For an investigation of fuel oil and gasoline adapted to naval requirements, $60,000; for aviation for naval purposes, $188,042,969; for expenses in connection with the civilian Naval Consulting Board, $100,000.

Two Applications for Permits to appropriate water which, combined, represent an outlay of $6,000,000 were recently filed in the office of State Engineer Lewis, Salem, Ore., by H. S. McGowan, of Pacific County, Washington. The application asks for a year in which to prepare plans and specifications of the proposed projects, and it is believed that the initial step that has been taken is in preparation for a possible legislation in Congress throwing open the waters to public development.

One application is to appropriate the waters of the Deschutes River to the extent of 45,000 cu.ft. a second. The proposed project is in Sherman and Wasco Counties, the river forming the boundaries between the two counties, and the purpose stated in the application is hydro-electric development and transmission for manufacturing purposes and general use. A dam which is being planned would be 118 ft. high, 800 ft. long at the top, 300 ft. long at the bottom, built of reinforced concrete with wasteway. The estimated cost of the project is $2,000,000.

The other application states the same purpose. The project proposed is in Jefferson County and would require 3500 cu.ft. per second. The estimated dimensions of the dam necessary are 236 ft. high, 420 ft. long at the top, 90 ft. long at the bottom, built of reinforced concrete of the overflow type. The estimated cost of the project is $4,000,000.

The Poget Sound Traction, Light and Power Co., Seattle, Wash., will have, when its present development is completed, hydro-electric plants supplying Seattle and Tacoma with power for industrial needs with a combined capacity of 107,997 hp. divided as follows: White River, 63,000; Electron, 18,667; and Snoqualmie Falls, 26,330, hp. The steam plant's capacity will aggregate 38,264 hp., 24,000 at the Georgetown plant, 6667 at Western Avenue, 4267 at Post Street, and 3330 in the Tacoma steam plants. The total capacity will then be 146,261 hp., which will be ample for some time. To the traction company's development must be added the hydro-electric and steam auxiliary plants of the Seattle municipal electric system, having a combined capacity of 24,000 hp. The White River or Lake Tapps development is the largest power project in the Northwest, and is still far from fully developed. It was made by diverting the flow of White River at a high point in its channel into three natural lake beds lying high on the plateau overlooking the lower White River valley. Twelve dams were constructed to create a reservoir and channel cut from the upper river to this reservoir. Before the work was done the company had to purchase 36 miles of riparian rights extending on both sides of the stream from the point of divergence 28 miles down to the point where the water again enters the river bed. By this means 2,500,000,000 cu. ft. of water is impounded. The station is located on the valley level of the lower river, and the water enters the penstocks from an outlet on top of the plateau.

Business Items

The Power Turbo-Blower Co., will move, on May 1, from 17 Battery Place to 347 Madison Ave., New York City.

The Whitlock Coil Pipe Co.'s Philadelphia office is now at 1009 Commercial Trust Building. William Wilcox, the district engineer, is in charge of the office.

NEW CONSTRUCTION

Proposed Work

N. H., Portsmouth—The Bureau of Supplies and Accounts, Wash., D. C., will soon receive bids for furnishing under Schedule No. 1766, at Navy Yard, here, 13,000 ft. plain rubber air hose for pneumatic tools and 5000 ft. 2½ in., rubber lined, cotton, fire hose; Schedule No. 1767, 1000 ft. 12½ in. engineers department hose, 1000 ft. bright finish, brass, wood hose.

Vt., Middlebury—The Hortonia Power Co., Gryphon Corner Bldg., Rutland, is having plans prepared for the erection of a 1-story, 28 x 90 ft. power house here. Grover & Connor, Rutland, Engrs.

Vt., Springfield—The Colonial Light and Power Co. has had plans prepared by W. S. Barstow Co., Inc., Engr., 50 Pine St., New York City, for the erection of a substation, garage, etc. G. F. Sanderson, Supt.

Mass., Boston—The U. S. Government plans to build a power plant. Estimated cost, $35,000.

Mass., Grafton—The State Commission on Mental Diseases is in the market for a new boiler to cost $8000; also setting up and connecting same with a battery and into the stack to furnish light, heat and power.

N. Y., Brooklyn—The Edison Electric Co., 360 Pearl St., has had plans prepared for alterations and additions to its 1-story power house on Gold St. G. L. Knight, 13 Willoughby St., Arch.

N. Y., Brooklyn—The Kings County Electric Light and Power Co., 360 Pearl St., has applied to the Public Service Commission for permission to issue $1,000,000 bonds; the proceeds will be used to build additions and make improvements to its plant. W. F. Wells, Gen. Mgr.

N. Y., Dunkirk—City plans to install a new lighting system in the business section. Estimated cost, $5000.

N. Y., Jamestown—The Crescent Tool Co., 200 Harrison St., soon receives bids for a 1-story, 100 x 200 ft., power house on Harrison St. Estimated cost, $200,000. Equipment including 1500 kw. gas driven generators and 1500 kw. steam turbine driven generators will be installed. F. A. Shoemaker, Builders Exchange, Buffalo, Engr. Noted Apr. 9.

N. Y., Mohawk—W. W. Wotherspoon, Supt. of Public Works, Capitol, Albany, is having plans prepared for the erection of hydraulic power plants under Barge Canal Contract No. 176.

N. Y., Utica—The Adirondack Power Co., Glen Falls, plans to build a power house near here. Estimated cost, $100,000. W. A. Buttrick, Glens Falls, Mgr.

N. J., Mountain Lakes—The Board of Education, Hanover Township, plans to install a new heating system in the local school building.

N. J., Plainfield—The International Power Corporation plans to build a power plant in Freeville near here.

N. J., Trenton—The Crescent Insulated Wire and Cable Co., Olden and Taylor St., will soon receive separate bids for an entire steam heating system, electric elevator and electric lighting system. Peuckert & Wundr, 310 Chestnut St., Philadelphia, Arch.

Penn., Birdsboro—The E. & G. Brooke Iron Co. plans to build a 6 mi. electric transmission line from here to iron and copper mines at Elverson to supply current for the electrical equipment used in the mine.

Md., Myersville—City plans to install an electric lighting plant and a water-works system.

Ga., Dallas—The Dallas Utility Co., recently incorporated, plans to install an electric power plant on Pumpkin Vine Creek, Paulding County. J. S. Boges, Mgr.

Ohio, Bryan—The Village plans to expend about $10,000 for extensions to its electric lighting and water-works systems.

Ohio, Cleveland—City has had plans prepared by the City Engineer, for the construction of a 3-story, 169 x 175 ft. electric lighting plant. Estimated cost, $256,000.

Ohio, Cleveland—The Steel Products Co., 2196 Clarkwood Rd., has had plans prepared for the erection of a 1-story, 50 x 60 ft. heating plant to be erected on Cedar Ave. Estimated cost, $50,000. Burchard, Roberts & Wales, Engr., 622 Swetland Bldg., receives bids until May 18. Noted Apr. 16.

Ohio, East Cleveland—(Cleveland P. O.)—The Board of Education, Shaw High School Bldg., plans to install a low pressure boiler for steam heat, also a central heating plant in Technical High School on Prospect Ave. W. H. Nicklas, Engr., 1900 Euclid Ave., receives bids for same.

Ohio, East Liverpool—City is receiving bids for the installation of a new lighting system on Main St. from 3rd to 18th St.

Ohio, Holgate—The Pleasant Light and Water Co., recently organized with $10,000, will take over the municipal plant and install additional equipment in same.

Ohio, Springfield—The Springfield Light, Heat and Power Co. has petitioned the State Utility commision for authority to issue $100,000; the proceeds will be used to purchase boilers and mechanical equipment.

Ind., Connersville—The Rex Manufacturing Co. has had plans prepared for the erection of a 1-story, 58 x 120 ft. power house. E. C. Bacon, Engr., 617 Merchants Bank Bldg., Indianapolis, is receiving bids for same.

Mich., Flushing—The Hart Milling and Power Co. is having preliminary plans prepared for the erection of a power plant, pumping station, etc. L. T. Sayre, Pres.

Wis., Brodhead—The City Council will receive bids until Apr. 30 at the office of R. F. Leger, Attorney, for the erection of a brick power plant. Noted Apr. 9.

Wis., Cedarburg—The Cedarburg Canning Co. has had plans prepared for the erection of a 2-story 20 x 80 ft. boiler and storage room addition to its plant. Estimated cost, $10,000. W. F. Helgen, Arch.

Wis., Fond du Lac—The F. Rueping Leather Co. is having preliminary plans prepared by E. Kottke, Engr., for the erection of a power plant.

Wis., Sheboygan—The Badger State Tanning Co., 3 Water St., has had plans prepared for the erection of a 1- and 2-story, 76 x 130 ft. power house, machine shop, etc. Juul & Smith, Engr., 805 North 8th St., receiving bids. Noted Jan. 22.

Wis., Superior—The Superior Iron Works, 3rd St. and Grand Ave., plans to build a 2-story, 60 x 96 ft. boiler shop. Estimated cost, $5,000.

Iowa, Keokak—The E. I duPont de Nemours Co., Wilmington, Del., is improving and building an addition to its power plant at Mooar. Estimated cost, $200,000. C. K. Weston, Wilmington, Publicity Agt.

S. D., Sherman—Bim Bros. has been granted a franchise for an electric lighting system.

Tex., Bremont—The Calvert Water, Ice and Electric Light Co., Calvert, plans to install an electric lighting system here and extend its transmission line from here to Calvert. A. E. Stoltz, Calvert, Ch. Engr.

Okla., Prague—City voted $15,000 bonds for electric lights. Noted Feb. 5.

Okla., Yale—City election soon to vote on bond issue for electric lights

Que., Montreal—O P. Tremblay, 291 Prud 'Homme Ave., Notre Dame de Grace, is in the market for 20-25 hp. electric motor and three 7 or 2-10 hp. transformers.

Ont., Sudbury—The Water and Light Committee is in the market for an electric pump with 12,000 gal. capacity and a 175 hp., 2 phase induction, direct drive, 220 volts, a.c. motor. W. J. Rose, town clk.

Ont, Toronto—The Veterinary Specialty Co., Ltd., 1595 Dundas St., W., is in the market for a 100 hp. boiler, a 75 hp. engine and 1-ton power elevator.

Man., Winnipeg—The Board of Control plans to build a gas plant here. Address A. Puttee, Controller.

B. C., Nelson—The Town plans to build an electro melting plant. A. Thomas, city engr.

CONTRACTS AWARDED

Mass., Boston—The New York, New Haven and Hartford R.R., New Haven, has awarded the contract for the erection of a 1-story, 20 x 140 ft., electric battery building, C. W. Murdock, 185 Church St., New Haven.

Mass., Cambridge—The Cambridge Electric Light Co., 46 Blackstone St., has awarded the contract for the erection of a 1-story, 44 x 69 ft. addition to its boiler house, to the J. F. Griffin Co., 17 Milk St., Boston. Estimated cost, $20,000.

Mass., Springfield—The United Electric Light Co., 73 State St., has awarded the contract for improvements to its plant, to Stone & Webster, 147 Milk St., Boston. Estimated cost, $300,000. Work includes installation of new switching equipment throughout the plant; also a 25,000 hp. steam turbine.

N. Y., Brooklyn—The U. S. Government has awarded the contract for a 1-story, 48 x 80 ft. steel power house to be erected at the Navy Yard, here, to the Westinghouse, Church, Kerr Co., 37 Wall St., New York City.

N. Y., Rochester—The Board of Contract and Supply has awarded the contract for the erection of a power plant, to A. Friederich & Sons Co., 710 Lake Ave.

N. Y., Yonkers—The National Sugar Refining Co., Main St., has awarded the contract for the erection of a boiler house, to Lynch & Larkin, 127 Downing St. Estimated cost, $40,000. Noted June 26.

N. J., Newark—The Northern Leather Works and Produce Co., Inc., 377 Broadway, New York City, has awarded the contract for the erection of a power house, to H. W. Franklin, 110 Fort Green Pl., Brooklyn.

Penn., Allentown—The Allentown Bethlehem Gas Co., a subsidiary of the United Gas Improvement Co., Broad and Arch St., Philadelphia, has awarded the contract for the erection of a generator and boiler house addition, to the Ochs Constr. Co., 442 Wire St.

Penn., Grove City—The Grove City Creamery Co. has awarded the contract for the erection of a 3-story power plant, to Rose & Fisher, 1719 Pennsylvania Ave., Pittsburgh. Noted Oct. 23.

Penn., Philadelphia—The Atlantic Refining Co., 3144 Passyunk Ave., has awarded the contract for alterations and improvements to its power house, to Metzger & Fisher, Otis Bldg. Estimated cost, $11,300.

Md., Linthicum—The Consolidated Gas, Electric Light and Power Co., Lexington St. Bldg., Baltimore, has awarded the contract for the erection of a 26 x 40 ft. addition to its power station, to the Coggswell Koether Co., 406 Park Ave., Baltimore. Noted Mar. 26.

Va., Norfolk—The Virginia Railway and Power Co. has awarded the contract for the erection of a 1-story, 50 x 100 ft substation, to Nicholas & Linderman, Seaboard Bank Bldg. Estimated cost, $11,700. Noted Oct. 7.

W. Va., Parkersburg—The Parkersburg Iron and Steel Co. has awarded the contract for the erection of a 1-story, 30 x 42 ft. power house, to the Rust Eng. Co., Farmers Bank Bldg., Pittsburgh, Penn. Estimated cost, $12,000.

Ohio, Alliance—The Dougherty Operating Co. is building a large plant here to supply current to two cities. Estimated cost, $2,225,000. M R. Bunt, Ch. Engr.

Ohio, Lorain—The American Ship Building Co. is building a large power plant here. Estimated cost, $200,000.

Ill., East St. Louis—B. Gratz, c/o the American Manufacturing Co., 1026 South 11th St., St. Louis, Mo., has awarded the contract for the erection of a 1-story, 51 x 88 ft. power plant, to L. H. Gron, Benoist Bldg., St. Louis, Mo. Estimated cost, $40,000. Noted Dec. 4.

Wis., Eau Claire—The Eau Claire Boiler and Laundry Co. has awarded the contract for the erection of a boiler house and laundry, to The Hoeppner and Bartlett Co.

Minn., Duluth—The McDougall Duluth Shipbuilding Co., 15th Ave., has awarded the contract for the erection of a large boiler shop, to McLeod & Smith, 705 Sellwood St.

Ore., Portland—The Northwestern Electric Co. has awarded the contract for the erection of an auxiliary steam plant, to C C. Moore & Co., San Francisco, Cal.

Calif., Richmond—City has awarded the contract for furnishing a 5-ton electric crane at the wharf, to the Cyclops Iron Works, 837 Folsom St., San Francisco, cost, $75,000; furnishing an electric motor, to the United Electric Vehicle Co., 1239 Sutter St., San Francisco, $4383.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Apr. 18, 1918	Individual Apr. 18, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Apr. 18, 1918	Individual Apr. 18, 1918
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Apr. 18, 1918	One Yr. Ago	Apr. 18, 1918	One Year Ago
Pea	$3.45	$2.80	$4.35	$3.70
Barley	2.15	1.50	2.40	1.75
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net tou f.o.b. mines are as follows:

	Williamson and Franklin Counties April 18, 1918	Mt. Olive & Staunton April 18, 1918	Standard April 18, 1918
6-in. lump	$2.65-3.00	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed	2.15-2.30	2.15-2.30	2.15-2.30

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba.	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, APRIL 30, 1918 No. 18

Combustion of North Dakota Lignites With Suggestions for Design of Furnaces

By HENRY KREISINGER
Engineer, United States Bureau of Mines

Convinced that those adjacent to the great lignite fields should learn how best to use this fuel and not draw upon the coal from distant mines, "Power" some time ago requested Dr. Manning, of the Bureau of Mines, to permit Mr. Kreisinger to write for "Power" an article in which he would present the results of his investigations in the commercial use of lignites in which the West and Northwest abounds. The article is therefore published by permission of Dr. Manning, Director of the United States Bureau of Mines, and is in part from a report to be submitted to the Director. Mr. Kreisinger points out that combustion is limited to about the first three inches of the fuel bed and that the CO_2 is rapidly and completely reduced to CO at about four inches from the grate, necessitating the introduction of oxygen (air) above and against the fuel bed. Because of the heat-absorbing effect of CO_2 reducing to CO and because of the high moisture content, the flame should sweep forward over the fuel bed. The horizontal grate is unsuited to lignite, a step-grate with large air openings being best adapted. The article should help those who will burn lignite because of the Fuel Administration's zone system for the distribution of coal.

THE natural lignite of North Dakota is of a brown color and has a distinct woody structure. Approximate analysis shows it to contain 40 per cent. moisture, 25 per cent. volatile matter, 28 per cent. fixed carbon and 7 per cent. ash. The heating value of natural lignite is very low, being only about 6300 B.t.u. per pound. When exposed to weather, the moisture evaporates rapidly and the lignite crumbles into small flat pieces, or flakes. Similar crumbling also takes place, to a large extent, in the fire and is one of the chief objections to burning lignite. The high moisture content and the crumbling when exposed to weather are serious drawbacks to transportation of the lignite over long distances, thus limiting the use of this fuel to comparatively small districts around the lignite mines.

To avoid these objections attempts are being made to carbonize the lignite in coke ovens or in gas retorts and use the carbonized residue as fuel. The residue has much lower moisture and much higher heat value, and for this reason there seem to be possibilities that it could find use over wider territories. The residue analyzes about 14 per cent. moisture, 9 per cent. volatile matter, 66 per cent. fixed carbon and 11 per cent. ash. Its heating value is 10,400 B.t.u. per pound. It consist mostly of small pieces, all of which pass through ½-in. screen and about 40 per cent. through ⅛-in. screen. It is dull gray, almost black in color, and under a low-power microscope appears to be of homogeneous structure, somewhat like some of the hard bituminous coals. Its specific weight is about 0.8 that of anthracite of similar size.

Combustion Qualities of Lignite and Its Carbonized Residue

In the ordinary furnace with horizontal grate the lignite of North Dakota is very difficult to ignite. The surface of the fuel bed is rather dark and uncheerful, with flames appearing only in spots. The flames are of bluish yellow color and clean, containing little soot. The crumbling of the lignite makes a rather dense fuel bed, offering high resistance to the flow of air. Some of the small pieces sift through the grate and continue to burn in the ashpit, especially if the fire is disturbed. With careless handling of the fire so much burning lignite may be sifted through the grate that the ashpit may have more fire than the furnace. In the fuel bed the processes of combustion are largely limited to the first three inches from the grate. This is probably partly due to the compactness of the fuel bed and partly to the high activity of the carbon in the lignite. The compactness of the fuel bed breaks the current of air passing up through it into many small streams, so that the oxygen and the products of combustion come in close contact with the hot carbon. The carbon may be in such form that it combines rapidly with the oxygen and also with CO_2, which acts as an oxidizing agent. The carbon combines with the oxygen passing up through the layer next to the grate and forms CO_2. The CO_2 itself is rapidly and almost completely reduced to CO three to four inches from the grate so that at the surface of the fuel bed there is practically no oxygen and little, frequently less than 1 per cent., of CO_2. The reduction of CO_2 to CO is a heat-absorbing process, consequently a large part of the heat generated in the layer next to the grate is absorbed in the upper layers of the fuel bed by the reduction. This heat absorption by the reduction process is partly a cause of the darkness of the surface of the fuel bed. The high moisture content of the lignite causes this fuel to absorb large quantities of heat and is a further cause of the darkness at the top of the fuel bed. The processes of combustion in the fuel bed are shown graphically in Fig. 1, which shows the results of some combustion experiments made at the Bureau of Mines.

The rapid oxidation limits the high temperature to a thin zone near the grate, where most of the ashes accumulate, and because of the heat tend to fuse into clinker.

The gases rising from the fuel bed consist mostly of CO, hydrogen and light hydrocarbons, all of which are easily burned. There seem to be no, or little, hydrocarbons which are likely to decompose and produce smoke; consequently the lignite, compared with bituminous coals, can be considered as a smokeless fuel. Complete combustion is further aided by the fact that the distillation of volatile matter is nearly uniform throughout a firing cycle, provided the firings are not too far apart in point of time; the distillation being uniform, it is easy to supply the right amount of air to burn lignite completely without large excess of air. When burning lignite, there are no such high peaks of combustible gases immediately after firing, demanding large air supply, as is the case with bituminous coals; in fact, the demand for air is about as uniform as it is in hand-firing anthracite coal. This feature is shown in Fig. 2, which gives the percentages of CO_2 in the furnace gases taken at 15- to 20-sec. intervals during several firings when burning lignite, anthracite, Pocahontas and Pittsburgh coals, the length of the firing cycle being the same in all cases.

The carbonized residue, being of small size, lies compactly on the grate and offers high resistance to the flow of air through the fuel bed; high draft is required even with a 4-in. fuel bed and moderate rates of combustion. This high resistance to the passage of air is probably the greatest drawback to burning the carbonized residue on a horizontal grate. The high draft is likely to blow holes through the fuel bed and make an uneven fire.

The draft required for given rates of combustion of natural lignite and the carbonized residue is shown graphically in Fig. 3. As indicated in the figure, it is practically impossible to obtain rates of combustion of 20 to 30 lb. with a 6-in. fuel bed of the residue with a chimney draft.

BEHAVIOR OF THE FUEL BED

The activity of the carbon to combine with oxygen and CO_2 is even greater than that of the carbon in the natural lignite. The oxygen passing up through the grate is all consumed in burning the carbon to CO_2, and the CO_2 reduced to CO in the first two or three inches above the grate; the upper layers in the fuel bed remain practically inactive. The reducing process keeps the gases comparatively cold and the top of the fuel bed dark, unless the rates of combustion are increased beyond 30 lb. On ordinary grates such high rates of combustion would require high draft. When the rate of combustion of about 40 lb. of fuel per square foot of grate per hour is approached, there is started a strong agitation in the fuel bed; the particles of fuel are moving so that the whole surface of the fuel bed appears like a boiling liquid. When this stage is reached, further increase in the rate of combustion is not accompanied by a proportional increase in the draft required to produce this rate of combustion. This is shown in Fig. 3, particularly by the curve for carbonized residue for a 6-in. fuel bed.

The high temperature resulting from the intensified combustion near the grate tends to melt the ash into clinker. The clinker is dense and impervious to air, and it is doubtful that rates of combustion between 20 and 30 lb. could be maintained more than two or three hours before it would be necessary to remove the clinker. The clinkering tendency is aggravated by the fact that on account of the small size of the fuel, a grate with small air spaces must be used, the air spaces not being sufficiently large to insure continual riddance of ash. The main cause of the clinkering is the low fusing temperature of the ash, which is only about 2000 deg. F.

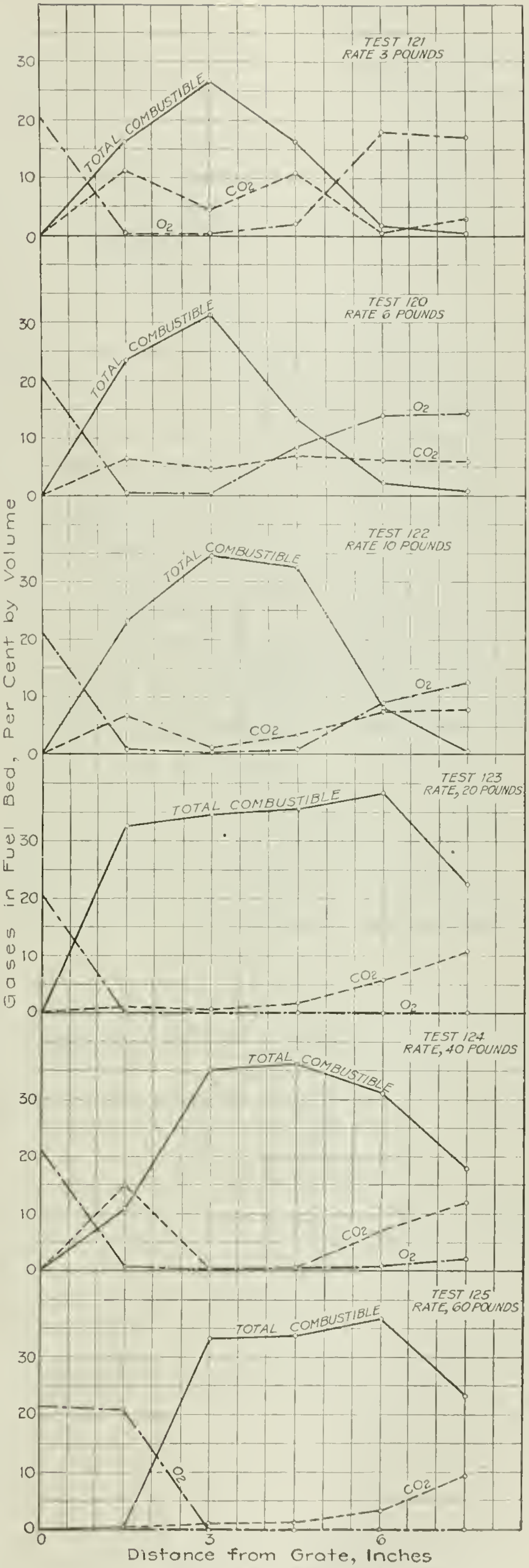


FIG. 1. RESULTS OF COMBUSTION TESTS

The gases rising from the fuel bed contain a large percentage of combustible gas, mostly CO, with no oxygen and practically no CO_2. Judging by the rapidity of the reactions in the fuel bed, it would seem that the natural lignite, as well as the carbonized residue, would make a good fuel for gas producers, the tendency to clinker, of course, being the only drawback to this fuel for this purpose.

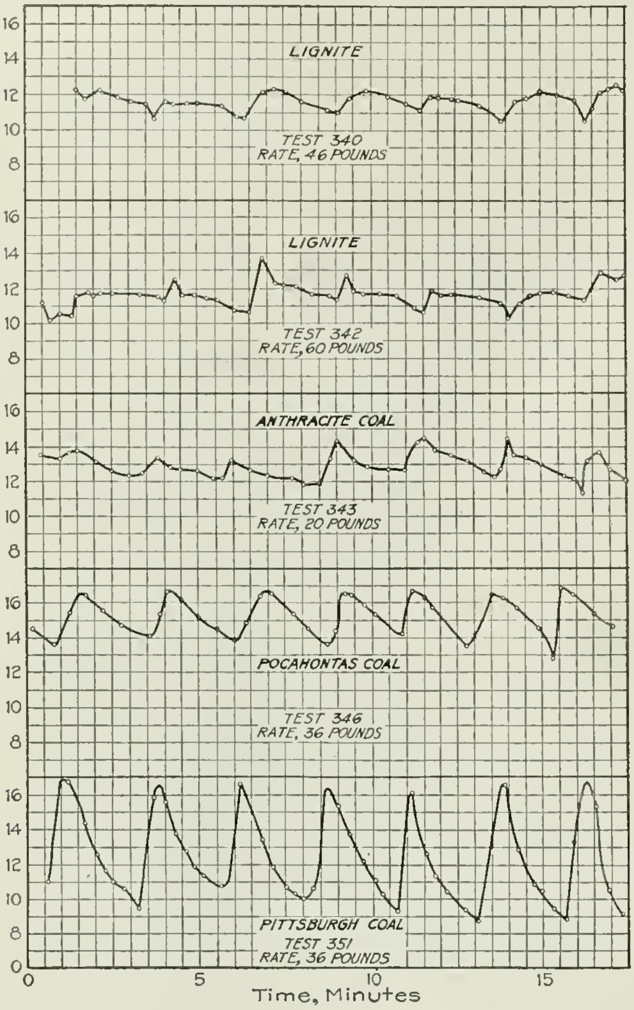


FIG. 2. CO_2 WITH VARIOUS FUELS

REQUIREMENT OF A FURNACE FOR BURNING LIGNITE AND ITS CARBONIZED RESIDUE

Any furnace that will burn the lignite and its carbonized residue successfully must fulfill the following conditions: It must have a provision for rapid ignition; it must supply enough air with ordinary draft to produce a reasonably high rate of combustion and make a hot fire; it must have a grate of such design that will prevent sifting of combustible into the ashpit and at the same time permit of cleaning the fire without impairing its function. A special furnace was designed and constructed in accordance with these requirements and with particular application to house-heating purposes. The essential features are shown in Fig. 4.

Rapid ignition is obtained by the rear arch, which turns the hot gases and flames back over the fuel bed. Thus, the incoming fresh fuel is heated not only by conduction through the fuel and radiation from the arch, but mainly by convection by coming in contact with the hot gases and flames from the already burning fuel. If a long front arch is used with no rear arch, the flames and hot gases flow away from the incoming coal and the fire has a tendency to be moved from under the arch and extinguished.

To heat lignite having 35 per cent. moisture to ignition temperature takes more than twice as much heat as is required to heat bituminous coal containing 10 per cent. of moisture. It is therefore difficult, if not impossible, to supply enough heat by radiation from the ordinary front arch to ignite the lignite. The rate of heat transmission by radiation depends almost entirely on the temperature. Therefore, to supply more than twice the heat by radiation from the arch would require that the arch be kept at considerably higher temperature when burning lignite than when burning ordinary bituminous coal. But with lignites it is not possible to obtain temperatures nearly as high as with bituminous coals. Therefore, it is plain that another factor in the heat transfer must be brought into action, and that is the heat transmission from the hot gases by convection.

The grate is inclined and has wide horizontal air spaces which can be easily kept open, permitting free flow of air through the grate. Additional air is admitted through the clinker-removing door at the lower end of the grate. As this air passes up between the arch and the fuel, it scrubs against the surface of the fuel bed and a large part of it is used in burning or gasifying solid fuel, thus making it unnecessary to force all the air needed for the gasification of the fuel through the fuel bed.

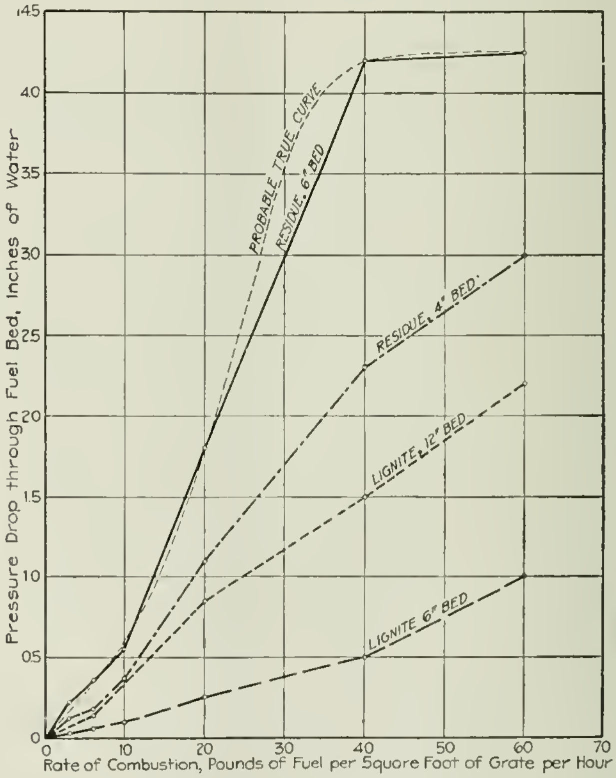


FIG. 3. DRAFT REQUIRED FOR LIGNITE

Experiments showed that the scrubbing action of the additional air caused a rapid and a rather complete oxidation at the surface of the fuel bed, indicated by the bright-red heat, which was practically absent on the tests made in an ordinary furnace with horizontal grate. Thus, there were two oxidation zones, one next to the grate and one at the surface of the fuel bed, probably with a small reducing zone between them. Because the air which enters through the cleaning door against a low resistance burns or gasifies solid fuel, higher rates of combustion can be obtained with ordinary natural draft.

The air spaces in the grate are horizontal, and the successive steps or grate bars are overlapping in such a way that there is no sifting of the combustible into the ashpit. The inclination of the grate is such that the fuel is fed from the magazine down the grate by gravity. The rate of feeding can be increased by a slight agitation or rocking of the grate bars. The fuel does not cake, and therefore the gravity feed is not interfered with as is the case with most bituminous coals. Most of the ash slides down the step grate with the fuel and finally reaches the horizontal portion of the grate, after most of the combustible has burned off. The horizontal part of the grate has small air openings through which the ash can be shaken into the ashpit. Any clinker that accumulates on this horizontal portion of the grate can be removed through the door provided for this purpose or by dumping the grate, without disturbing the fire on the inclined grate.

The thickness of the fuel bed, and to some extent the rate of feeding, are controlled by the opening of the gate of the fuel magazine.

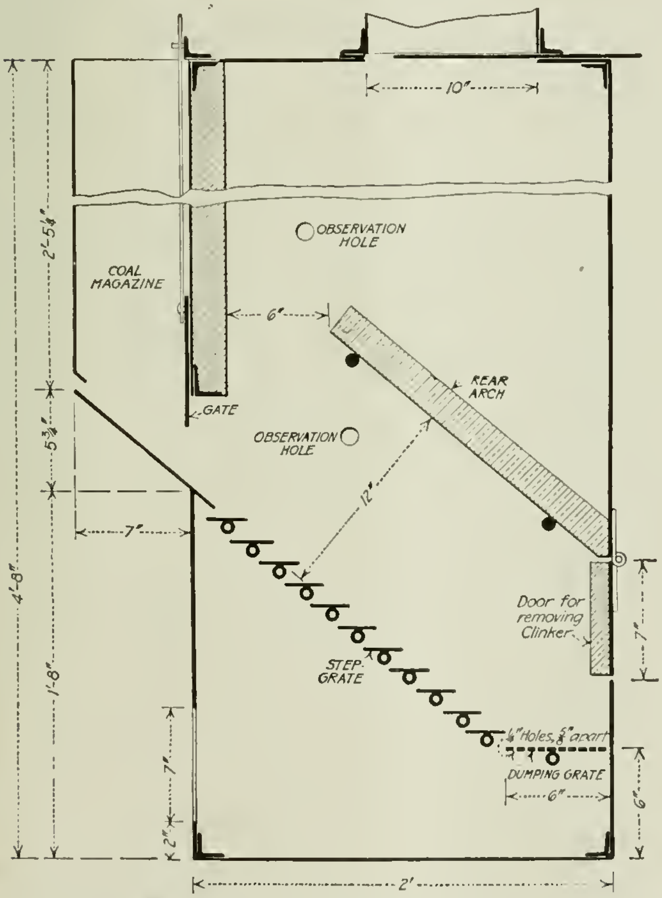


FIG. 4. EXPERIMENTAL HOUSE-HEATING FURNACE FOR LIGNITE

A fire was started in this furnace by building a small wood fire on the horizontal portion of the grate and covering the inclined portion with a bed of lignite about four inches thick. As the flames from the wood fire passed over the bed of lignite, they set it afire, so that in less than an hour the lignite over the entire grate was burning. With a draft of 0.1 to 0.15 in. of water, the lignite made a bright, red-hot fire, although the arch never became visibly red-hot. There seemed to have been considerable combustion at the surface of the fuel bed, due to the air entering through the cleaning door and scrubbing the surface.

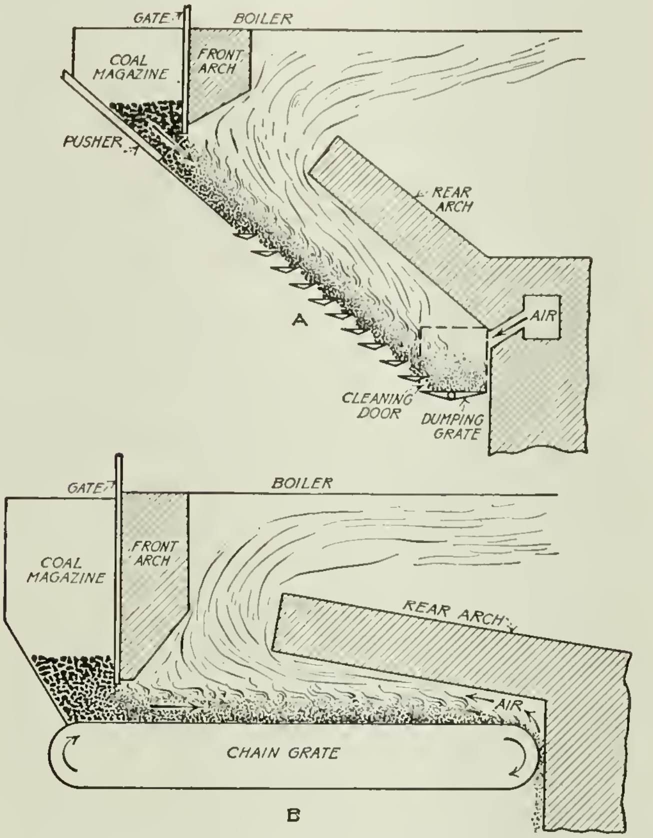


FIG. 5. PROPOSED ROUGH DESIGNS OF FURNACES FOR BURNING LIGNITE UNDER BOILERS

When the lignite was broken to pieces not exceeding about two inches, the feeding of the fuel was nearly automatic. With larger pieces the fuel had to be occasionally moved down by moving the grate bars or by poking the large pieces through the magazine gate. The fuel contained a considerable amount of slack, which, however, did not seem to cause any particular trouble. Some clinker was found on and near the horizontal portion of the grate. This clinker was very porous and floated in the free ash without touching the grate, and seemed to have been formed near the surface of the fuel bed. It was removed by hooking it out from the horizontal portion of the grate, and the fine ashes were shaken through.

The carbonized residue, on account of its uniform size, flowed down the inclined grate without any help and made a rather intense fire wholly out of comparison with the sluggish fire that could be obtained on a horizontal grate. In fact, it seems that the carbonized residue, when burned in this special type of furnace, would make an ideal fuel for house-heating purposes.

The principles embodied in the design of the special furnace shown in Fig. 4 can be applied to boiler furnaces with a promise of success. Fig. 5, diagram *A*, suggests the design of an inclined step-grate boiler furnace. The fuel can be fed down the grate by gravity aided by hand regulation, or it can be pushed out of the magazine mechanically by a pusher plate. The horizontal air spaces between the step-grate bars can be kept open easily by hand poker or by rocking the grate bars. The clinker can be removed through the side cleaning door, or it can be dropped by the dumping grate. The fine ashes accumulate on the dumping grate through which they can be shaken into the ashpit. The air is admitted through the horizontal air spaces between the step-bars of the grate and through the special openings at the end of the grate. Probably two-thirds to three-fourths of the air needed for combustion should be introduced at the end of the grate, so that as the air passes between the fuel bed and the arch it scrubs over the surface of the fuel bed and burns the coal. This air enters the furnace against a very small resistance, therefore a comparatively small draft may bring large quantities of air into the furnace and produce a fairly high rate of combustion. The air entering through the air spaces between the grate bars has to pass through the fuel bed against a comparatively high resistance, and it would require high draft to supply enough air to gasify the solid fuel.

Air Admission to the Fuel Bed

There should be as little air as possible entering through the coal magazine or through the plate in front of the coal magazine, where the fuel is merely being dried and does not burn. The completeness of combustion should be controlled by regulating the air admitted at the lower end of the grate and not by regulating the admission of air through the magazine. The air admitted through the magazine does not help in burning solid coal, but merely assists in burning the gases rising from the lower portion of the fuel bad. The gases rising from a fuel bed of lignite consist mostly of carbon monoxide and hydrogen, which are comparatively easy to burn, so that the flames would not extend too far beyond the top of the arch. The comparatively narrow space between the rear arch and front arch would help in bringing the air and combustible gases together, and cause intimate mixing. There would probably be a considerable amount of the fluffy ash carried with the gases. As soon as the gases pass beyond the contraction between the two arches, they expand and their velocity slows down, causing the ash to be deposited on top of and beyond the rear arch; so that comparatively little ash would be carried into the boiler.

The special openings for introducing air at the end of the grate would not fuse over because they do not come in contact with the hot gases and the slag which the gases contain.

Diagram *B*, of Fig. 5, shows the application of the principles to a chain grate. The diagram shows the grate in horizontal position, but it is believed that better results could be obtained if the top of the grate were inclined about 20 deg. to the horizontal.

The motion of the grate feeds the fuel into the furnace, and the thickness of the fuel bed is controlled by the opening of the gate. The air needed for combustion is introduced through the openings in the grate bars and in the rear of the grate where the ashes are discharged into the ashpit. In this case the air which enters the furnace between the end of the grate and the bridge-wall is used to burn the solid fuel on the grate as it is made to pass between the arch and the fuel bed toward the front of the grate, and therefore helps both in the rate and the completeness of combustion, and is not detrimental to efficiency, as it is with the ordinary chain-grate furnace.

Provisions should be made to stop the admission of air through the coal magazine and through the front part of the grate, where the lignite is being dried. When burning lignites, it is improbable that the furnace temperature will be high enough to injure the arch. With the CO_2 (carbon dioxide) averaging between 13 and 14 per cent., the furnace temperature will not exceed 2200 deg. F., and with the top of the arch exposed to radiate heat to the boiler above it, the arch would probably never get above 2000 deg. F. There are plenty of refractory materials that will hold under such temperatures. When burning carbonized residue, which does not contain such a high percentage of moisture as natural lignite, higher temperatures might be obtained. If these temperatures would be too high for the material in the arch, the latter could be constructed of special tiles suspended from water tubes, which could be made a part of the boiler. Similar construction is used on arches in locomotive furnaces. It should be borne in mind that, since the arches are inclined, only the horizontal component of the weight of the arch acts in pulling the arch down.

These furnaces can probably be used for burning other low-grade fuels that are difficult to ignite.

Something About Pumps

One Saturday afternoon as Willis was on his way home after shutting down for the week's end, he dropped into the engine room of the Stahley Manufacturing Co.'s plant, where an engineer by the name of Williams was in charge. He found Williams working on a pump that was used for returning the water of condensation to the boilers, and a much disgusted person he was at that particular instant.

"How is she coming," asked Willis, as he moved over toward the pump. "You seem to be up to your eye-teeth in trouble this afternoon."

"Trouble's no name for it. Here I am stuck for the day, while the rest of the fellows are off until Monday morning, just because this blamed pump won't work any better than a dog's front legs when it comes to scratching fleas."

"Well, a little thing like a pump should not keep you here very long. What seems to be the matter with it first and last?"

"She won't handle the hot water for a cent. I don't know what's the matter with the dum thing."

During this little conversation Willis had been inspecting the rings of packing that Williams had removed from the water end of the pump and discovered that they were designed for cold water and not at all fitted to pump hot water such as the pump had been handling.

"Where did you get this packing," he asked as Williams straightened up to get the kinks out of his back. "Get it at a rummage sale?"

"No, I got it a few days ago from a fellow who said his packing was just as good as what we had been using and a little cheaper. I fell for his line of talk and have had trouble ever since. What's the matter with the stuff? Do you know?" he asked as he noted the amused look of Willis.

"Surest thing you know," replied Willis. "This packing might be all right for cold water, but for hot water such as you are trying to make this pump handle you might just as well pack it with cheese cloth and be done with it. You put in some packing that is made to work with hot water and I calculate the pump will get down to business in no time. Williams," said Willis, "you can make up your mind to one thing if not another, and that is that when a machine won't do its work there is a good reason, and when it has been working all right for a spell and then suddenly goes wrong, you can gamble that some simple thing has taken place that can be easily remedied. The best thing a fellow can do in such a case is to think a little and see if he hasn't done something that might be responsible for the trouble.

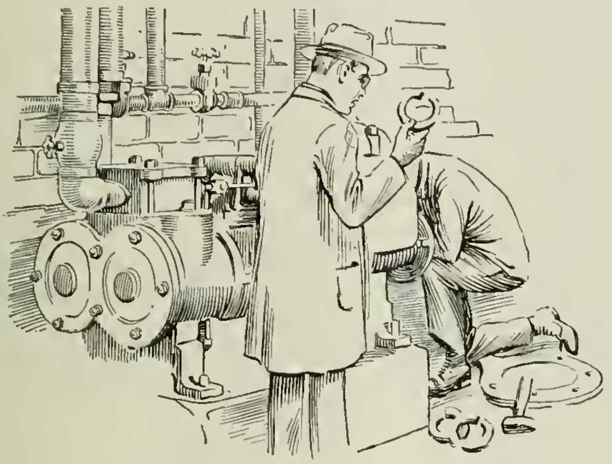


FIG. 1. "WHERE DID YOU GET THIS PACKING?"

"Now in your case if you had got in a think or two you would have come to the conclusion that something must have happened to the packing, seeing it was the only thing on the pump that was different from the regular state of affairs, and then you would have found, if you had read the label on the box, that the packing was not the kind for the work. Of course you can generally tell by the looks of a packing what kind of water it will handle, although it might be a little difficult in some cases, but this box is plainly marked 'For use with cold water,' as I have observed since I dropped in here. Now I didn't mean to preach you a sermon, but carelessness usually is responsible for most of our troubles and don't you forget it."

"Maybe, maybe," answered Williams, "but that ain't always the case, not by a long shot."

"I never told you about Silas Wetherbee, did I? Well, Silas had a new pump come one day, and after he had got it piped up as spruce as a young feller going courting for the first time, he started it up and the pump was as dry as a one-year old brindle bull. All the prominent engineers around about were called in to set matters right, but although the pump piston would shoot back and forth there wasn't any water coming out of the discharge pipe.

"The pump was of good make; in fact, Silas had another one that had never given any trouble, and he couldn't imagine why the new one wouldn't pick up and go on about its business the same as any decent pump should.

"As it happened, I strolled into the plant when about everyone had condemned the pump to the hottest place they could think of and Silas asked me to try my luck at it. He told me about every thing that had been done to get it started, and I decided there wasn't any use in going over the same road the others had traveled.

"Well, to make a long story short I got Silas to break the suction pipe pretty close up to the pump and then got a pail of water and stuck the short end of the suction pipe in it. Silas started up the pump and that water disappeared quicker than you can say scat. We tried it again and the same thing happened, and I told Silas I calculated that if the pump could get water there wouldn't be any trouble about its throwing a stream out of the discharge pipe to wherever he wanted it to go."

"What was the matter with the pump that it wouldn't take water? Another case of using packing that wasn't fit for the work?"

"Nothing of the sort. The dom idiot had connected the suction pipe to an old one that ran to a pond a little distance away, but which for some reason or other had been abandoned and the suction end left about a foot above the water. Naturally, the water wasn't going to make no hop, skip and a jump that distance into the suction pipe just to please Silas or anyone else.

"Silas said the cigars were on him, and I guess they were for I never saw any of them. However, that little incident goes to show that a feller can put up an awful holler when the fault is his own."

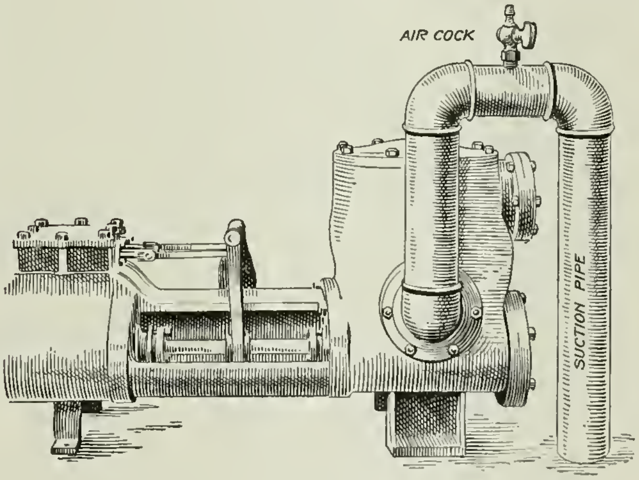


FIG. 2. "WE PUT A PET-COCK IN THE SUCTION PIPE"

"I don't see why anyone would pipe up a pump to an old suction pipe without knowing whether it was in good condition or not."

"You wouldn't think it any more than that a fellow would use cold-water packing to pump hot water," answered Willis with a grin.

"Sometimes a fellow gets a surprise when a pump won't work. I remember some years ago in one plant where I worked a large pump that was used only occasionally was always supposed to be in good condition. The suction pipe was fitted with a foot valve, and it had always worked to perfection. One day I wanted that pump in a hurry, and when steam was turned on there was nothing doing.

"Naturally, I went over the thing and could find nothing out of order. Finally, the foot valve was examined, when we found that the pump valves were dry and the cause of the trouble was discovered to be due to leaves that had lodged against the foot valve and so prevented water from getting up into the pump. Of course the pump had run down, which accounted for the dry valves.

"Foot valves have caused me some trouble, but on the whole I take it that they are better than nothing on the end of the pipe, as they keep fish, eels and other rubbish from getting into the pipe. I always have 'em on my suctions unless the water is coming from a well where there is but little danger of the pipe taking anything large enough to get stuck in the pump valves."

"Yep, I know," answered Williams, "but just the same that foot valve came off the pipe and mighty quick at that. I don't see what there was to prevent the pump from running down without the foot valve just as easily as it did with it on and the clapper stuck open."

"If you will only give me a chance, I'll tell you what was done. You see, we ran the suction pipe up to a point a little above the top of the pump-valve deck and then capped it with an elbow in which a long nipple was screwed. On the other end of the nipple another ell was fitted and the other end of it was fitted to a pipe that connected with the pump. This arrangement gave two legs to the suction pipe, and as the long nipple was fitted with an air valve it was an easy matter to cut the pipe into two sections, so that when the water in the pipe from the supply started to run down, the water in the pipe connected to the pump would remain where it was, and it was there when we wanted to start up. The only thing we had to remember was to open the air-cock when shutting down the pump, just to cut the water into two separate bodies."

"Well, I suppose pumps are necessary about a steam plant, but I wish that someone would get up something that would work without valves and pistons in handling hot-water returns. Then there would be less gloom, for me at least. A pump is a nuisance anyway."

"Why, Williams, you don't mean to say that you don't know of a way to get your returns back into the boiler without a pump, do you? Didn't you ever hear of the return loop? No? Well, I ain't got the time to tell you about it just now, as I have got to get home so as to keep peace in the family; but the next time I get a chance I'll drop in and give you a few pointers on the loop that may come in handy some time or other. Now I guess I'll meander along and see what the old lady's got for dinner."

Whitewash and Fire-Retarding Mixture

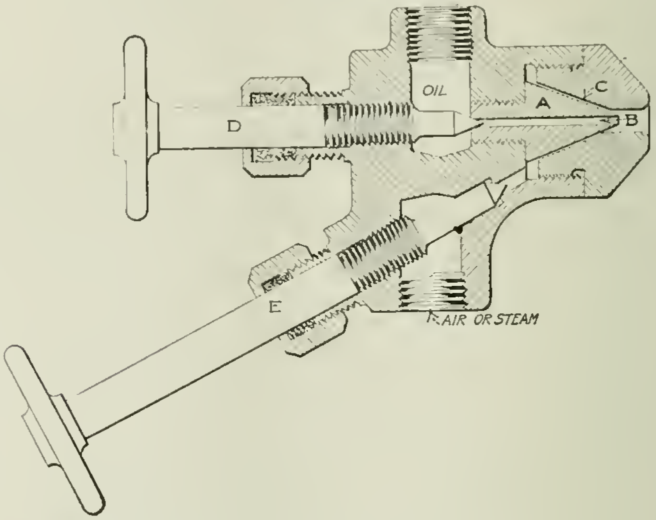
Following is the formula for what is known as the United States Government whitewash mixture, which also acts as a fire-retarding coating over interior wooden surfaces: Slake ½ bushel of quicklime with boiling water, keeping it covered during process; strain and add 1 peck of salt dissolved in warm water; put 3 lb. ground rice in water and boil to a thin paste; ½ lb. of powdered Spanish whiting; 1 lb. of clean glue dissolved in hot water. Mix well and let stand for several days. Keep in kettle or receptacle and apply as hot as possible with a whitewash or paint brush.

Anderson Fuel-Oil Burner

In burning fuel oil its atomization must be thorough, and in order to attain this result a proper burner must be used and the more simple its construction the better. Oil burners are of two types, inside and outside mixing. In the former the oil and steam come in contact inside of the burner and the mixture is atomized in passing through the burner nozzle. In the latter type the steam passes through a narrow slot or through a series of small holes below a similar slot through which the oil flows, the oil being picked up by the steam outside of the burner and thus atomized by it.

An oil burner of the inside-mixing type has recently been perfected by the N. C. Davison Gas Burner and Welding Co., 3145 Penn Ave., Pittsburgh, Penn.

The device consists of a central cone *A* with an oil opening *B* through the center. The oil is atomized by air or steam that is admitted through the cone-shaped opening *C* surrounding the oil cone. The air or steam crosses the oil just at the mouth of the nozzle *A* and atomizes the oil, so that immediate combustion takes place without smoke, even in a cold furnace. The flames can be cut down to 1 ft. in length or increased to as much as 18 ft. The burner is simple in construction and is easily operated. The needle valves *D* and *E* are for hand-controlling the oil and air supply respectively.



SECTION THROUGH THE ANDERSON OIL BURNER

As a matter of fact, three types of oil burners are made. The first is a straight oil burner in which air or steam is used for atomizing. For this purpose a pressure of from 30 to 100 lb. of air or steam is used and an oil pressure of from 5 to 50 lb. Then there is a combination oil and gas burner for use where gas can be had part of the time. Air for gas is supplied at from 4 to 8 oz. and high-pressure air or steam when using oil. The third type of burner is for oil when air at low pressure is used for atomizing. This air can be used at a pressure of from 6 to 10 oz. This burner is made either for straight oil burning or for a combination of oil and gas, both fuels being supplied with the low-pressure air.

These burners are suitable for use under steam boilers, with openhearth furnace-ingot and billet furnaces, core ovens and all types of down-draft kilns and ovens. Wherever coal, coke or gas is used, the burner is adaptable.

From Superheated Steam to Blast-Furnace Gas Engines

By A. L. Fritz

Converting an experienced steam-engine operator into a blast-furnace gas-engine operator cannot be thoroughly accomplished in a few days' time. From superheated steam to blast-furnace gas is a long, hard jump, and having measured the distance, so to speak, I know that it is a hard proposition.

After operating cross-compound horizontal-vertical steam engines for five years, I was suddenly transferred to a blast-furnace gas-engine room containing four 3000-kw. units, and that yellow transfer card, once it became effective, turned out to be a round-trip ticket to His Satanic Majesty's winter resort.

I was put to break in with an experienced gas-engine operator, and his only fault was his creed, for it was his personal contention that every gas engineer could find out things for himself, because that was how he got his. Such reasoning is good enough if it is not carried to extremes, but that was what he did, with the result that when I began to fight those engines alone I soon found that there were a number of little kinks in my new job that I would have to unravel, and do it mostly on my own initiative.

Of course I was told and shown how to start and stop a unit and also instructed as to the running position of the ignition under normal conditions, but I was not told anything about some of the abnormal conditions that eventually made their appearance.

Left Alone With Units in Service

After four days of breaking in, I found myself alone with three units in service and the pilot light signifying that the switchboard operator required the fourth one. This unit had been idle about eight hours, and as blast-furnace gas is very irregular, when I got started up and got the machine in phase, the needle on the indicating meter forgot to stop at its usual position, but passed it going and coming; in other words, the needle went from pin to pin, from nothing to 4000 kw. It required only about five minutes of that swinging load to make the switchboard operator a raving maniac, so to speak.

I tried to quiet the engine down by changing the air intake on the mixing chambers, but the more air levers I moved the more the engine bucked the load. With prematuring and nonexplosions it took but a short time to acquire a severe gas headache, and I began to wish someone else had my work card for the time being.

Conditions got far below anything they were used to (on account of my swinging), and to get me out of a bad hole my former instructor was called in. He made two trips around the engine, pulled his cap to one side of his head, gazed at the meter needle and it suddenly stopped its wild rampage and indicated 2800 kw. I asked the gentleman what was wrong and what he did to rectify it, and he curtly replied, "nothing."

I knew right then that he didn't carry a paid-up membership in any "Honest Jawn Club," and I also knew that it was up to me to "get onto" what I didn't know.

After weeks of hard, bitter scrambling, coupled with many a gas head, I learned to really handle the engines. During this time I learned something of the ill temper of such a machine, and it dawned on me that the gas engineer really earned his extra dollar per turn above the steam operator's rate.

My relief was an experienced operator, and although he told me very little, he always left the watch shipshape, and I acquired the blue-chalk habit. For instance, I had a chalk mark on all the air levers on the mixing chambers, and if a unit got to swinging, I could change the air; and if it didn't get results, I could put it back where it belonged. In this way I usually found the trouble before I got around to the last lever.

Locating the Cause of Trouble

Sometimes it would be a dirty brush on the ignition, a grounded ignitor, or a fuse blown out, and once in a while a unit would swing on account of too much cold circulating water. Again, it might swing on account of a shoe slipping down on a multiplying lever on an air-inlet valve; a brush-holder might work loose, letting the brush get out of line with the commutator, thus making the contact too early or too late on that ignitor and therefore causing a jerk in the load.

I gradually learned to judge conditions, and eventually I got the whip hand over the operating kinks that go to make the gas-engine log sheet look good to the "Old Man." I found out that by keeping the circulating water at a normal temperature in the pistons and cylinder jackets and a regular oil feed for cylinder lubrication, my trouble invariably dwindled down to air mixture.

It is important, in gas-engine operation, to govern the amount of lubrication closely and to be sure it is not fed hit-and-miss, but a drop in each spray to every three turns of the layshaft, for instance. Furthermore, increase the oil feed on a cylinder if it gets to backfiring very much, as backfiring causes dry spots on the cylinder walls and pistons; but do not flood a piston to remove a black spot; use a few applications of kerosene and then adjust the lubricating oil to that individual unit.

Watch the clearance on the inlet- and the exhaust-valve lifts and see that there is at least a $\frac{1}{16}$-in. clearance. Keep the gas lift equalized on all inlet valves and also keep the ignition equalized on both sides of the engine. See that the swing joints do not leak and ruin the oil circulation. Try both oil pumps every day on each unit to see that they are in order and keep the expansion joints tight.

Operator Must Learn Pulse of Engine

It is up to the operator to learn the pulse of each engine, for the natural circumstance under which a gas engine operates tends to work things loose—a great deal more so than the even pulsing stroke of a steam engine—and it pays to thoroughly inspect each unit frequently.

And last but not least, by all means cultivate the good will of the switchboard operator; cater to his professional hobbies relative to gas engines. His job is no sinecure, for gas engines make his a hard task, and if his ethics of coöperation are the least bit below par, he can make life miserable for the unfortunate who happens to be the man behind the throttle on a blast-furnace gas engine.

Current-Transformer Connections

By W. R. WOODWARD

Engineer, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn.

A description is given of two types of current-transformer construction, and then the reverse "V" and the star connections of this type of apparatus are discussed.

CURRENT transformers are used for one or both of two purposes; namely, to reduce the current in the circuit to a value suitable for use with instruments or to insulate the instruments from the high-tension circuit. They are so designed that the secondary current is a definite proportion of the primary current for practically any value of primary current which may flow.

The current transformer is simple in construction, consisting of a primary and a secondary winding, both of which inclose a laminated iron core. The primary winding consists of a large number of turns of comparatively small wire, when the transformer is built for a low current (say 10 to 5 amperes) and of a small number of turns of heavy wire or strap when built for a large current (say 100 to 5 amperes). The secondary is usually wound for 5 amperes and has a large number of turns of about No. 12 wire.

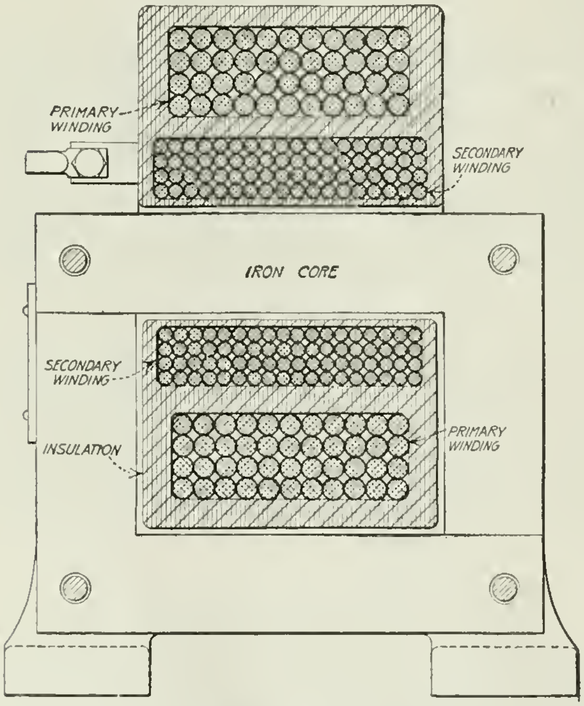


FIG. 1. SECTIONAL VIEW THROUGH A COMMON TYPE OF CURRENT TRANSFORMER

If the primary winding is to be used in a high-tension line, it is insulated from both the core and secondary winding, as shown in Fig. 1, which gives a cross-sectional view of a typical transformer. Figs. 3 and 4 are general views of the same piece of equipment. Fig. 3 is for stationary service, and Fig. 4 is a similar piece of equipment to that shown in Fig. 3, fitted with a handle to make it portable. Terminals P are the primary and S the secondary. A maximum voltage rating is usually given on the nameplate, which merely indicates the strength of the insulation, and the transformer must not be used on voltages above that rating, but may be used on any voltage below it. For instance, a transformer marked 6900 volts maximum may be used on a 2300- or 110-volt circuit, but not on an 11,000-volt circuit.

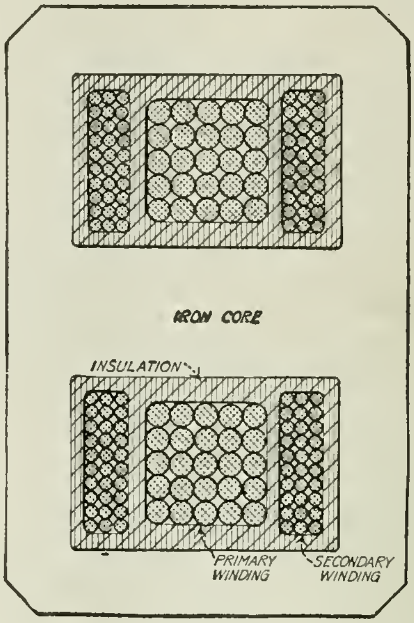
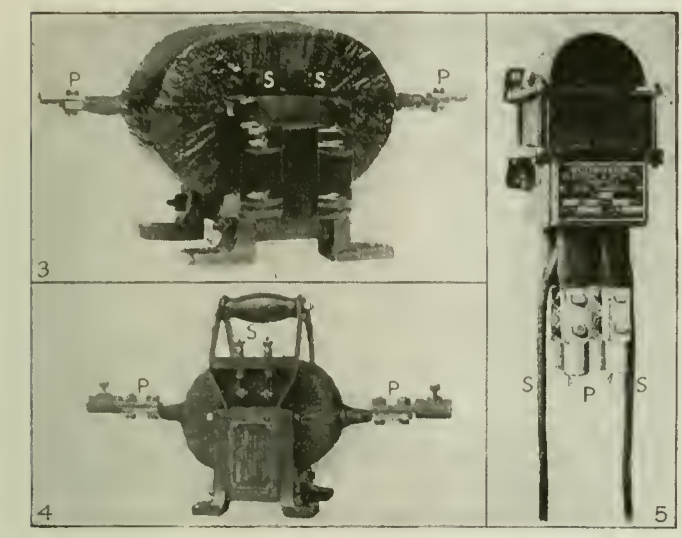


FIG. 2. SECTION THROUGH CURRENT TRANSFORMER USED FOR EITHER LOW OR VERY HIGH VOLTAGES

In a particular type of current transformer, such as shown in Figs. 1 and 3, the number of secondary turns is practically the same for any ratio, the only difference between transformers of different ratios being the number of primary turns and size of primary conductors.

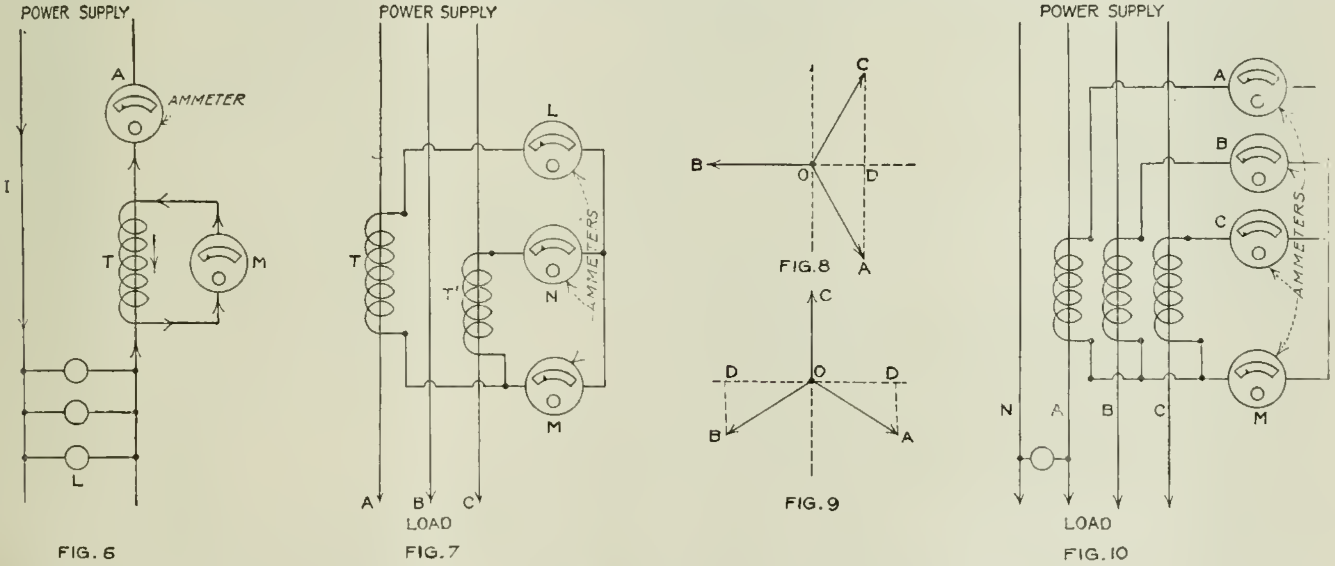
Figs. 2 and 5 are a cross-sectional view and a general view of another type of current transformer having a different arrangement of winding and core to that in Figs, 1, 3 and 4. This type is commonly used for low voltages, 2300 or less, and also for very high voltages, 33,000 and above. It is suitable only for designs where the primary leads can both be conveniently brought out from the same end of the transformer, as in house wiring, where a transformer is installed on low voltage for a watt-hour meter or for high-voltage, oil-insulated transformers. The type, Fig. 3, is better where the primary leads are arranged to come out at opposite ends and is convenient for switchboard mounting.

The action of a current transformer can best be understood by remembering that in any transformer the current flowing in the secondary winding flows around the core in a direction opposite to that flowing in the primary and that the secondary ampere-turns (current × turns) are practically equal to the primary ampere-turns. The reason they are not equal is that the primary winding also carries the exciting current. In the current transformer the proper ratio is obtained by changing the primary turns as mentioned in the foregoing, and the error due to the exciting current is reduced to a small value by working the iron circuit at a much lower magnetic density than is common practice in ordinary constant-potential transformers. The magnetic density in the iron, and consequently the exciting current and ratio value, depend upon the impedance of the meter load connected to the secondary of the transformer.



FIGS. 3 TO 5. TYPES OF CURRENT TRANSFORMERS

If a large number of meters having a high resistance or impedance are connected to the transformers, a considerable voltage is necessary to make the current flow through the meters. To develop this voltage a certain flux must pass through the magnetic circuit, which in turn requires primary exciting current or ampere-turns which are not reproduced in the secondary winding. If the number of meters be reduced, the voltage developed in the secondary winding becomes less, thereby reducing the exciting current and improving the ratio. The secondary voltage developed will always be only the amount required to force the secondary current through the meter load. If the secondary resistance be increased to infinity (that is, becomes open-circuited), the secondary voltage will rise to the maximum (that is, the iron will become saturated). This will cause the iron to heat up, and the voltage across the secondary terminals becomes very dangerous.



FIGS. 6 TO 10. CURRENT-TRANSFORMER CONNECTIONS, AND VECTOR DIAGRAMS SHOWING THE CURRENT RELATIONS OF CURRENT TRANSFORMERS CONNECTED IN A THREE-PHASE CIRCUIT

A single-phase circuit having a current transformer *T* is shown in Fig. 6, where *L* represents the load of the circuit and *I* the current flowing in the direction shown by the arrowheads at a particular instant. The meter *M*, connected in the secondary of the current transformer, has a scale marked to indicate the current flowing through the load, thereby taking account of the ratio of transformation in the current transformer. The meter *M* therefore reads exactly the same current a direct-reading meter would if connected in the line at point *A*.

The connections of current transformers on polyphase circuits are in some cases rather complicated; in this article, however, the more common connections will be considered in detail.

The most common connection for three-phase three-wire circuits is the reversed "V" connection shown in Fig. 7, in which two current transformers *T* and *T'* may be used to indicate the current in all three wires. The current from the transformer in phase *A* flows through instruments *L* and *M* and, so far as instrument *L* is concerned, is essentially a single-phase connection, therefore instrument *L* will indicate the current in the line *A*. Similarly, the current from the transformer in phase *C* flows through instruments *N* and *M*, therefore instrument *N* indicates the current in line *C*. The combination of the currents flowing through meters *L* and *N* passes through meter *M*; this will cause the latter to indicate the current in line *B*. This fact is illustrated by the vector diagram in Fig. 8.

In considering the vector diagram, Fig. 8, let it be assumed that when the arrows point to the right the current is flowing in a particular direction which will be called positive, and when the arrows are pointing to the left it is flowing in the opposite direction, or negative. When the arrows point up or down, the current will therefore be zero, and the value of current in any line will be proportional to the distance from the vertical line drawn through *O* to the point of the arrow.

The currents in the lines *A* and *C* are represented in Fig 8 as both being positive and each to be one-half their maximum value; that is, their projection on the horizontal axis, or distance *OD*. The current in line *B* is represented as being negative and at its maximum value. Now the law of electric currents, known as Kirchhoff's Law, is that at a junction of conductors, such as at *O*, the sum of the positive and negative currents is zero; that is, any current flowing into this point on one or more conductors is equal to the current flowing out of the same point on one or more other conductors. The current in *B*, being negative, flows toward the point *O*, and is, therefore, equal to currents *A* and *B*, flowing away from this point. Therefore the current in line *B* is the vector sum of the currents in the lines *A* and *C*. Now, since the currents in the instruments *L* and *N* are exactly proportional to the currents in the lines *A* and *C*, the current in *M* must be proportional to the current in *B*.

In Fig. 9 the current in *C* is illustrated as being zero, and at that instant the currents in *B* and *A* are equal. The current in instrument *N* is, therefore, zero, and since the current from *A* flows through the meters *L* and *M*, their readings are necessarily equal, which, as can be seen from the diagram, is necessarily the case, since the projections of *OA* and *OB* on the horizontal are equal.

This connection for instruments may be used for ammeters, relays, trip coils, the current coils of wattmeters or power-factor meters, and, in fact, any current carrying coil whatsoever. However, there are some objections to using this connection for protective relays and trip coils, which will be considered later in a discussion of the "Z" connection.

METER INDICATION ALSO CORRECT FOR UNBALANCED CONDITION

In the foregoing we have considered that the three-phase load was perfectly balanced. The indication of the meters, however, will be correct as well for any unbalanced condition. The worst unbalancing possible is to have a single-phase load on two wires, with no load on the third. Suppose a single-phase load is connected across wires *A* and *B*, the currents in the two legs of the circuit will then be in direct opposition to each other; that is, if the current in *A* is positive, the current in *B* will be negative and of the same value. The current from transformer *T* will flow through instruments *L* and *M*, indicating an equal load on wires *A* and *B*, and no current will flow in *N*, indicating no current in *C*.

Suppose, again, that a single-phase load is connected to lines *A* and *C*. The current from line *A* will flow through instruments *L* and *M* as before, and current from line *C* will flow through instruments *M* and *N*. These currents tend to flow through instrument *M* in opposite directions and, being equal, are canceled. Instrument *M*, therefore, indicates zero current in line *B*, which is correct.

In case of a three-phase four-wire system, it is necessary to use three transformers, which are usually connected in "Y" or star, as shown in Fig. 10. Since it is possible for some load to be connected between one phase and the neutral, such as between *A* and *N* as shown, the current on the other phases is thereby unbalanced so that it is necessary to use three transformers. With the connections as shown, each instrument being connected to a transformer in each phase, the operation is essentially the same as for single-phase. The current which flows in *A* does not necessarily flow in *B* and *C*, but a portion may be carried off on the line *N*. The instrument at *M* will indicate the value of current flowing in the neutral wire *N*.

Burning Rhode Island Anthracite

According to a report issued by the Locomotive Pulverized Fuel Co., of New York City, tests were recently made at Olyphant, Penn., with regard to the utilization of pulverized Rhode Island anthracite in comparison with Pennsylvania anthracite. The Rhode Island coal used was mined near the surface and before being prepared for the test had been lying exposed to winter weather, so that the moisture content was high.

The tests were conducted on a 465-hp. Stirling boiler that had been in regular service with pulverized Pennsylvania anthracite as fuel. About six tons of the pulverized Rhode Island coal was substituted during the regular operation of the boiler, with no changes in the furnace, feeding equipment or operating adjustments, to compare the combustion results. No difficulty was experienced and the combustion was satisfactory.

A second test was made to determine the relative combustion and boiler efficiency, under approximately the same operating conditions, with Pennsylvania anthracite bird's-eye and Rhode Island anthracite. The latter fuel burned in practically the same manner as the former, but there was a greater accumulation of ash in the slag pit. The relative properties of the two fuels may be seen from the following:

	Pennsylvania Per Cent.	Rhode Island Per Cent.
Moisture	0.92	0.42
Volatile matter	6.82	6.65
Fixed carbon	74.55	62.75
Ash	18.63	30.60
Sulphur	......	0.82
Fineness, through 100-mesh	98.00	99.00
Fineness, through 200-mesh	90.00	93.00
Heating value (calculated) B.t.u. per lb. dry coal	11,830	9,785

The comparative results obtained in the tests of the two fuels are given in the following table:

RESULTS OF PULVERIZED FUEL TESTS

	Pennsylvania Anthracite	Rhode Island Anthracite
Duration of test	Continuous	4 hr. 20 min.
Average boiler pressure, gage	141 lb.	140 lb.
Factor of evaporation	0.978	0.991
Horsepower developed	460	386.5
Weight of fuel used	46,096 lb.	8721 lb.
Weight of water evaporated	388,356 lb.	58,300 lb.
Actual evaporation per pound of coal	8.42 lb.	6.68 lb.
Equivalent evaporation from and at 212 deg. F. per pound of coal	8.24 lb.	6.62 lb.
Boiler efficiency, per cent	67.3	65.65

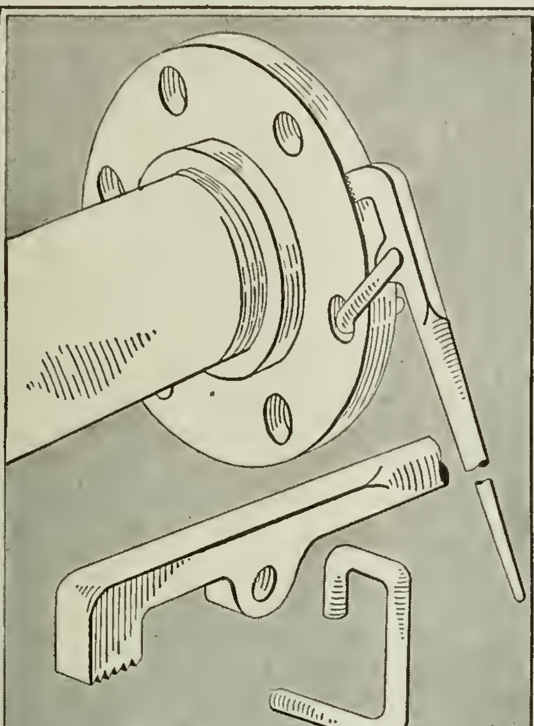
The Rhode Island coal used in the tests was some of the byproduct from mine operations on a tract of graphitic anthracite, which is being worked primarily for graphite. It pulverized and was dried with less difficulty than the Pennsylvania anthracite.

Every Liberty Bond you buy is a safe financial investment in the future happiness and self-respect of your children. Buy as many as you can and let them inherit as good a country as you did.

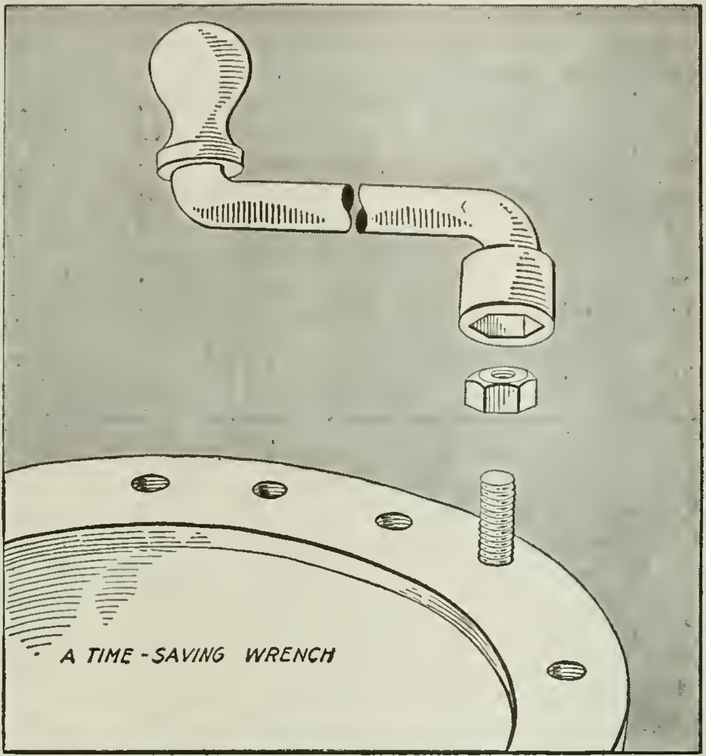
Bondholders, don't shout until you are out of the war woods. The danger is still here. Buy bonds until the war is over.

From an Engineer's Notebook

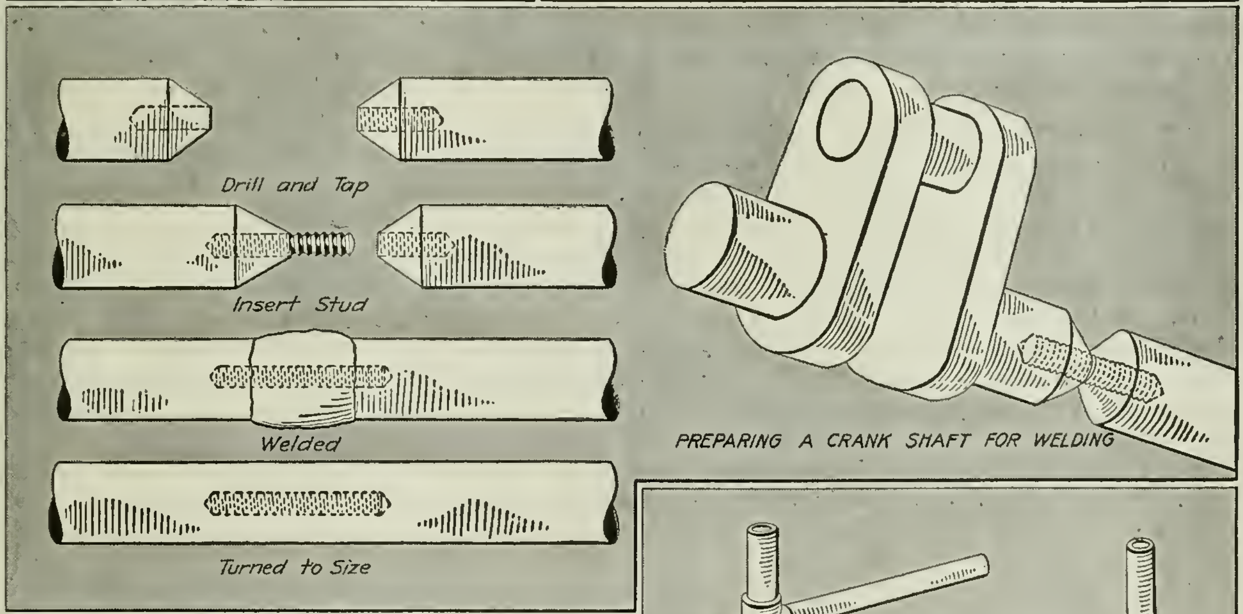
By M. P. Bertrande



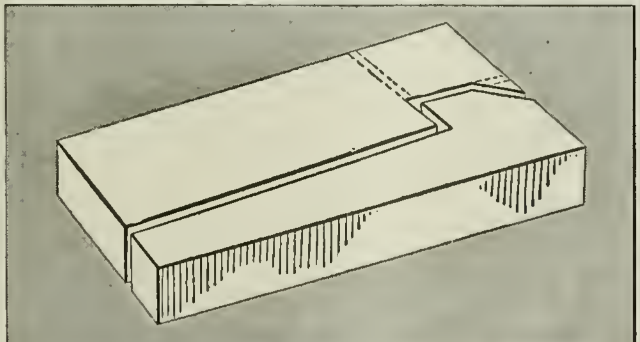
HANDY FLANGE WRENCH



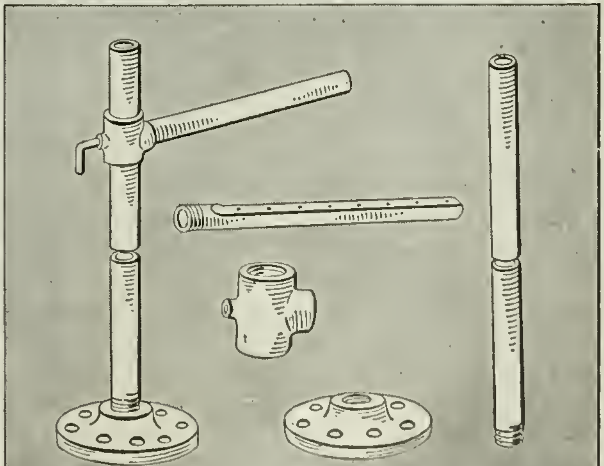
A TIME-SAVING WRENCH



PREPARING A CRANK SHAFT FOR WELDING



KEYS MAY BE SAWED QUICKER THAN BY FORGING



OLD-MAN MADE FROM PIPE AND FITTINGS

The Boiler Inspector's Work

BY M. T. GLENN

There are many occupations of which the general public knows practically nothing and of the details of which men in kindred pursuits have only a vague idea. One such is that of the boiler inspector. While boiler inspection has been practiced in this country for more than a half century and in Europe for a still longer period, very few, even among the steam-engineering profession, know much about the boiler inspector; how he works, what tools he uses, what he looks for in order to determine whether a boiler is safe or otherwise.

NATURALLY, a boiler inspector is supposed to inspect boilers and, in a vague sort of way, he is expected to be able to predict when a boiler is going to blow up. This latter supposition is not exactly correct, for sometimes an old vessel will display the perversity of inanimate objects and refuse to explode even though it is continued in service long after the inspector "condemns" it and the insurance is cancelled. That the inspector does give timely warning of the impending danger is attested by the fact that comparatively few boilers explode notwithstanding the increasing number in service. Not all boilers are insured or inspected, and it is among those not inspected that a large percentage of the explosions occur.

How the Inspector Goes About His Duties

When a boiler user signs an application for insurance, the insurance company notifies one of its inspectors, and it is his duty to examine the boiler or boilers in question and report upon the construction and condition, stating the safe working pressure. The inspector notifies the plant of the date of his expected arrival early enough to permit preparation for the inspection. He finds his way to the plant (which frequently is a difficult task), proceeds to the boiler room to see if everything is in readiness for him, then inquires where he can change his clothes and is often shown into the engine room, where a greasy chair or workbench serves for a clothes rack. Here he disrobes and, since safety is second nature to him, takes care to leave no money or other valuables in his clothes (in at least one instance an inspector's clothes disappeared during his absence and he had to return to his headquarters in his overalls). He dons an inner suit of light-weight material which is highly absorbent and readily laundered, a pair of socks and rough shoes; then a special oversuit that has boot straps to prevent the legs "riding" up and interfering when he is backing out of a manhole, and an attached hood to keep the hair and back of neck free from soot and ashes. A pair of gauntlet gloves completes the uniform, and he is an object to attract attention whenever he ventures out on the street in this attire, as he sometimes does in order to go from one plant to another near-by.

For an internal inspection the following outfit is required: A small cross-peen hammer, a test pump and gage, and a light. The best type of light to use for this work is a subject of much controversy, and it might be well to digress a few moments and look into the merits and demerits of some of them. Some inspectors prefer the old-style "tallow dip"; others use the candle, but with a special holder which feeds by a spring in the handle so that the light remains about twelve inches from the hand and can thus be introduced into out-of-the-way places. There is a serious objection to the candle aside from the fact that it is becoming more and more difficult to obtain and does not give a very brilliant light, it sometimes melts very quickly in an extremely hot boiler and leaves one in the dark just at a time when he needs a light badly to see how to get out as rapidly as possible. Another type of light that is still used by some who have inspected boilers for many years is a home-made kerosene torch consisting of a piece of gas pipe capped at one end and stuffed with waste at the other. Kerosene oil is obtainable at practically every boiler room, and this "flambeau" has the advantage just mentioned in connection with the special candle holder—it can be poked into narrow crannies, but it is "smelly" and shines in the inspector's eyes as well as on the object at which he wishes to look. Most inspectors prefer either the flash light or the miner's acetylene lamp. They both throw a good light in the desired direction without any back glare. The former is rather expensive to use, and batteries are less easily obtained in small towns than is carbide for the miner's lamp; but it does not have to be cleaned and filled every time it is used, as is the case with the gas light.

Other Things Needed for a First Inspection

But to return to the inspector's outfit, if it is a "first inspection," he will require, in addition to the articles mentioned, a rule, a thickness gage and a pad and pencil, there being no less than 75 items to be filled in on the data sheet for an ordinary horizontal-tubular boiler. It is a matter of habit with an inspector which portion of the boiler he examines first and what sequence he follows, hence the following method or order is given only as an illustration without being set up as an example of the best procedure. Let us assume that he first crawls through the fire-door onto the grates and looks for such defects as burned or blistered plates, cracks or leaks. In the case of a water-tube boiler he strikes the tubes to ascertain if any are getting dangerously thin, notes the condition of walls, baffles, etc., to be sure that no great amount of cold air enters except through the burning fuel and that the gases are directed along the path the designer intended them to take. He then enters the rear clean-out door, gives the same attention to the fire surfaces and setting as at the front end, then enters the boiler by the upper manhole and examines the shell, heads, tubes and braces for such conditions as scale, traces of oil, corrosion in its various forms and any other defects, cracks, missing rivet heads, broken braces and the like. Before leaving this part of the boiler, he examines the feed pipe to see that the opening in its end is clear and that it does not discharge near a seam, plate or tube, and also inspects the other openings to outer attachments. When he enters the lower manhole, he looks for sediment or scale, oil and corrosion, also for indications of burned or cracked plates, which are sometimes seen better from the inside on account of the soot on the fire surfaces, sees that braces are not slack and that the blowoff opening is clear. If there are water tubes, the caps of some of them at least should be removed so that he may obtain an idea of the condition of the whole.

Finishing the boiler proper, he turns his attention to the attachments. The steam gage is taken down and tested; if found incorrect, it is adjusted if possible or a new one ordered. Before the gage is replaced, he blows through the small pipe and connecting valve to be sure that they are unobstructed. The safety valve can be examined only superficially at best when there is no pressure on the boiler, but the inspector endeavors to see the spring, if it is a pop valve, to assure himself that it has not been compressed too closely and that the valve should perform its function. Fortunately, a pop valve seldom gets out of order, and the best way to "fix" a defective one is with a new one and thus be on the side of safety.

The inspector calculates the safe working pressure, taking into consideration age and condition, which enter largely when a boiler has been in operation for considerable time unless the conditions are practically ideal. Mailing in his report and data with a recommendation completes the first inspection.

THE PROPER WAY TO PREPARE A BOILER FOR INSPECTION

In making ready for inspection the fire is first drawn and the pressure permitted to fall to 15 lb. or less, while the ashes and clinkers are removed from the grates and bridge-wall and the soot and ashes from the combustion chamber. When the setting is sufficiently cool to preclude the possibility of damaging the empty boiler, and after the tubes have been blown and fire surfaces swept, the blowoff valve is opened wide and all the water is blown out. Next in order comes the removal of the manhole plates; the top one should be taken off first if the boiler is of the water-tube type, and the blowoff valve should not be closed until this plate is off, unless the boiler is vented by some other means to prevent a vacuum being formed. In opening a horizontal-tubular boiler, the following method should be followed to avoid scalding the one who removes the top manhole plate: Open the lower manhole, close the flue doors and open the damper. The top manhole may now be removed with impunity as the stack draft will draw the steam downward as soon as the joint is broken. Finally, the rear clean-out door and fire-doors are closed, the ashpit doors opened and the boiler left to cool. It will be noticed that with this arrangement the stack draft draws a current of air through the top manhole and then cools much of the water surfaces on its way to the stack via the lower manhole, while another air current enters the ashpit doors and cools the setting and fire surfaces of the boiler. As there is no way to induce this air current except by the aid of the stack draft, it is necessary that the large doors in front be kept closed. Since there is no connection between the water surfaces and the draft in the case of the water-tube type of boiler, it requires more time to cool, but the same method applies regarding the air cooling of the setting and fire surfaces.

Referring to the attention attracted by a boiler inspector while in his suit, the writer was once mistaken for a highwayman, although he did not know it at the time and only learned of it through conversation with a relative of the other party. After inspecting several boilers, he received a message from the office of the mill to come up and answer a long-distance telephone call. He went to the office and, entering through the back door, found himself in a reserved enclosure where the only person in the place was making out the payroll, having, spread out on his desk, several hundred dollars in currency. It was not till some months later that the inspector was told that the cashier confessed that the unexpected appearance of the boiler inspector nearly caused him to have an attack of heart failure, as he mistook him for a robber and was resigned to his fate.

THE INSPECTOR FINDS HIMSELF IN AN EMBARRASSING POSITION

The writer was once mistaken for an inmate of an institution known as the State Hospital for the Insane, although this time he was not dressed in the suit described, but was clothed in his street garb and right mind. Only a fortunate chance prevented his having to spend the night in a ward. After calling the gentleman in charge of the buildings and equipment by telephone and making arrangements to inspect a couple of the boilers, the inspector walked into the grounds through the only gate available, spoke to the gateman and asked where Mr. Blank could be found. Following directions, he found that gentleman and was intrusted with a key to a spare room in which to change his clothes and was told, "Just leave the key with the gateman, I will probably be gone for the day." After finishing his work and changing to his street clothes, the inspector started for home and was a little disturbed to note from a distance that the gateman had been changed since he entered. As he approached the gate, the attendant walked out from his shady bench and intercepted him. He proffered the key and told the man that Mr. Blank had requested him to leave it with the gateman when he left. That worthy had had plenty of experience with the wiles of inmates and their cunning attempts to escape, so without appearing to think it at all strange he accepted the key and promised to see that Mr. Blank got it when he came in the morning, but without in the least relaxing his vigilance or letting the inspector get between him and the open gate. The inspector, in his turn, was careful to make no false move which might lead the gateman to think he belonged inside, hence when the gateman suggested that he go over and have a seat in the shade and take a drink (water—this happened in a "bone-dry" state), he accepted with as good grace as possible and even accepted the proffered afternoon paper, although he used it more to hide his growing uneasiness while forming schemes for outwitting the man near-by and affecting his "get-away" than for reading. Fortunately, a diversion occurred which he guessed might give him time to think more clearly. A medical student serving as an interne at night came in and stopped to pass the time of day with the gateman. Seeing the suspect sitting near-by, he said, "Good evening." The inspector returned the greeting but without much spirit, and when the gateman asked the student if he knew "this man", the inspector thought, "Why, he wouldn't know me from Adam," but was agreeably surprised when the student replied, "Yes, I know him. He is the boiler inspector. I met him and Mr. Blank along the boiler-room walk several days ago." Thus the situation was suddenly relieved for both the inspector and the gateman, who hastily apologized.

The following is an illustration of how little some men know about boilers. An insurance company sent a telegram instructing their inspector in the district to investigate damage to a boiler at an oil mill in a small town, appending the words, "See Mr. Light." On arriving at the oil mill, the inspector accordingly asked for the gentlemen named and was invited into the back office for a confidential talk in which he was told that the mill, which was owned by the speaker, had been leased to a corporation by which he was employed as manager. He had retained his insurance policy on the boilers, and now that one of them was leaking badly around the tubes at the rear end, he feared that the engineer had neglected his business and that the water had been allowed to get low. Mr. Light asked the inspector to examine the boiler and report to him, saying nothing to the other employees around the plant. Upon investigating the interior of the offending vessel, the inspector found scale caked between the tubes several feet from the rear, making a solid mass all the way back to the head, thus preventing water from circulating around the tubes and cooling them and the head. When he reported to Mr. Light that the water had not been allowed to get low and that scale accumulating between the tubes had caused the trouble and must be removed before the boiler was fired any more, that gentleman thanked him and said, "I'm mighty glad to know that it was not neglect on the part of the engineering force. We will have the scale removed."

Why Coils Sometimes Fail To Heat

When pipe coils are used for heating, in conjunction with radiators, it is sometimes noticed that circulation through the coils is not good, especially if they are long and made of small pipe connected up with return bends instead of headers. The reason is the greater resistance of the coil, since the steam must traverse a greater distance. Sometimes a coil will heat at both ends but not all over. This is because steam enters from the return piping as well as from the supply and the air is trapped between the two. The location of the air vent becomes an important matter in such cases.

Waterproofing Porous Material

Brick, stone or cement walls may be rendered waterproof by one or more applications of gasoline in which 5 to 10 per cent. of paraffin wax has been dissolved or cut. The fluid may be applied with a brush or spray pump. It is colorless unless an excessive amount of wax has been used, in which case it will leave a gray color or coating, but coloring matter such as lampblack may be added. The joints of a brick wall may be penciled, then the whole wall gone over with uncolored fluid. The surface should be as dry as possible when the waterproofing is applied, to allow it to penetrate, since the gasoline simply acts as the vehicle to carry the wax into the pores of the material to seal them up. This means of sealing the small pores is also beneficial in reducing air leaks from concrete fan ducts, etc. The disintegration of porous material when exposed to moisture and then to freezing temperature is caused by the irresistible expansive force exerted by the entrapped water in freezing. This of course applies to cement walks and roofing as well, so that waterproofing is beneficial in many ways.

Turner Baffle-Wall Construction

The shapes of the vertical passes in water-tube boilers have been determined largely by the fact that loose tile placed against flame plates were used for the baffle walls. Effort to build an inclined wall to give the theoretically perfect pass resulted in the dislodgment of the tile under the vibration of the tubes, due to the tube cleaners or to the release of the steam bubbles and from the action of soot blower, etc.

Replacing loose tile is a difficult matter, as tile of the original size cannot be used without spreading the tubes temporarily to get the tile in place, and the alternative is to use smaller tile which results in wide-open joints through which the hot gases short-circuit.

With the development of the Turner baffle wall, by the Engineer Co., 17 Battery Place, New York City, a construction is provided that eliminates these objectionable features. This wall is built by introducing in the diagonal alleys between the tubes a molded, corrugated tile, dovetailed at the ends. The pockets thus formed by the tubes and the adjacent rows of tile are filled with a plastic material which fills the space no matter

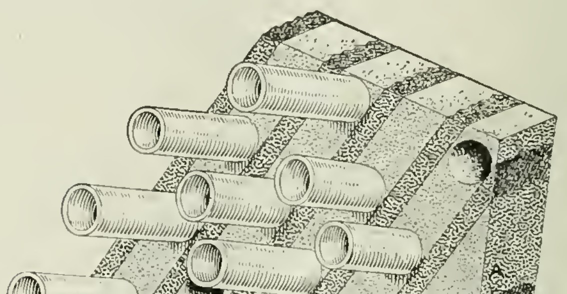


FIG. 1. DETAILS OF BAFFLE-WALL CONSTRUCTION

how irregular. This plastic material does not grip the tubes as it shrinks in hardening and leaves a small annular space around them. A tube can be withdrawn when cold and replaced by another. The filling cannot be displaced, however, as it bonds with the corrugations *A* in the tile, and the latter dovetail at each end with each other as at *B*, Fig. 1.

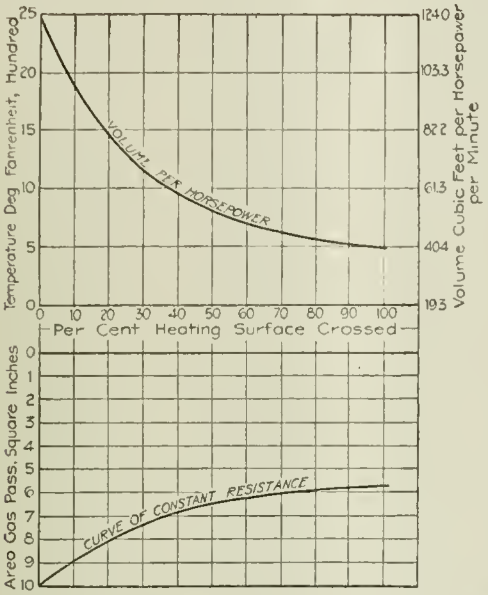


FIG. 2. TOP CURVE SHOWS RELATION OF GAS TEMPERATURE AND VOLUME; LOWER CURVE, AREA OF GAS PASS; EACH FOR PERCENTAGE OF HEATING SURFACE CROSSED

It is therefore possible to build a practically gas-tight wall at any desired slope through which tubes can be withdrawn and replaced without damage to the wall. No flame plates are necessary.

It has been found an advantage in boiler design to give the gases of combustion as near a uniform velocity through the passes as possible. A study of the curve showing the decrease in volume of these gases due to the cooling effect of the surfaces over which they pass (Fig. 2) shows that with 40 per cent. of the heating surface in the first pass, the area of its outlet should be about 60 per cent. of the area at the bottom. As the cooling effect of the drum and the superheater are comparatively small, the area at the top of the second pass should be somewhat less than that at the top of th first pass and the second pass should also taper.

The third pass shows little cooling effect, and its shape is not so material, so long as ample space is provided for the exit of the gases.

The elevation of the boiler shown in Fig. 3 illustrates the application of these principles. The bridge-wall is moved back to enlarge the furnace chamber and to keep down the furnace temperature. By the location of the bridge-wall the opening of the first pass was established. The Turner wall starts from the bridge-wall and slopes forward at such an angle as to make the top area 60 per cent. of the bottom, the heating surface exposed in first pass being about 40 per cent. of the total.

The rear wall is carried down at right angles to the tubes, it being a matter of judgment as to its slope and how far down to extend it. Some engineers claim it is an advantage to contract the lower end of the second pass so as to increase the velocity of the gases at this point and shoot them well down over the lower rows of tubes and toward the rear end of the boiler. The expansion of the gases on their release also helps to this end, and the reduction in velocity due to the change from passage across the tubes to passage along the tubes, as well as the mushrooming into the space back of the bridge-wall, tends to drop into that space any cinders or soot that would otherwise be carried up the stack.

The advantage over the alternative use of a short section of horizontal baffle on the lower row of tubes running forward from the top of the bridge-wall to the bottom of the ordinary baffle wall, Fig. 3, is evident. First, a larger tube surface is exposed in the first pass to the radiant heat of the fire and to the gases when hottest, tending to increase the capacity and at the same time lower the furnace temperature, since the heat goes into the water instead of the setting. Second, a flat surface and not an elbow with a joint impossible to keep tight with the inevitable expansion and contraction of the horizontal baffle is presented to the flames. Third, the difficulty of renewing the lower tubes, which are most frequently burned out, is lessened as they carry no horizontal baffles. Fourth, there is no dead angle at the bottom of the second pass where the vertical and the horizontal baffles join. Fifth, there is no leakage as there would be through the horizontal and transverse joints of the horizontal baffles.

Another application of the sloping baffle wall is the downward extension of the rear baffle to lessen cinder carrying by reason of the change in the velocity and by the momentum of the cinders shooting them clear of the gases when the latter turn upward. This action does not take place readily when the turn is made among the tubes, as the cinders hit the tubes, rebound, are caught up and carried away by the gases.

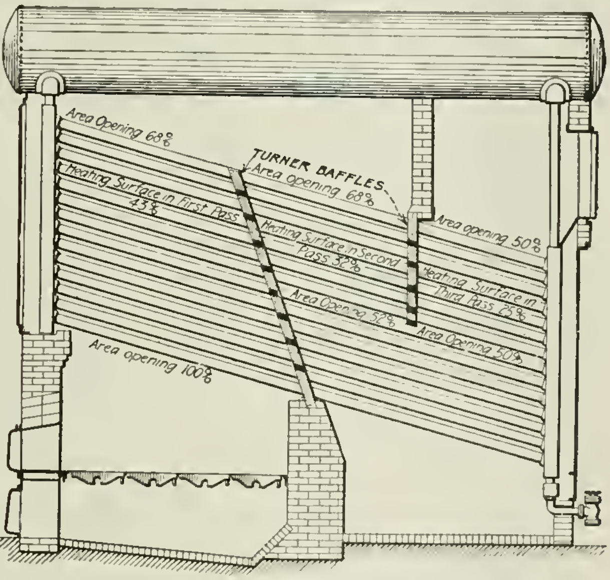


FIG. 3. CONSTRUCTION OF BAFFLE WALLS FOR MAINTAINING UNIFORM GAS VELOCITIES

As a nation we have drafted men to fight for us. That means we have chosen them to suffer hardship and to sacrifice life, if need be, to protect us and our interests. This places upon each one of us an equal obligation to suffer whatever hardships are necessary to give them all the equipment they need for success.

FINANCING THE SECOND YEAR OF THE WAR

Share of Yearly Incomes Contributable in Taxes and Bond Purchases

Distribution of incomes of $3,000 and over based on income tax returns for 1916; below $3,000 on carefully made estimates

Column I Family Income Group	II Average Family Income	III Percentage Contributable by Each Family	IV Amount Contributable by Each Family	V Number of Families in Group	VI Total Income of Families	VII Total Contributable by Families
Under $850*				7,288,000*	$4,703,217,000	$102,773,000
$780 — $910	$850	9.60	$82	3,590,000	3,051,500,000	294,380,000
911 — 1,040	1,000	9.90	99	3,525,000	3,525,000,000	348,975,000
1,041 — 1,170	1,100	10.30	113	2,737,000	3,010,700,000	309,281,000
1,171 — 1,300	1,250	10.80	135	2,262,000	2,827,500,000	305,370,000
1,301 — 1,430	1,350	11.20	151	1,826,000	2,465,100,000	275,726,000
1,431 — 1,560	1,500	11.70	175	1,602,000	2,403,000,000	280,350,000
1,561 — 1,690	1,600	12.20	195	1,228,000	1,964,800,000	239,460,000
1,691 — 1,820	1,750	12.60	220	710,000	,242,500,000	156,200,000
1,821 — 1,950	1,900	13.20	251	475,000	902,500,000	119,225,000
1,951 — 2,080	2,000	13.50	270	385,000	770,000,000	103,950,000
2,081 — 2,210	2,150	14.00	301	306,000	657,900,000	92,106,000
2,211 — 2,340	2,275	14.50	330	243,000	552,825,000	80,190,000
2,341 — 2,470	2,400	15.00	360	189,000	453,600,000	68,040,000
2,471 — 2,600	2,550	15.40	393	142,000	362,100,000	55,806,000
2,601 — 2,860	2,750	16.10	443	200,000	550,000,000	88,600,000
2,861 — 3,000	3,000	16.90	507	167,000	501,000,000	84,669,000
3,001 — 4,000	3,500	18.80	658	85,000	297,500,000	55,930,000
4,001 — 5,000	4,500	22.40	1,008	72,000	324,000,000	72,576,000
5,001 — 6,000	5,500	25.80	1,419	52,000	286,000,000	73,788,000
6,001 — 7,000	6,500	29.40	1,911	36,500	237,250.000	69,751,000
7,001 — 8,000	7,500	32.80	2,460	26,500	198,750,000	65,190,000
8,001 — 9,000	8,500	36.40	3,094	20,000	170,000,000	61,880,000
9,001 — 10,000	9,500	40.00	3,800	15,500	147,250,000	58,900,000
10,001 — 15,000	12,500	42.00	5,250	45,309	566,362,000	237,872,000
15,001 — 20,000	17,500	45.00	7,870	22,618	395,815,000	178,003,000
20,001 — 25,000	22,500	46.50	10,460	12,953	291,442,000	135,488,000
25,001 — 30,000	27,500	48.00	13,200	8,055	221,512,000	106,326,000
30,001 — 40,000	35,000	51.00	17,850	10,068	352,380,000	179,713,000
40,001 — 50,000	45,000	55.50	25,000	5,611	252,495,000	140,275,000
50,001 — 60,000	55,000	59.10	32,500	3,621	199,155,000	117,682,000
60,001 — 70,000	65,000	61.50	40,000	2,548	165,620,000	101,920,000
70,001 — 80,000	75,000	64.00	48,000	1,787	134,025,000	85,776,000
80,001 — 90,000	85,000	64.70	55,000	1,422	120,870,000	78,210,000
90,001 — 100,000	95,000	66.30	63,000	1,074	102,030,000	67,662,000
100,001 — 150,000	123,000	69.10	85,000	2,900	356,700,000	246,500,000
150,001 — 200,000	174,000	71.50	124,400	1,284	223,416,000	159,729,000
200,001 — 250,000	225,000	72.20	162,500	726	163,350,000	117,975,000
250,001 — 300,000	277,000	73.00	202,210	42,	118,279,000	86,343,000
300,001 — 400,000	345,000	73.70	254,400	469	161,805,000	119,313,000
400,001 — 500,000	448,000	74.50	333,700	245	109,760,000	81,756,000
500,001 —1,000,000	683,000	75.20	513,800	376	256,770,000	193,188,000
1,000,001 —1,500,000	1,106,000	76.00	840,500	97	107,282,000	81,528,000
1,500,001 —2,000,000	1,701,000	76.70	1,305,500	42	71,442,000	54,831,000
2,000,001 —3,000,000	2,459,000	77.50	1,905,700	34	83,606,000	64,793,000
3,000,001 —4,000,000	3,459,000	78.20	2,706,600	14	48,426,000	37,892,000
4,000,001 —5,000,000	4.514,000	79.00	3,566,000	9	40,626,000	32,094,000
5,000,001 and over	10,284,000	79.70	8,201,500	10	102,840,000	82,015,000
Reported non-taxable incomes not apportioned in reports—50% estimated contributable				. . . . .	2,000,000,000	1,000,000,000
Family Groups and individuals—their estimated total incomes and ability to contribute				27,304,199	$38.250,000,000	$7,250,000,000
Corporations and other business enterprises—their estimated total incomes and ability to contribute after dividend distributions				. . . . .	11,750,000,000	2,750,000,000
Total estimated National Income and amount realizable therefrom				. . . . .	$50,000,000,000	$10,000,000,000
Banks—the share of the burden which they probably must carry. This is not the estimated peak load, but a conservative estimate of the average minimum burden						3,500,000,000
Estimated receipts from direct taxation and bond sales						$13,500,000,000
Estimated receipts from indirect taxes, such as customs, excise taxes, stamp taxes, including sundry receipts						1,500,000,000
Cost of Second Year of the War, estimated						$15,000,000,000

*This group is largely composed of individuals.

HOW TO USE THE TABLE: Find your income in Column I. Multiply this by the "percentage contributable,"—Column III. The result is the total amount which you should contribute during a year. Deduct the amount which you pay in taxes—the remainder is the amount of Liberty Bonds which you should buy from income during a year.

Illustration:	$5,000 income.	Less tax, say $80		$10,000 income.	Less tax, say $675
	$5,000 x 22.4% = $1,120	Bonds to be bought $1,040		$10,000 x 40% = $4,000	Bonds to be bought $3,325

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Editorials

What Is My Share of the Cost of the War?

HIS or her share in the cost of carrying on this great conflict to make the world a decent place to live in is one of the questions that should be foremost in the minds of every man and woman in this country today. The Bankers Trust Company, of New York City, recently issued a pamphlet, "What is my Share of the Cost of the War," in which the problem of financing the second year of the war is discussed. The analysis set forth in this pamphlet brings the problem home so vividly that it should make every American do more than think; it should make him act. The table on page 624 of this issue is taken from this pamphlet and gives a very comprehensive presentation of the task.

According to the pamphlet, "During the first year of the war the expenditures of the Government have amounted to over nine and a half billion dollars, or more than fourteen times the average expenditures of the seven years previous to the war. The advances which we made to our Allies for the purchase of materials and supplies have accounted for nearly one-half of our total expenditures.

"The expenses for the next twelve months will probably be considerably larger. Congress voted appropriations for the current fiscal year ending June 13, next, of eighteen and three-quarter billion dollars, but the Government has not found it possible to expend this amount of money, and we doubt if such a large amount can be expended in the coming twelve months. We believe that it is safe to estimate the total expenditures for the next twelve months at about fifteen billion dollars; therefore, to raise this amount is the task we are facing."

Regarding the use of the table the pamphlet points out several things that it is important to keep in mind. One of these is: "The calculations, except for incomes below eight hundred and fifty dollars, are based on family incomes. This seems fair because most of us live in families and perforce think and act in terms of family income and outgo. It goes without saying, however, that an individual without family responsibilities can contribute proportionately more from a given income than the head of a family can contribute or than a given family group having the same income can contribute." In other words, one is not only to contribute the part set forth in the table, but all that it is possible for him to contribute.

The authors call attention to the fact that "in no better way can there be brought home to one the magnitude of the burden of this war and what it means than to consider conscientiously what constitutes ones fair share of the burden. It is no use to blink at the facts of the case. We may as well face them now and, if we have not already done so, prepare to adjust our affairs so that we can take up the burden. Not for this year alone, but perhaps for next year and then for other years to follow.

"It is obvious that business and methods of living heretofore customary cannot go on as usual. In the last analysis what the Government needs is not money but goods and service. Therefore, to the extent that each one of us curtails his wants and thus releases industrial operatives and goods for war work, he is to that degree giving the greatest assistance to the Government. In this way also individual expenditure is automatically decreased with a corresponding increase available to the Government. It behooves us, therefore, to take stock of our resources and to determine thoughtfully and methodically what is the greatest amount of bonds for which we can arrange to subscribe."

Using the Nation's Lignite Supply

IF YOU will look at the coal map of the United States you will see that the Southwest and the Northwest, particularly the Dakotas, North Dakota especially, contain considerable deposits of lignites. The North Dakota natural lignite has about the following average composition: Moisture, forty per cent.; volatile matter, twenty-five per cent.; fixed carbon, twenty-eight per cent.; ash, seven per cent., the heating value being about 6300 B.t.u. per pound. These sections of the country are remote from the coal fields of the East, and they are distant from the Illinois and Indiana coal fields. When these sections of the country use coal either from the Kentucky, Tennessee or West Virginia fields, or the Pennsylvania field, and from the coal fields of the Middle West, the coal must be transported long distances by rail and the lakes and at considerable cost, which becomes more than a monetary loss during a time of rail congestion. National economics, therefore, seems to dictate that the industries adjacent to the lignite fields should learn how to burn this fuel. Lignite in a natural state cannot be transported even short distances from the mines for the reason that the moisture evaporates, causing the lignite to break up into small chunks and flakes and, if subjected to much jarring, it disintegrates into powder, all of which makes the fuel inconvenient to handle.

While commendable progress has been made in the use of lignites, they are not used on a large scale, even by the industries adjacent to the lignite fields. Experience has shown, however, that lignites can be burned under boiler furnaces without insurmountable difficulty. An electric company in Colorado, for example, has been successful in burning natural lignites on an underfeed stoker, the stoker enabling the boiler to develop ratings up to 300 per cent. of normal, and to be able to put the boiler on the line under full boiler pressure from a fire at dead bank in five to seven minutes. This is a boiler installation of the usual kind; that is, the boiler is not overstokered. Altogether, experience in this Colorado station has shown that even with the ordinary type of underfeed stoker in a boiler setting not especially designed for lignite fuels, great flexibility in boiler output is possible. During the fuel crisis of last winter, the people of North Dakota successfully burned lignite in house-heating boilers and stoves. The experience in Colorado and North Dakota, together with that in Texas, where lignites abound, shows that the lignites may be burned under boilers used for power purposes.

It is likely that experience will dictate that the natural lignites be carbonized; that is, that the moisture particularly be driven off before the fuel is transported long distances. The carbonized lignite presents no difficulty in burning under power boilers.

Elsewhere in this issue Henry Kreisinger, engineer of the Bureau of Mines, and well known for his work on combustion in boilers, has a most interesting article on the combustion of North Dakota lignite, with suggestions for the design of furnaces to burn this fuel. It is interesting to note that combustion is limited to the first three or four inches of the fuel bed of a lignite fire and that the CO_2 is rapidly and completely reduced to CO within the first four of the fuel bed. This, of course, makes necessary the introduction of oxygen or air above and against the fuel bed in order that the CO may be burned to CO_2. It is interesting to note, also, that the reduction of the CO_2 to CO near the surface of the fuel bed is such a heat-absorbing process that the surface of the fuel bed under ordinary conditions is a dull red. With a natural lignite, the absorption of heat by the moisture is a factor in causing combustion to be slow at the surface of a lignite fuel bed.

It is of particular interest to note that the author is of the opinion that an ordinary horizontal grate is unsuited to lignite and that a step grate should be used. The step grate is best adapted for the reason that the ash may find its way down the grate and will not plug the air spaces which, in a separate grate, may be made very large, as they must necessarily be to burn the lignite with success. The step grate also avoids dropping the ash and combustible into the ashpit where, with an ordinary horizontal grate, the ashpit may, when burning lignite, contain more fire than the grate itself.

It is Mr. Kreisinger's opinion that a chain grate, if inclined about fifteen degrees toward the refuse end, and set in a furnace having a long combustion arch extending from the rear far forward in order to drive the flame down upon the incoming coal which, of course, is high in moisture, will successfully burn natural lignite. Directing the flame forward is intended to drive off the moisture from the incoming green coal. We are sure that Mr. Kreisinger's article will add appreciably to the literature on this subject and that the results of his investigations will prove of material value to those engaged in designing furnaces for successfully burning the lignite fuels.

It is up to the builders of stokers and furnaces to take advantage of the experiments of the Bureau of Mines and supplement them with research of their own to the end that stokers and furnaces particularly adapted to lignites may be available to industries in and near the vast lignite fields.

We should not be unmindful of the apparent possibilities of burning lignite in powdered form, particularly so in view of the low fusing temperature of the ash, namely, two thousand degrees Fahrenheit. Just what success have the powdered-fuel exponents had burning lignite in pulverized form?

Coal-Saving Nostrums

STILL again we are forced to call attention to the numerous nostrums which are being urged upon the public as fuel savers. There are usually a few sporadic cases in evidence, but the present exceptional conditions with regard to fuel have engendered a veritable epidemic of them. "Kologen" will save, according to the advertisement, from twenty-five to forty per cent. of your coal bills, and you can get enough for fifty cents to treat a ton of coal. A patriot by the name of Schoen will give you a formula for effecting the same result. The formula is water, salt, and "one common chemical," the name of which he sells ordinarily for one dollar. But as every ton of coal saved now helps win the war, he considers it a patriotic duty to spread these instructions as widely as possible; so during the present emergency a silver quarter, "to cover cost," gets it by return mail. It does not seem to have occurred to the aforenamed patriot that it would not take so much space in the advertisement to name the ingredient as to call it "a common chemical," and if it were any good any paper would be glad to print it for its news value.

Meyers' patent compound for saving coal is another. We have analyzed and exposed many of these nostrums. There is no substance which, sprinkled upon coal, can save one-third, one-quarter, one-tenth, or any appreciable proportion of it, except through the psychological process of leading the fireman to expect an improvement and unconsciously to bring it about; and there is no need of paying twenty-five or fifty cents for a canful of cheap chemicals in order to do this.

Will the Coal Shortage Continue?

WASHINGTON cannot conceal the fact that the Fuel Administration and the Railroad Administration are at loggerheads. As a result there is an alarming shortage of bituminous output because of car shortage. Goodness knows, we went through enough distress last winter, some of it unavoidable, much of it avoidable. Are we to face it again? If so, is it to be because some officials want to make a showing on cost sheets? If these men do not want to appear as selfish children, let them cease to be childish. The public is sick of needless messes. It wants coal, it needs it; miners want to work steadily, car builders are not holding back. Let the Railroad Administration drop the bludgeon it holds over Mr. Garfield.

During the period of agitation on the daylight-saving law, which went into effect April 1, many objections were raised against it. However, the reports coming from different quarters would indicate that the evening peak of the central stations is being considerably relieved without adding anything to the morning peak, a coal saving is obtained, and furthermore, what was not expected, it has proved to be a public safety and defense feature—so much so that the executive committee of the United States Chamber of Commerce at a recent meeting was unanimous in its agreement that the measure should be made a permanent one to operate through the year.

Correspondence

Something To Be Proud Of

I am sure that *Power* readers will be interested in some figures on running an ordinary 500-hp. plant during the unusual year of 1917. This is an old plant, started in 1850 as a mill, now furnishing power to eleven tenants, using individually from 3 to 109 hp., and scattered over a property 400 ft. square. Until March we were running both shaft and electric drives, but at that time we cut off all the shaft drive and are now all on electric transmission. During the last year we delivered an average of 365 hp. to the tenants, at a cost of $23,750, or $65 per hp. These figures are so unusually high for those which anyone is willing to publish that readers would be interested in some of the incidental things that go to make up this result.

All the employees of the plant have had their wages increased about 25 per cent. this past year; our payroll was $80 a week for regular running and $9 a week for overtime on maintenance and repairs, making a total of $89 a week, or $4632 for the year. Our coal bill was for 2564 tons at $6.10, or $15,640; our bills for supplies and repairs were $1688. Some of the items of this amount are as follows: Boiler repairs, $451; oils and grease, $135; boiler compound, $65; building repairs, $32; water, $257; stoker and furnace repairs, $138; engine repairs, $16; packing, $37; electrical supplies and repairs, $144; pipe, valves and fittings, $109. Taxes and insurance amounted to $900.

We are equipped with water-tube boilers and overfeed stokers, and slide-valve automatic engines, and furnish direct current at 115 volts for both power and lighting.

We burn bituminous slack, which during 1916 cost us $3.10 a ton on the boiler-room floor. During 1917 this coal or other coal bought to fill our requirements cost $6.10 per ton on the boiler-room floor. In addition to this condition, the water evaporation fell from 10 to 8 lb. on account of poor coal, poorly prepared coal or coals of qualities strange to us, which puzzled us to find the best method of firing. It was also necessary for six months to put an extra man in the boiler room on account of these conditions.

Our engines are using 40 lb. of steam per indicated horsepower-power, and the efficiency from the indicated horsepower to the tenant's recording wattmeters is 75 per cent. We delivered 317 hp. to these wattmeters, which was 423 i.hp. at engines. On a steam consumption of 40 lb. this equaled 564 hp. at the boilers at 30 lb. per boiler hp. In addition to this we delivered 48 boiler hp. of live steam, which we recorded with condensation meters. This 612 boiler hp. did not include steam used in feed pumps and stoker engines or condensation in mains. Our boilers were run at about rating, on an average.

Notwithstanding the high costs of power, caused principally by inefficient engines, along with some 35-year old equipment which I have not as yet been able to get rid of, and with high-priced coal, one of our large central stations, which has 30,000 kw. turbines, has been unable to make an interesting proposition to us, practically failing on the one point of heating the buildings. Exhaust steam for heating has saved us where our engines would have thrown us down.

Our figures for building maintenance were: Repair and supply bills, $1382; payroll, $4196; coal, $3910; taxes and insurance, $1500; Total, $10,988.

We have 180,000 sq. ft. of rentable floor space, which makes the maintenance costs less than 7c. per sq.ft. In proportioning the boiler-room costs, including coal, we proportion 80 per cent. to power and 20 per cent. to buildings.

Regardless of these unvarnished figures, which are truly "something awful," we are proud of what we accomplished last year. By "we" I mean my men, who have backed me up so well, our manager, who has done the same, and myself—coöperation which is hard to beat. Surrounded by unfavorable conditions, we have made a determined effort to make the most out of them, and feel that we have done our "bit," as over three-fourths of our power was used for strictly Government essentials, and the balance was utilized for various good purposes. ARTHUR SUMMERS.

Philadelphia, Penn.

Synchronoscope Operated Sluggishly

Synchronizing indicators are intended to be connected to the circuit only during the period that they are actually in use. If these instruments are left connected to the circuit permanently, there is danger that they will be overheated and injured. In a certain instance a synchronizer had for some time evinced a tendency to act sluggishly. The sluggish action of the instrument apparently did not suggest to the operator that its indications might not be dependable, since it was not until two machines had been connected together while out of phase that the operator awakened to the possibility of an investigation being in order. Testing failed to reveal any open-circuits or other external irregularities, and as the synchronizing lamps continued to be normal in their indications, it appeared that the trouble must be located within the synchronizer itself.

The instrument was removed from the switchboard and partly disassembled, when it was discovered that, owing to overheating, insulating compound had run out of the windings and clogged the air gap between the rotating member and the polepieces, so that the former was practically prevented from turning. However, the winding appeared not to have been injured, and after cleaning the air gap, a trial of the instrument proved its indications to be normal. The heating was found to be caused by the operator leaving the instrument connected to the circuit continuously.

Brooklyn, N. Y. E. C. PARHAM.

A Peculiar Wiring Trouble

Recently, a friend of mine took charge of a power plant that was in a somewhat neglected condition. Among other troubles one of the fuses on one side of a lamp circuit kept blowing frequently. Finally, the circuit was fused with copper wire, and this solved the problem as far as that particular circuit was concerned. Soon after the circuit lighting the boiler room started the same trouble; the fuse blew on one side of it. This circuit was also fused with solid copper, which ended difficulties as far as fuse blowing was concerned.

A signal bell in the engine room had been giving considerable trouble from the contact point on the vibrator burning so badly as to render it inoperative a number of times. A short time after the boiler-room circuit had been fused with copper wire, the same trouble happened to the bell again, and it was also found that the push-buttons were so badly burned as to be useless. New push-buttons were put in, and in a short time the bell and buttons were found to be burned out again.

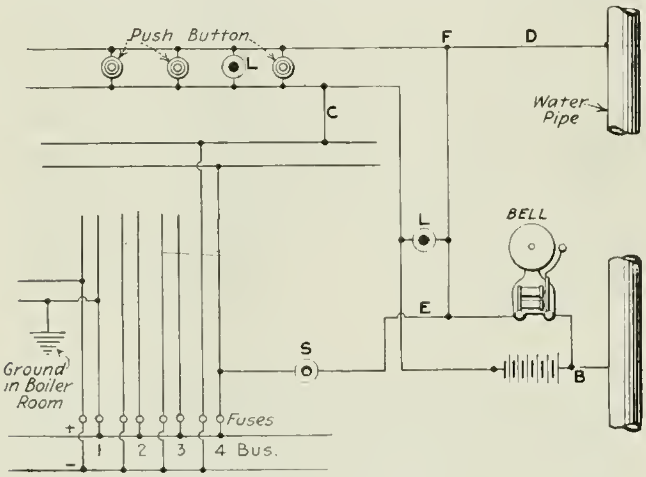


DIAGRAM OF BELL AND LIGHTING CIRCUITS

It is quite evident that the bell wire was in contact with 110-volt lighting circuit at some place. Testing the bell wire failed to locate anything wrong, however. It was therefore decided to arrange a telltale light to indicate whenever the lighting-circuit voltage might be present on the bell. One lamp was connected across the bell circuit close to one of the push-buttons, and another was connected across the bell wire near the bell in the engine room. The sketch illustrates the connections, and *L* and *L* indicate the location of the telltale lamps. The next morning after the lamps were installed they lighted.

To find the circuit on which the trouble originated, the fuses of each circuit were removed and replaced one at a time. When the fuse on the negative side of circuit No. 4 was removed, the light went out. This, by the way, was the side that was fused with copper wire. When the fuse was replaced, the lamps lit again.

When the positive fuse of circuit No. 1 was removed, the lights went out again. This was the boiler-room circuit and did not come anywhere near the bell wire. In tracing out the wires on circuit No. 4 we found that a tap had been taken off one side of the circuit and run between the beams of the ceiling to one side of the bell circuit, indicated at *C*. From this it will be seen that one side of the bell wire was connected to the negative side of a lighting system. Following the bell wire back to the engine room, near the elevator shaft one side of the bell circuit was found connected to a water pipe, as shown at *D*. When this wire was removed, the telltale lights went out.

In the engine room, connected to another water pipe, was found a short wire that had apparently been disconnected from the bell some time before, as the end was hanging near the bell. Another wire was connected to the bell wiring at point *E* and ran along the ceiling through a lamp socket *S* to positive side of circuit No. 4.

Evidently, at some time an attempt had been made to operate the bell on a circuit taken from the lighting system, and to cut down the expense of wire the use of the water pipes had been resorted to. Under the conditions shown, whenever a ground occurred on the positive side of a system, it is plainly evident that there would be full voltage across the bell, as the circuit would be complete from the ground in the boiler room through connection *D* between the point *F* and the water pipe, around to the bell and battery and through *C* to the negative side of the line. This is what burned off the contact point of the bell. After this occurred full lighting-circuit voltage existed across the push-buttons. Closing the push-buttons practically amounted to a short circuit.

The trouble on the boiler-room circuit was due to one of the wires coming loose from the knob on which it had been fastened and swinging down from the ceiling. The plant was provided with a damper regulator, and when the damper was wide open the wire became squeezed between the arm of the regulator and a wooden post. This also explained the intermittent action of the trouble. Unless the damper was wide open, the wire would not be grounded and no trouble would be experienced.

E. W. MILLER.

Minneapolis, Minn.

Ash-Handling Machinery

Herbert E. Birch, in his article on "Buying an Ash Handling System," in your issue of Feb. 5, page 186, mentions the liability to explosion with the pipe conveyor system, as referred to in the Apr. 3, 1917, issue of *Power*. In this connection I would like to call attention to the fact that it will be impossible to have an explosion in the tank connected with a steam-jet system, although the writer knows of several explosions that have occurred where the air system was used.

There seems to be in the construction of the article a thinly veiled effort to discredit the steam-jet system, and I am satisfied that if the author of this article had investigated the latter conclusively, he would not consider the prices advertised in your journal as handling a ton of ashes by this system as "salesmen's hot air." It is generally conceded that conveyors of any class are more efficient than man-power pushing a wheelbarrow or other device. As to the cost of systems, I believe that the specific price of $2200 is rather ill-advised for the reason that I am personally familiar with systems costing considerably less and at the same time have known systems including the bin for the reception of ashes that have cost less.

St. Louis, Mo. ROBERT H. MILLER.

The Boston Turbine Accident

In reading the description of the wrecking of the 35,000-kw. turbine at Boston, in the Mar. 19, 1918, issue of *Power*, the facts and evidence as given suggest an apparently clear and logical process of demolition through which the exhaust end of the turbine may have passed.

The first indication of trouble, according to the article, was when the machine was heard to rub and observed to vibrate, and this came in the nature of a shock. Simultaneously the turbine was heavily overloaded. The operators tried to stop the rubbing, but were unable to do so. These facts can be accounted for by the distortion of the 18th diaphragm, probably in the nozzle vanes, due to increased pressure drop between the 18th and 19th stages, allowing the diaphragm disk to rub the inlet side prongs of the blade forks of the 18th wheel, causing heating in these prongs. When a sufficiently high temperature had been reached, with the consequent reduction of the tensile strength of the blade material, these prongs parted and allowed the blades to foul the nozzle vanes of the 19th diaphragm. This fouling would cause the second shock and commotion. The time required for heating the prongs would be the reason for the time which elapsed between the first and second shocks. The 18th wheel blade débris shows that the inlet side prongs were burned blue and fused, and fractured near the root.

The 18th wheel blades fouling the 19th diaphragm nozzle vanes would partly sever these vanes and allow the 19th diaphragm disk to drop down on the hubs of the 18th and 19th wheels and begin to revolve, completely parting the disk from its ring. The 19th wheel blades would be fouled by the 19th diaphragm nozzle vanes, which, in turn, wouuld foul the nozzle vanes of the 20th diaphragm. The disk of the 20th diaphragm would be parted from its ring and begin revolving in a manner similar to the 19th diaphragm disk. When a sufficiently high speed was attained, the diaphragm disk would burst and begin throwing off pieces. One of the diaphragm disks evidently started disrupting first, and in doing so pieces were probably projected against the diaphragm-supporting cone and deflected toward the generator end. The five pieces that went through the building wall near the generator end of the shaft uphold this supposition. The lapse of time between the second shock and the instant pieces began coming through the turbine casing, when the operating crew were seeking cover, would allow the severed diaphragm disks to reach their bursting speeds.

These diaphragm disk pieces in striking the diaphragm-supporting cone would possibly break it up. The probable weakest section for resisting such blows would be through the 18th diaphragm groove—the supporting cone being held to the shape by the 17th diaphragm and the adjacent external flange. The upper factured piece or pieces of the cone would drop down on the wheels, be whirled around, possibly demolish the exhaust end bearing bracket of the turbine, and finally land among the condenser tubes. The other revolving diaphragm disk probably let go after the supporting cone had been destroyed. The diaphragm pieces that were thrown off radially suggest this action.

Nothing is said of the 18th diaphragm in the description of the accident.[1] It would also be of interest to know to which diaphragm disk the five pieces found near the generator end of the shaft belonged.[2] It would appear that the primary cause of the accident was in the 18th diaphragm, and a secondary cause the absence of a protective rubbing surface on the rim of the 18th wheel, although the 18th, 19th and 20th wheels all have the forked blading.

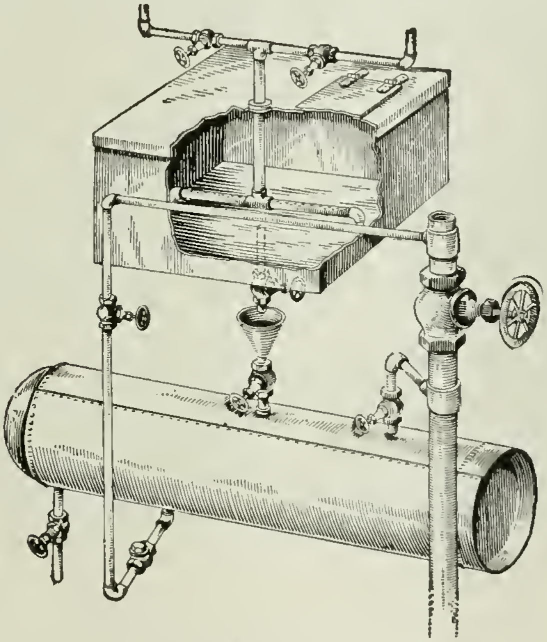
In the comment on the windage test of the last stage wheel of the 25,000-kw. turbine it would appear that the medium in which this test was run was air at atmospheric pressure. Whether the wrecked turbine at Boston was supplied with a vacuum breaker the description does not say, but a vacuum breaker operating in conjunction with the emergency trip throttle valve would be a means of braking a turbine wherein the blade velocities are high, after the generator had been disconnected from its load and before the air pump could be shut down.

C. H. WATSON.

Portland, Ore.

Compound Mixing and Feeding Tank

There are many arrangements of tanks for mixing and feeding boiler compound, but I think I have a better one than any I have seen or read about, therefore I submit it. The illustration will show at a glance its good points. Circulation through the tank is regulated by partly closing the valve in the main-feed line to the boilers. The piping arrangement shown is only intended to convey the general idea and may be modified to suit conditions.



BOILER-COMPOUND FEEDER

B. DAN DE PASS.

Hudson Heights, N. J.

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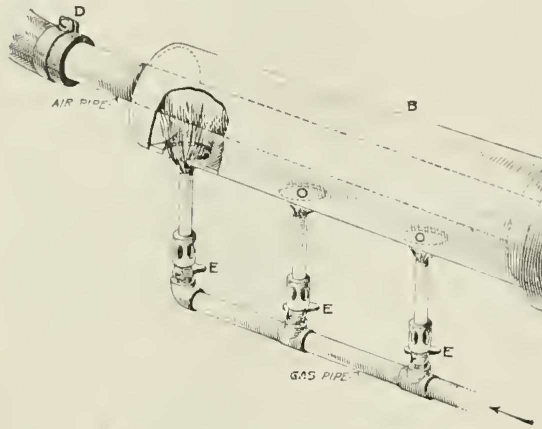
[1] "All wheels and diaphragms up to and including the 17th stage are intact." See paragraph under Fig. 4, page 393, "Power," Mar. 19.

[2] See top of second column, page 392 of "Power," Mar. 19: "When this frame broke it is probable that the 19th and 20th diaphragms let down on the shaft. . . The significant fact is that these diaphragms are the only large pieces of metal to completely break up and leave the turbine. It was some of these pieces that went through the roof and terra-cotta temporary end wall of the building."

Drying Out Electric Motors

During a high-water period in the Ohio River one part of our plant was submerged, putting many of the motor-driven machines out of commission. We cleaned the machines as quickly as possible, but drying out the motors proved to be a somewhat difficult proposition. After trying several schemes, the method shown in the illustration was devised and used successfully.



METHOD OF HEATING AIR IN A PIPE

Referring to the figure, *A* is a ½-in. pipe leading from a compressed air receiver. A reducing valve was placed in the pipe line before entering the plug *P*. This valve reduced the air pressure down to about 30 lb. per sq.in., which we found more satisfactory than a higher pressure. *B* is a piece of 3-in. iron pipe with openings *O* to allow the gas flames to heat the air in the pipe *A*. Several gas jets may be used, if necessary to work on more than one motor at a time.

A tee-joint may be placed at *D* for branch pipes leading to different motors. The whole heating apparatus can be placed on the floor, and by using flexible-hose branches, the scheme makes a very convenient arrangement.

We left the motors on the floor and blew the air through them, regulating the gas flame so that the air was kept at a temperature that may be called warm. Flexible nozzles covered with asbestos paper were used, as they were found to be better than solid metallic nozzles for getting into the different parts of the motors easily. G. E. MICHAEL.

Pittsburgh, Penn.

Repair the Liberty Bell

Having become acquainted with the wonderful versatility of the oxyacetylene welding torch, the picture of the Liberty Bell on the cover of *Power*, Mar. 26, suggests, "Why not repair the Liberty Bell and have it ready to ring when the Prussians are beaten and the war comes to an end?" There certainly must be some welder who would undertake the job and who is skillful enough to insure its success. I have welded large gongs and small dinner bells of bronze that resounded just as melodiously as when new, before developing any defect. Welding seems to restore the tone of a bell completely. If the welding is done from the inside of the Liberty Bell, there will be nothing to show that there ever had been a crack.

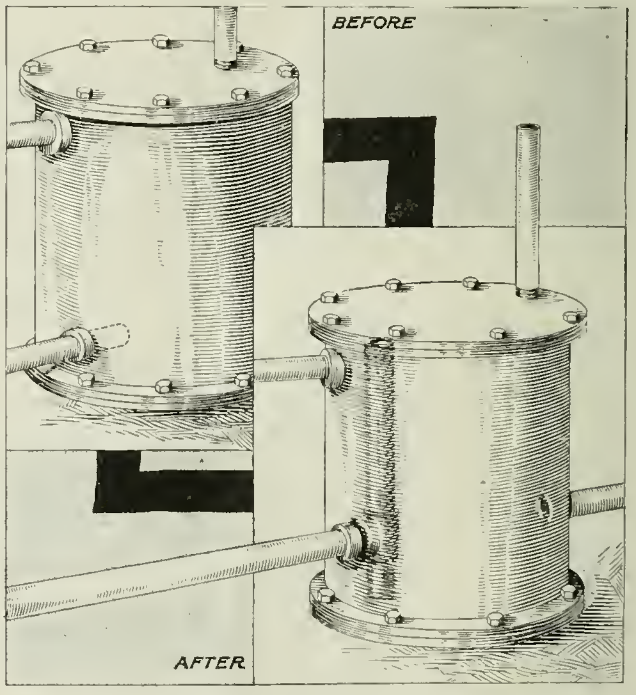
Think of the old Liberty Bell at the conclusion of the war lifting up its voice again, speaking once more for Liberty in a glad peal resounding from one end of the land to the other. Sentiment might, it is true, be aroused against restoring the voice to the bell, but as well refuse to restore the sight, hearing or voice of some cherished one who had become afflicted, when the surgeon offers a cure. There may perhaps be a reason why welding this bell is impossible. At least it ought to be put up to an expert before the glorious old bell is abandoned to perpetual dumbness. M. MEIGS.

Keokuk, Iowa.

Keeping Oil Out of Feed Pump

We were troubled with oil in our boilers following the time the receiving tank got pumped dry. A repetition of the accidental pumping dry was remedied in a satisfactory and inexpensive way, as shown in the illustration.

The original suction pipe extended straight in, while the new arrangement has a tee on the end of the pump suction pipe, and an open-end standpipe extending above the overflow level, so that when the water level reaches the suction level, air is admitted to the pump through the standpipe and the pump gets no more water, leaving a seal of several inches. The oil is disposed of through the overflow by allowing the tank to fill and overflow occasionally, so it goes outside instead of into the boilers. This arrangement is cheaper than float valves, etc., and is sure to work.



INSIDE PIPING KEEPS SURFACE OIL FROM PUMP

Oil City, Penn. T. A. MARSHALL.

An Electrical Phenomenon

On page 594, Apr. 23 issue, the discussion letter "An Electrical Phenomenon" should have been signed, Dr. K. Becker, Perth Amboy, N. J.—Editor.

Inquiries of General Interest

Cleaning Water-Leg of Vertical Boiler—How can the water-leg of a vertical fire-tube boiler be thoroughly cleaned? B. W.

Fasten a chain to the end of a wire, having each of sufficient length to pass around the inside of the boiler from one handhole to the next. Then draw the chain into the water-leg and pull it back and forth while washing out the loose dirt with water from a hose.

Negative Exhaust Lap—In a D slide valve what is negative exhaust lap and what is its effect on operation of an engine? T. J. M.

Negative exhaust lap is the amount by which the exhaust edge of the valve fails to cover the port when the valve is in its central position. The effect of negative exhaust lap is to hasten the opening and delay the closing of the ports to the exhaust.

Breakage of Spring of Shaft Governor—What would result if the spring of a shaft governor should break while in use on a high-speed engine? W. F.

The office of the spring is to oppose the action of the centrifugal force on the governor weight in causing shorter cutoff. With the centrifugal force unrestrained, cutoff would take place at the earliest point, the speed would immediately be reduced, and unless the engine were relieved of the load it would slow down or stop.

Indications of Carrying Water Too Low—What are indications that water has been carried too low in a boiler? E. T.

Low water causes tubes to leak at their ends and burning of heating surfaces that have been uncovered by water. Examination of the interior of the boiler will show red coloration of the material at the point where the water has been too low and scale will be cracked off down to the level at which the water was carried.

Parabolic Governor—What is a parabolic governor? F. J. M.

A parabolic governor is one in which the governor balls are constrained to move in the path of a parabola whose principal axis is the vertical axis of rotation. The height of an equivalent pendulum suspension of the balls is constant for all positions, the governor is in equilibrium at but one speed and is said to be isochronous. Such a governor cannot be used successfully on an engine without checking its action with a spring or dashpot, for the slightest increase in speed above the normal causes the balls to rise to their highest position with sudden decrease of speed, alternating with promptly falling and increase of speed.

Movement of Main Bearing on Bedstone—How can movement of the low pressure side main bearing of a cross compound engine on the bedstone be remedied? W. P. S.

If the nuts on the foundation bolts cannot be set down hard enough to hold the stand from slipping, it may be that the bolts are not threaded long enough and washers are required, or that the anchorages are not holding. If the bolts are smaller than the bolt holes in the bedstone, filling the cavities with a thin grouting of neat cement may improve the anchoring or at least hold the bolts steadier. If the anchorages are secure, then with the nuts of all foundation bolts set down hard there should be no movement over the bedstone if the engine is in good alignment.

Testing Accuracy of Vacuum Gage—How is the accuracy of a vacuum gage tested? R. A.

A vacuum gage is generally provided with a dial and pointer for indicating inches of mercury pressure below the pressure of the atmosphere. A gage of this kind usually is tested by connecting it to one end of a U-shaped glass tube of which both legs are about 30 in. long and filled about half their length with mercury. For calibrating the gage one end of the U-tube and the gage are connected to the receiver of an air pump or an ejector operated by steam or water. If the gage is correct, its readings will agree with the number of inches difference in level of the mercury in the legs of the U-tube for different degrees of exhaustion. If a condensing engine is operating when the calibration is to be made, the gage and U-tube may be connected to the condenser and a comparison of the readings will show the errors of the gage for the condenser pressures that are present.

Pump-Piston Speeds and Relative Capacities—What is considered good practical piston speed for reciprocating pumps of various lengths of stroke? Having two pumps of the same diameter and different lengths of stroke, would the pump of longer stroke be considered to have greater capacity? B. F. K.

Good working piston speeds for reciprocating pumps of various strokes are as follows: 3-in. stroke, 40 ft. per min.; 4-in., 50 ft.; 5-in., 60 ft.; 6-in., 65 ft.; 8-in., 75 ft.; 10-in., 80 ft.; 12-in., 90 ft.; 15-in., 100 ft. Many pump manufacturers rate capacities at somewhat higher speeds. A pump with shorter stroke can run with more frequent reversals, but the higher piston speed obtained with longer stroke gives greater capacity for the same diameter.

Effect of Ash on Steaming Value of Coal—Is the value of coal for steaming purposes in proportion to the heat value of the combustible ingredients of the coal? W. L. J.

Ordinarily, the efficiency of combustion decreases with the increase in percentage of ash. The greater the ash content the greater the labor and cost of managing the fire and handling the ashes and the less the efficiency and capacity. When the ash is in excess of 20 per cent. of the dry coal, the commercial value as fuel falls so rapidly with increase of ash that, for use in ordinary furnaces, coals which contain 40 per cent. of ash are comparatively worthless. A high percentage of ash may clinker and clog the fuel bed, thus requiring a higher draft, while the incombustible ingredients form insulating layers that hinder the oxygen of the air supply from coming in contact with the combustible elements of the coal, thus requiring a larger air supply and greater loss from excess air for combustion of the fuel.

Equalizing Cutoff without Indicating Engine—After setting the valves of a Corliss engine, how can the equality of cutoff be tested and corrected without indicating the engine? T. E. H.

Make a mark on the crosshead and a corresponding mark on the guide when the crosshead is at each end of its travel. To test the correctness of cutoff, block up the governor to about the medium height. Then with the wristplate hooked in gear with the eccentric, turn the engine slowly in the direction it is to run, and when the cutoff hook is detached by the cam, stop turning the engine and measure on the guide the distance traveled by the crosshead. Continue turning the engine and note the distance traveled from the other end of the stroke when the steam valve of that end is tripped. If the distance traveled is the same, cutoff will be equal for the particular height to which the governor was blocked and will be approximately equal for other positions of the governor. If the distance is not equal, adjust the length of the governor reach rods until the points of cutoff are alike.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Latent Heat of Vaporization of Ammonia*

BY NATHAN S. OSBORNE AND MILTON F. VAN DUSEN

The authors, who are physicists with the Bureau of Standards, Washington, D. C., have completed experiments in the determination of the latent heat of vaporization of ammonia, and have compiled a table both in calories per gram and B.t.u.'s per pound with a range of 40 deg. below zero to 110 deg. above. The ammonia used in the determinations was prepared by Messrs. McKelvy and Taylor of the Chemical Division of the Bureau from commercial anhydrous ammonia manufactured by the synthetic method. A statement of previous determinations is made and these determinations are plotted on a chart accompanying the article.

In tables of the heat content of ammonia, such as engineers require, the latent heat of vaporization constitutes the major part. Nevertheless the direct measurements of this property are among the rarest of the available experimental data. This is attributable probably to the fact that the latent heat of vaporization may, by thermodynamic formulas, be computed from other properties more easily measurable; however, the data which have heretofore been available for this calculation have not been of a precision such as to yield satisfactory values for the latent heat. The measurements here presented have been carried out in response to the request of the associations of refrigerating engineers of this country for more accurate data upon which to base calculations for machinery using ammonia in the production of artificial refrigeration.

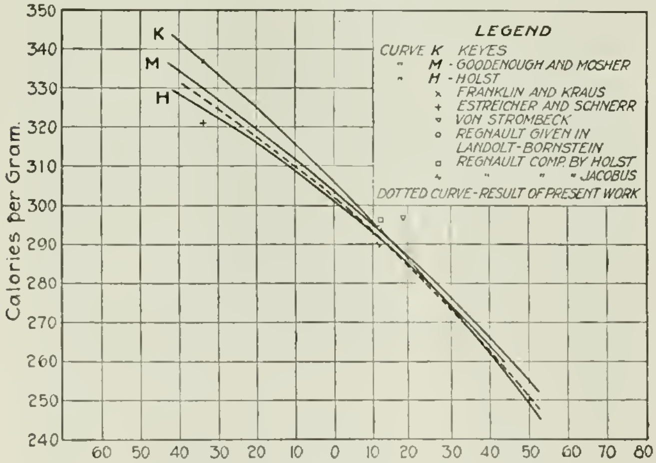


FIG. 1. RESULTS OF PREVIOUS DETERMINATIONS OF LATENT HEAT OF VAPORIZATION OF AMMONIA

Results of previous determinations of the latent heat of vaporization of ammonia are represented graphically in Fig. 1. The three curves also shown in this figure represent the values computed from other data by Keyes, Goodenough and Mosher and Holst. Regnault published a record of twelve experiments saved from the ruins of his laboratory destroyed during the Siege of Paris in 1870. The apparatus consisted of two calorimeters—the first, or evaporization, calorimeter in which the ammonia was allowed to evaporate from a steel container and flow through a chamber containing baffle plates, and the second, or expansion, calorimeter in which the ammonia vapor from the first calorimeter was allowed to expand to atmospheric pressure. The capacity of the liquid-ammonia container of the first calorimeter was 246 c.c., but it was filled with various amounts ranging from 17 to 134 grams in different experiments. In each experiment the ammonia was completely evaporated and all vapor expanded to atmospheric pressure. The observed fall in temperature in the water in the first calorimeter varied from 1.7 deg. to 13 deg., and in the second it was usually less than 1 deg. From the data obtained in the first calorimeter Regnault calculated a quantity r_1, which is the heat required to change one gram of saturated liquid ammonia at the initial temperature and pressure to vapor at the mean temperature of the experiment and at a pressure equal to a pressure in the expansion chamber in the first calorimeter.

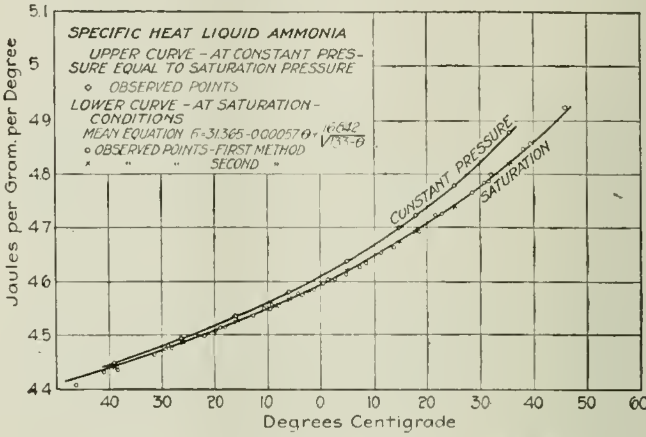


FIG. 2. SPECIFIC HEAT OF LIQUID AMMONIA

The calorimeter used in making the experimental determinations given in this bulletin is of the aneroid type and was specially designed to meet the requirements of this investigation. At this point the authors go into a thorough description of the calorimeters used, the methods of use employed, the theory of the methods and the experimental details.

TABLE 1. LATENT HEAT OF VAPORIZATION OF AMMONIA

Temperature	0	1	2	3	4	5	6	7	8	9
	Calories per Gram									
C										
—40	331.7	332.3	333.0	333.6	334.3	334.9	335.5	336.2	336.8	337.5
—30	324.8	325.5	326.2	326.9	327.6	328.3	329.0	329.7	330.3	331.0
—20	317.6	318.3	319.1	319.8	320.6	321.3	322.0	322.7	323.4	324.1
—10	309.9	310.7	311.5	312.2	313.0	313.8	314.6	315.3	316.1	316.8
— 0	301.8	302.6	303.4	304.3	305.1	305.9	306.7	307.5	308.3	309.1
+ 0	301.8	300.9	300.1	299.2	298.4	297.5	296.6	295.7	294.9	294.0
+10	293.1	292.2	291.3	290.4	289.5	288.6	287.6	286.7	285.7	284.8
+20	283.8	282.8	281.8	280.9	279.9	278.9	277.9	276.9	275.9	274.9
+30	273.9	272.8	271.8	270.7	269.7	268.6	267.5	266.4	265.3	264.2
+40	263.1	262.0	260.8	259.7	258.5	257.4	256.2	255.0	253.8	252.6
	B.t.u. per Pound									
F										
— 40	597.0	597.7	598.3	599.0	599.6	600.3	600.9	601.6	602.2	602.9
— 30	590.2	590.9	591.6	592.3	592.9	593.6	594.3	595.0	595.6	596.3
— 20	583.3	584.0	584.7	585.4	586.1	586.8	587.5	588.1	588.8	589.5
— 10	576.1	576.8	577.6	578.3	579.0	579.7	580.4	581.1	581.9	582.6
— 0	568.7	569.4	570.2	570.9	571.7	572.4	573.2	573.9	574.6	575.4
+ 0	568.7	567.9	567.2	566.4	565.7	564.9	564.1	563.3	562.6	561.8
+ 10	561.0	560.2	559.5	558.7	557.9	557.1	556.3	555.5	554.7	553.9
+ 20	553.1	552.3	551.5	550.7	549.9	549.1	548.2	547.4	546.6	545.8
+ 30	544.9	544.1	543.3	542.4	541.6	540.7	539.9	539.0	538.2	537.3
+ 40	536.5	535.6	534.7	533.8	533.0	532.1	531.2	530.3	529.5	528.6
+ 50	527.7	526.8	525.9	524.9	524.0	523.1	522.2	521.2	520.3	519.4
+ 60	518.5	517.5	516.6	515.6	514.7	513.7	512.8	511.8	510.9	509.9
+ 70	508.9	508.0	507.0	506.0	505.0	504.1	503.1	502.1	501.1	500.1
+ 80	499.1	498.1	497.0	496.0	495.0	494.0	493.0	491.9	490.9	489.8
+ 90	488.8	487.7	486.7	485.6	484.6	483.5	482.4	481.3	480.2	479.1
+100	478.0	476.9	475.8	474.7	473.6	472.5	471.3	470.2	469.0	467.9
+110	466.7	465.6	464.4	463.3	462.1	460.9	459.7	458.5	457.3	456.1

The ammonia used in the determinations was prepared by Messrs. McKelvy and Taylor, of the Chemical Division of the Bureau of Standards, by methods to be described in detail in an independent paper. The sample used in the

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*Scientific Paper No. 315, Bureau of Standards, Washington, D. C.

determinations of latent heat of evaporation was prepared in May, 1916, from commercial anhydrous ammonia manufactured by the synthetic method. Tests of the purified sample showed about one part in ten thousand by volume of noncondensing gases in the vapor phase and about one part in ten thousand by weight of water.

The latent heat of vaporization of ammonia is given in calories per gram, Centigrade degrees, and B.t.u. per pound, Fahrenheit degrees in Table I. Table II gives the vaporization of ammonia in calories per gram computed by various writers and given in their ammonia tables. The results of the present authors are included for comparison.

TABLE II HEAT OF VAPORIZATION OF AMMONIA IN CALORIES PER GRAM COMPUTED BY VARIOUS WRITERS AND GIVEN IN THEIR AMMONIA TABLES

The results of the present work are included for comparison

Temperature Deg. F.	C.	Ledoux, 1878	Peabody, 1889	Wood, 1889	Zeuner, 1890	Mollier, 1895	Dieterici, 1904	Wobsa, 1908
— 40	— 40	335 2	332	322 0	333 0	332 7		
22	— 30	330 5	324	316 0	329.9	330 6		324 3
— 4	— 20	325 3	316	309 9	325.8	327 2		317.0
+ 14	— 10	319 7	308	303 8	320 8	322 3		309.0
+ 32	0	313 6	300	297 6	314 9	316.1	309 7	300.4
+ 50	+ 10	307 2	292	291 3	308.0	308.6	298 4	290.9
+ 68	+ 20	300 3	284	284 8	300 1	299 9	285 4	280.6
+ 86	+ 30	293 0	276	278.4	291 3	289 7	272 2	269.4
+104	+ 40	285 3		271 9	281 6	278.0	258.3	257 4
+122	+ 50			265 3			243 6	244 6
+140	+ 60	...		258 6			227 9	
+200	+ 93 3		..				165 2	
+250	+121 1	.	.					
+270	+132 2	....	..					

Temperature Deg. F.	C.	Hybl, 1911	Macintire, 1911	Lucke, 1912	Mosher, 1913	Holst, 1915	Keyes, 1916	Osborne and Van Dusen, 1917
— 40	— 40			335 3	334 4	328.5	342 0	331 7
— 22	— 30	325 2	327 9	328 1	327 1	322 5	333 6	324 8
— 4	— 20	318 2	320 8	320 9	319 6	316 0	324 9	317 6
+ 14	— 10	310 7	313 0	313 1	311 8	309 0	315 7	309 9
+ 32	0	302 6	304 4	304 6	303 6	301.4	306 0	301 8
+ 50	+ 10	293 7	295 0	294 8	295 0	293 2	296 0	293 1
+ 68	+ 20	284 2	284 7	284 6	285 9	284 4	285 5	283 8
+ 86	+ 30	274 0	273 5	273 5	276 4	274 8	274 4	273 9
+104	+ 40	263 0		261 4	266 2	264 2	262 7	263 1
+122	+ 50	.		248 3	255 4		250 2	251 4
+140	+ 60	..	.	234 7	243 7		236 8	
+200	+ 93 3	.		176 7	195 3		181 9	
+250	+121 1				127 6			
+270	+132 2				61 2			

In Bulletin No. 313 the same authors give the results of experiments in the determination of the specific heat of liquid ammonia. The same type of calorimeter was used as in the determination of the latent heat, and the specific heat of the saturated liquid ammonia has been determined throughout the temperature interval —45 deg. to +45 deg. C. Two distinct and independent methods were used, each of which avoids sources of air present in the other. In the first method the heat added to a fixed amount confined in the calorimeter under saturation conditions and the resulting change in temperature is measured. By using data for the specific volumes of the two phases and the latent heat of vaporization, the corrections for the vapor are applied, giving the specific heat of the liquid when saturated. In the second method the calorimeter is kept full of liquid with a constant pressure. The heat added to the variable amount in the calorimeter and the resulting change in temperatures are measured. A correction for the heat withdrawn and the expelled liquid is determined by special experiments. The greatest difference between the mean results of both methods and the result of either method is represented by an empirical equation which is less than one part in one thousand. In Fig. 2 the results of all determinations by both methods are shown graphically. Fig. 3 shows the present and previous determinations of the specific heat of ammonia.

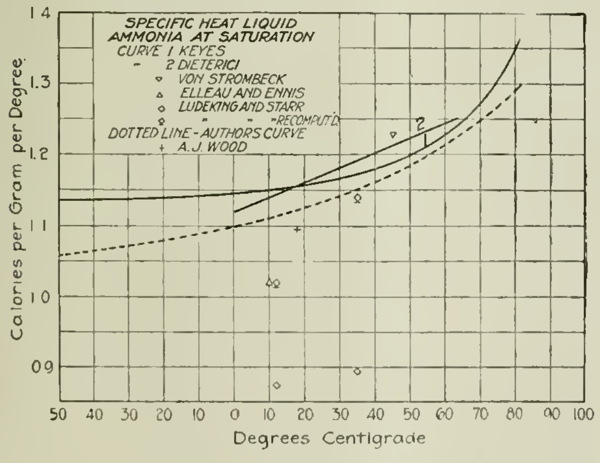

FIG. 3. PREVIOUS AND PRESENT DETERMINATION OF THE SPECIFIC HEAT OF LIQUID AMMONIA

Table III gives the specific heat of liquid ammonia under saturation conditions expressed in calories per gram per degree C. Table IV gives the heat content of the saturated liquid ammonia reckoned from the temperature of melting ice in calories per gram and B.t.u. per pound.

It is interesting to note that the result of 34 separate determinations agree with the mean within one part in one thousand. Both of these papers are now on sale, No. 315 costing 5c. and No. 313 costing 5c.; address the Superintendent of Documents, Washington, D. C.

TABLE III. SPECIFIC HEAT OF LIQUID AMMONIA UNDER SATURATION CONDITIONS

Expressed in Calories per Gram per Deg. C.

Temp., Deg. C	0	1	2	3	4	5	6	7	8	9
—40	1.062	1 061	1 060	1 059	1 058	1 058	1 057	1 056	1.055	1 055
—30	1.070	1 069	1 068	1 067	1 066	1 065	1 064	1 064	1 063	1 062
—20	1.078	1.077	1 076	1 075	1 074	1 074	1 073	1 072	1 071	1 070
—10	1.088	1 087	1 086	1 085	1 084	1.083	1 082	1 081	1.080	079
— 0	1 099	1 098	1 097	1 096	1 094	1.093	1 092	1 091	1 090	1.089
+ 0	1 099	1 100	1 101	1 103	1 104	1 105	1 106	1 108	1 109	1 110
+10	1 112	1 113	1.114	1 116	1.117	1 118	1 120	1 122	1 123	1 125
+20	1 126	1.128	1.129	1.131	1.132	1.134	1 136	1 137	1 139	1 141
+30	1 142	1.144	1 146	1 148	1 150	1 152	1.154	1.156	1 158	1.160
+40	1.162	1 164	1 166	1 169	1 171	1 173	1 176	1.178	1 181	1 183

TABLE IV. HEAT CONTENT OF SATURATED LIQUID AMMONIA*

Reckoned from the temperature of melting ice.

Calories per Gram

Temp., Deg. C.	0	1	2	3	4	5	6	7	8	9
-40	—43.3	—44.3	—45.4	—46.4	—47.5	— 48.6	—49.6	—50.7	—51 7	—52.8
—30	32.6	33.6	34.7	35.8	36.8	37 9	39.0	40.0	41.1	42.2
—20	21.8	22.9	24.0	25.1	26.2	27 2	28.3	29.3	30 4	31.5
—10	11.0	12.1	13.1	14.2	15.3	16 4	17.5	18.6	19.7	20 8
0	0.0	1.0	2.2	3.3	4.4	5 5	6.6	7.7	8 8	9.9
+ 0	+ 0.0	+ 1.1	+ 2.2	+ 3.3	+ 4.4	+ 5.5	+ 6.7	+ 7.8	+ 8.9	+10.0
+10	11.1	12.2	13.4	14 5	15.6	16 7	17.9	19.0	20.1	21.3
+20	22.4	23.5	24.7	25.8	27.0	28.1	29.3	30.4	31.6	32 7
+30	33.9	35.0	36.2	37.4	38.5	39.7	40.8	42.0	43.2	44 4
+40	45.5	46.7	47.9	49.1	50 3	51.5	52.7	53.8	55.0	56.2

B.t.u. per Pound

Temp. Deg. F.	0	1	2	3	4	5	6	7	8	9
40	—77.9	—78.9	—80.0	—81.1	—82.1	—83.2	—84.3	—85.3	—86.4	—87 4
— 30	67.2	68.3	69.4	70.4	71.5	72.6	73.6	74.7	75.8	76.8
— 20	56.5	57.6	58.7	59.8	60.8	61.9	63.0	64.0	65.1	66.2
— 10	45.8	46.9	48.0	49.0	50.1	51.2	52.3	53.3	54.4	55.5
— 0	35.0	36 1	37.2	38.2	39.3	40.4	41.5	42.6	43.6	44.7
+ 0	35.0	33.9	32.8	31.7	30.7	29.6	28.5	27.4	26.3	25.2
+ 10	24.1	23.0	21.9	20.9	19.8	18.7	17 6	16.5	15.4	14.3
+ 20	13.2	12.1	11.0	9.9	8.8	7.7	6 6	5.5	4.4	3.3
+ 30	— 2.2	— 1.1	0.0	+ 1.1	+ 2.2	+ 3.3	+ 4.4	+ 5.5	+ 6.7	+ 7.8
+ 40	+ 8.9	+10.0	+11.1	12.2	13.3	14.4	15.6	16.7	17.8	18.9
+ 50	20.0	21.1	22.3	23.4	24.5	25.6	26.8	27.9	29.0	30.1
+ 60	31.3	32.4	33.5	34.7	35.8	36.9	38.1	39 2	40.3	41.5
+ 70	42.6	43.8	44.9	46.0	47.2	48.3	49.5	50.6	51.8	52.9
+ 80	54.1	55.2	56.4	57.5	58.7	59.8	61.0	62.1	63 3	64.4
+ 90	65.6	66.8	67.9	69.1	70.3	71 4	72.6	73.8	74 9	76 1
+100	77.3	78.5	79.6	80.8	82.0	83.2	84.3	85.5	86.7	87.9
+110	89.1	90.3	91.5	92.6	93.9	95.1	96.3	97.5	98 7	99.9

*Heat content as used here is defined by the relation: $H = e + pv$

Where H = heat content, taken as zero at the temperature of melting ice, e = internal or "intrinsic" energy, and H, e, and pv are all expressed in the same units.

In Scientific Paper No. 314 the same authors give the results of experiments in the determination of the latent heat of pressure variation of liquid ammonia for a temperature range of —40 to +40 deg. C. This paper may be obtained free by addressing the Director, Bureau of Standards, Washington, D. C.

The War-Savings Stamp plan is a means of directing the nickels, dimes and quarters of the ordinary man into the United States Treasury for safe-keeping so that at the end of the war the poor man may find himself no less poor, if not richer, than he was at the beginning. It means "postponed" prosperity, and thus from the business point of view is a most desirable asset.

Manning the New Merchant Marine

By HENRY HOWARD
Director of Recruiting Service, U. S. Shipping Board

The Director of the Recruiting Service, United States Shipping Board, tells of how America is meeting the problem of manning her great merchant fleets. The Recruiting Service is responsible for providing the whole human side of the ships built for the Shipping Board. Qualifications required of applicants to engineering schools; names and addresses of the section chiefs to whom applications should be made.

PRESENT construction plans for our merchant marine call for more than 8,000,000 tons of new shipping, to be completed within two years. At the beginning of the world war, in August, 1914, seven nations were credited with more than 1,000,000 tons of shipping each. Great Britain headed the list, with 19,799,119 tons; the United States stood next, with 7,928,688 tons, and Germany third, with 4,892,416 tons. The other nations stood: France, 2,173,544; Norway, 2,425,476; Sweden, 1,114,048, and Japan, 1,167,264. Austria had 998,130 tons. Of the tonnage of the United States something more than 2,000,000 tons was available for deep-water service in the Atlantic.

The first year of the war was sufficient to show the United States that the process of attrition in the world's supply of tonnage, due to normal war causes and to the illegal use of the submarine by Germany, was creating a shortage of ships. This shortage became acute when the United States entered the war in April, 1917, thereby adding to the already pressing problem of logistics this country's vast needs of sea transportation for troops and supplies and the quickened need of sending more and yet more supplies to our Allies.

Coincident with the sudden awakening of the nation to the vital need for more cargo ships and the energetic initial steps of the Shipping Board to produce them came forward the question of manning the new merchant marine so soon to come into being. The country as a whole not having been accustomed, in recent times, to think in terms of shipping, appeared doubtful of its ability to produce the mariners needed to handle its new fleets. We were no longer a seagoing people, said the doubtful; we had lost the art of the sailor when the American square-rigged ship went out of use as a leader among the world's cargo carriers. Surely, our war need was pressing enough to appeal to the patriotism of Americans with a liking for the sea.

By establishing free schools in navigation at important ports and free classes in marine engineering at some of the leading technical colleges, I proposed to train enough men of the types indicated to meet the forthcoming increased demand for American deck and engine-room officers for the new American cargo ships.

On May 29, 1917, I was authorized by the Shipping Board to inaugurate the training plan, and on June 1 was sworn in as Director of Recruiting Service for the board. Three days later the first free navigation school to be conducted under the direction of the United States Shipping Board was opened, with 20 students, at the Student's Astronomical Laboratory, Harvard University, kindly loaned by the college faculty. Later, this school was transferred to the Massachusetts Institute of Technology, where it has since been maintained.

The work of organizing additional schools went on until 41 in all were established on the Atlantic, Gulf and Pacific Coasts and the Great Lakes. The response of men qualified to enter the schools was quick and gratifying as to numbers and, nothwithstanding that no man was accepted as a student who had not served two years on a deep-water vessel, the percentage of men who qualified for admission, out of the total number of applicants called for preliminary examination, was large. Many of the applicants, actuated by patriotism, expressed a willingness to leave lucrative positions ashore in order to fit themselves for service in the merchant marine in war time. Others frankly hailed with delight an opportunity to get back to the sea, which they had left because of unpromising conditions in the decade preceding the opening of the great war.

National headquarters of the new training service were established at Boston, where a floor in the Boston Custom House was set apart for its use by the Treasury Department. For administrative purposes in establishing and maintaining the schools the country was divided into sections, following closely the geographical divisions employed by the United States Steamboat Inspection Service, which from the first coöperated heartily with the Recruiting Service of the Shipping Board in maintaining the standard set by the regulations of the Department of Commerce as to the experience required of a candidate for a merchant officer's license.

Each section was placed in charge of an official designated as section chief, in whose hands were placed all details as to the administration of the schools in that section. The board was fortunate in securing as section chiefs men of professional or business training, whose patriotism led them to donate their time to this service, their compensation being merely nominal—in most instances $5 a month. Important positions at national headquarters also were filled by volunteers with special capacity for administrative work.

The section chiefs of the service are as follows: Section I, Horatio Hathaway, Jr., twelfth floor, Custom House, Boston, Mass.; Section II, John F. Lewis, 108 South Fourth St., Philadelphia, Penn.; Section III, Hardy Croom, 130 Riverside Ave., Jacksonville, Fla.; Section IV, Ernest Lee Jahncke, 814 Howard Ave., New Orleans, La.; Section V, Farnham P. Griffiths, 465 California St., San Francisco, Calif.; Section VI, William J. Crambs, 860 Stuart Building, Seattle, Wash.; Section VII, Capt. Irving L. Evans, 933 Guardian Building, Cleveland, Ohio.

SYSTEM OF INSTRUCTION

Direction of instruction in the navigation schools was placed in the hands of Prof. Alfred E. Burton, dean of the Massachusetts Institute of Technology, who formerly was connected with the Coast and Geodetic Survey and who is a practical navigator of wide scientific knowledge.

The system of instruction perfected for the schools was in accordance with the most approved methods of teaching navigation. It was therefore possible to impart to a student in six weeks' study a groundwork of the theory and practice of navigation to enable him to pass the examinations of the United States Steamboat Inspection Service, entitling him to a license as a second or third mate. The examinations were conducted without any modification of the regulations applying to ordinary applicants for a license. After they had been passed, the student in need of practical experience on a steamer was sent to sea in the capacity of a reserve officer, for a period of two months to learn the ropes before actually assuming the full responsibilities of the position for which he was licensed. During this period he was paid $75 a month. Afterward he received the usual pay for his grade in the merchant service.

Since the opening of the first school in navigation by the Recruiting Service of the Shipping Board, 39 others have been opened. The graduates from these schools, in the ten months from June 1 to Apr. 1, numbered 1500.

ENGINEERING SCHOOLS

The development of the engineering schools was contemporaneous with that of the schools in navigation. The training of engineers was placed in the hands of Prof. Edward F. Miller, of the Massachusetts Institute of Technology, and classes were established at the following places:

Massachusetts Institute of Technology, Cambridge, Mass.; Stevens Institute of Technology, Hoboken, N. J.; Bourse Building, Philadelphia, Penn.; Johns Hopkins University, Baltimore, Md.; Tulane University of Louisiana, New Orleans, La.; Case Schools of Applied Science, Cleveland, Ohio; Armour Institute of Technology, Chicago, Ill.; University of Washington, Seattle, Wash. The school at Hoboken was later discontinued, and one was started at the Seamen's Church Institute in New York City.

The course in the engineering schools is of one month's duration. The qualifications for admission to these schools differ slightly from those required for admission to the navigation schools, as men with proper technical experience are admitted who may require as much as six months added training at sea before becoming eligible for licenses.

Experience required for an applicant to qualify for admission to enter one of these Shipping Board Engineering Schools is classified as follows: Three years as fireman, on ocean or coastwise steam vessel; two years as oiler or water tender (or combined service of two years in these positions); six months as chief or assistant engineer, on lake, bay or sound steamer; one year, chief or assistant, river steamer; one year as locomotive or stationary engineer (with six months' sea service, which may be obtained after finishing school course); graduation from engineering class of nautical schoolship; graduation in mechanical engineering from a technical school (with six months' sea service); one year in charge of stationary plant of not less than 1000 hp.; three years as apprentice to machinists' trade (with six months' sea service).

About 1200 marine engineers were graduated from the Shipping Board free engineering schools in the first ten months of their existence. Like the dock officers graduated, all were American citizens.

One noticeable effect of the Recruiting Service's call for Americans qualified to serve as officers in the new merchant marine was the stimulation given men qualified to take examinations for licenses, without special schooling. Large numbers of such men, excellent mariners and citizens, secured licenses on their own initiative, without attending the Shipping Board schools, as is shown by the unprecedented number of licenses granted from June 1, 1917, to Feb. 1, 1918, by the Steamboat Inspection Service. Not less than 3600 original licenses were issued in that period—including those issued to the men specially trained by this service—while not less than 900 licenses were extended or transferred from fresh waters to salt; while to Apr. 1, 1918, the number of new and extended licenses was more than 5000.

THE SEA SERVICE BUREAU

As a necessary adjunct to its training service for officers, the Recruiting Service in July, 1917, established a department whose functions are indicated by its title, the Sea Service Bureau.

Graduates of the schools were placed on board ship by this department, at first entirely through the coöperation of private steamship interests, and later also on ships controlled directly by the Shipping Board.

TRAINING MERCHANT CREWS

By the autumn of 1917 the construction program of the United States Shipping Board, by which considerably more than 1000 new ships will be commissioned under our flag, had advanced sufficiently to warrant the development of the second phase of the training plan originally submitted to the board for manning the new merchant marine; namely, the training of crews.

Much thought was given by the Recruiting Service staff to working out a system of intensive training for crews, by the use of a squadron of training ships. In December the Shipping Board approved the resulting detailed plans, and on Dec. 12, 1917, announcement was made in the press that the Recruiting Service was prepared to receive applications from young Americans between 21 and 30 who wished to be trained for service on merchant ships as sailors, firemen, coal passers, oilers, water tenders, cooks and stewards. In the three months following this announcement more than 7500 applicants sent their names to the Recruiting Service headquarters, Custom House, Boston, Mass.

The number of men required for this branch of the training service was at first estimated to be 85,000; but events subsequently led to a modification of this figure. The transportation of an immense American army to France, and of its supplies, called for the taking of a great many ships from the merchant marine. The need of arming all ships entering European waters with naval guns led to a proposal that all ships crossing the submarine zone be manned by the Navy. After several conferences on this point between officials of the Navy Department, the War Department—then operating the troop ships—and the Shipping Board, a decision was reached by which control of troop ships, animal transports and freighters carrying unbroken cargoes of munitions and supplies for military uses were placed in control of the Navy, to be manned by Naval crews, while Atlantic passenger liners, freighters with general cargoes for our Allies and all merchantmen plying outside the war zone were left in the control of the Shipping Board.

Work in training the new crews was begun the day the board's authority was granted me to proceed with the plan. To administer the training service, a department was created, termed the Sea Training Bureau, with a supervisor of training in charge.

For the training squadron two steel screw steamers were at once secured, the "Calvin Austin" and "Governor Dingley," twin ships, formerly in the passenger trade on the New England coast, each being of 3800 tons gross register, 299 ft. long and 60 ft. wide, with reciprocating engines and 2700 i.hp. Each vessel had a rated capacity for 783 passengers. Being speedily converted into training ships, the vessels each had capacity from 500 to 600 apprentices. Because of the large number of applicants it was possible to select superior material for their complements, which filled rapidly in the first weeks of 1918.

While these two ships were being filled, a third was being fitted out at Newport News. This was the former transport "Meade," ex-"City of Berlin," a graceful old Atlantic liner, with a sound hull and capacity for more than 1200 apprentices. It was planned to take this ship also to Boston, to be used as a station ship, while the other two made frequent training trips to sea. Later, a fourth ship, the "Governor Cobb," of the type of the two first-named, was put into the training squadron, and plans were put on foot for placing a training ship on the Pacific Coast and another at New Orleans.

The training course is of an intensive character. There is an instructor to each ten apprentices, and he is held responsible for the progress of his group. The apprentices virtually go to school all day, and every day except Sunday, during their stay on the ship, which is not less than a month in any case, and will probably exceed two months in few.

When the apprentices have finished their intensive training, they are added to regular crews in the merchant marine, on a given ratio to the experienced men carried. By this method it is expected that no difficulty will be experienced in securing full crews for all ships added to the merchant fleet by the Shipping Board, as well as for any existing ships that may need men.

In perfecting a plan for enrolling apprentices for its training ships, the Recruiting Service availed itself of the offer of a patriotic citizen of Boston, Louis K. Liggett, head of large interests in the drug trade, controlling nearly 6900 drug stores in 6393 cities and towns.

The young men accepted for training by the Shipping Board Recruiting Service are placed on pay at $30 a month for their period of training and are exempt from military service as long as they remain in the merchant marine, either as apprentices or as members of regular crews.

[Those applying for service as engineers aboard ships of the United States Shipping Board or for training at the various engineer schools of the board should address their applications to the headquarters of the section chiefs nearest their homes, or to United States Shipping Board, Recruiting Service, Custom House, Boston. This does not apply to the Navy or the Naval Reserve.—Editor.]

Centrifugal Pumps for Mine Service*

The experience of many years with a large variety of pumps forms the basis of this article. Although the theory of the centrifugal pump as usually set forth by writers on this subject is somewhat complicated, the machine itself is simple. Its successful installation and operation require only care and judgment.

FOR anyone wishing to study the theory of centrifugal pumps, there are three or four books in the English language devoted to the subject upon which he can devote as much energy as he desires. There are a few rules, however, that it is well to remember; namely, for equal efficiencies the power required to drive the pump varies as the cube of the speed, the head as the square of the speed, and the capacity directly as the speed. The head in feet that any impeller will work against is approximately the diameter of the impeller in inches times the revolutions per minute divided by 1950 squared, or $H = \left(\frac{d \times r.p.m.}{1950}\right)^2$.

The most distinctive part of the whole machine is the impeller, the function of which is to take the slowly moving water in the suction pipe and, by revolving create by centrifugal force a velocity head in the water convertible into a pressure of sufficient intensity to overcome the static and friction heads of the discharge pipe. The impeller is mounted on a shaft carried by bearings, and is inclosed in a casing. The shaft is connected to the driving element. This is, in a general way, all there is to a centrifugal pump.

The casing should be so designed as to be readily opened, giving access to the entire inside of the pump. This is most readily accomplished by employing the so-called horizontally split casing that has the suction and discharge openings on the bottom half which is bolted to the baseplate. Such an arrangement permits the top half of the casing to be removed without breaking any pipe joints or disturbing the alignment of the pump—considerations that are of great importance when repairs have to be made in a hurry.

VERTICAL SPLIT SUPERIOR TO HORIZONTAL

The horizontal split is not so good mechanically and structurally as the so-called "vertical split," in which the annular portion of the casing is in one piece and the internal parts are withdrawn from the end, after removing the end plate which usually forms the suction pump-head. But this procedure necessitates the breaking of the suction-pipe joint. Furthermore, the parts must be pulled out one at a time—first the impeller, then the diffusion ring, next that part of the casing forming the return guide for the water to the second impeller, then the second impeller and so on—a long, tedious job, especially in large units.

In putting the parts together, the reverse order must be followed and care must be taken to insure that all the parts come to place properly, in order to prevent them from overlapping and partly closing the water passages in the casing. In such cases reliance must be placed entirely upon careful measurements; and it is very hard to make men to whom a foot more or less is good enough understand the importance of measuring to 1/16 or 1/32 in. or less. With the horizontal split, as before stated, after lifting the top half off the machine all internal parts are in view and can be removed readily. Furthermore, before the top half of the casing is replaced one can *see*—not feel—that everything is as it should be.

The ends of the casing through which the shaft projects are provided with stuffing-boxes and glands. The stuffing-boxes should be deep enough to take not less than four or five rings of good soft packing. The glands, preferably made in halves, should fit tight in the box but be about 1/16 in. larger than the shaft. To the back of the stuffing-box renewable rings should be fitted, so that if they become worn and allow the packing to be squeezed into the pump, they can be replaced. The stuffing-box on the suction side particularly when the pump is working under a suction lift, should be provided with a water seal to prevent air being drawn into the pump and also to lubricate the packing with water.

Removable rings should be provided around those parts of the casing in which the impeller or other moving parts revolve, so that in case of wear—which is bound to occur even under the best conditions and quite rapidly when pumping acidulous mine water—these rings can be replaced.

One of the chief causes of loss in efficiency of centrifugal pumps is internal leakage between a stationary and a revolving element, prevented only by a close running fit. There are several types of labyrinth rings used, the idea being that the water has to traverse a narrow, tortuous passage which it can follow only with difficulty. These rings may have merit when good, clear water is pumped, but for mine use a plain straight ring is preferable. This should have a width of ¾ to 2 in., with a running clearance of 0.006 to 0.01 in., depending upon the size of the impeller and, except for the larger sizes when fresh water is used, should be of bronze.

In modern pumps the impellers are of the inclosed type, with the blades or vanes curving backward, making an angle of from 12 to 24 deg. with the outer diameter.

THIN BLADES CORRODE QUICKLY

Originally pump builders thought that the impeller blades should be as thin as possible, with the tops cut to a knife-edge, but this was found to be a fallacy, especially in bad water, for the thin blades corroded quickly and the knife-edges doubled over and closed the port openings. The impeller walls and blade should be 5/16 in. thick for 12-in. diameter impellers and ⅝ in. thick for 24-in. and larger impellers. With such impellers higher initial efficiency, far better average efficiency and much longer life are obtained than with thinner blades. Impellers should be provided with renewable wearing rings where they fit into the casing. These rings can be shrunk on, and all rotating elements should be balanced.

Some builders claim that diffusion vanes are essential to obtain high efficiency with multistage pumps. Others assert that they can get just as high efficiency without them. Diffusion vanes, which are stationary plates with guide vanes curved in an opposite direction to the impeller blades, are arranged to encircle the impeller and receive the water discharged from the impeller tips at high velocity, and by reducing its speed convert velocity head into pressure head. The usefulness of diffusion vanes is not always apparent, since by actual tests of different makes of two-stage pumps, under about the same operating conditions (one with and one without diffusion vanes) their efficiencies were found to be practically the same. If diffusion rings are used, they should be of bronze; and provision should be made to prevent their turning in the casing and to prevent leakage around the vanes.

The pump shaft should be of steel protected by cast-bronze sleeves or bushings placed over all parts of the shaft that come in contact with the water. The end bushings should project through the stuffing-boxes and form the nuts that keep the impeller in place laterally. Provision should also be made to prevent leakage along the axis of the pump shaft, which can be done by inserting fiber gaskets 1/16 in. thick between the impeller hubs and the ends of the bushings.

Impellers should fit snugly on the pump shaft, but need not necessarily be a driving fit, and they should be secured from turning by bronze (not steel) feather keys. The pump shaft, when hung in its bearings, should be large enough in diameter to support the weight of the impellers and the column of water without perceptible deflection, so that the internal sealing rings and bushings will not be

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*Abstract of an article by Herbert Axford, pump inspector, Coal Department, Delaware, Lackawanna & Western R.R., Scranton, Penn., in *Coal Age*.

required to support any weight. In many instances the undue wear of sealing rings has been directly due to the pump shaft deflecting under load.

Bearings should be of the ring-oiled type with renewable liners in halves. Bearing boxes should be provided with bolted caps, so that the bearing liners may be renewed or rebabbitted without removing the shaft; and so that when the top half of the casing is removed together with the bearing caps, the complete rotating element can be lifted from the pump.

One of the most important details in a centrifugal pump is the thrust bearing. Unbalanced end thrust causes a great deal of trouble to the operator and it is oftentimes difficult to locate and remedy the defect. Theoretically, every pump leaving the factory is hydraulically balanced. The double suction impeller has inlets of the same diameter on each side and the impellers thus having the same pressure on each side are perfectly balanced—on paper. But let one side get choked or one side take more water than the other, or the leakage through the sealing rings on one side be more than on the other, then an unbalanced condition is immediately established.

This unbalanced pressure has to be carried by the thrust bearing. There is also the single-suction impeller, wherein the water enters on one side only. This is balanced by putting a duplicate set of sealing rings back of the impeller. Holes drilled in the rear wall of the impeller connect with the inner chamber formed by the sealing rings and thus balance the pressure in this chamber with that of the suction. Sometimes some of these holes have to be plugged or enlarged in order to equalize the end thrust.

There is also the "back-to-back" type of impeller, where the suction on one impeller or one set of impellers is on the left-hand, while the suction of the other (or the other set) is on the right-hand side. This arrangement should form a perfect end balance, and yet the thrust bearing may get red hot after a few minutes' run.

Large Marine-Type Thrust Bearings Satisfactory

The most satisfactory bearing for all ordinary purposes is the marine thrust type—that is, a series of steel collars running between babbitted collars, plentifully supplied with oil. Such a bearing is preferably run in a bath of oil with the thrust box water-cooled to keep the lubricant at normal temperature. Furthermore, this thrust bearing should be made large.

Several companies are building pumps in which hydraulic balance is effected by water leaking from the discharge side of the impeller into a balancing chamber and then out past a balancing disk, which rotates with the pump shaft, into the suction side of the pump. This device works automatically and gives satisfactory service where the water is clear and free from grit and acid, but it soon becomes useless when pumping acidulous or gritty water.

The couplings which connect the pump and motor shafts should not be any heavier than necessary, and should be of the pin-and-buffer type to allow a certain amount of end play without putting stress on the thrust bearing of the pump.

The baseplate should be of cast iron, heavy enough to resist distortion if the pump be subjected to careless handling during erection, or if the foundation settles a little.

Although some of the points mentioned may seem trivial and others self-evident, they must all be watched carefully. If the front or inner bearing of some pumps should burn out—an occurrence by no means uncommon—it would be necessary, in order to replace the bearing, to move the whole pump from its base, break the suction and discharge connections and remove the coupling from the shaft. If the men who designed such pumps were compelled to repair them in a mine while the water was rising over their shoetops at the rate of an inch a minute, there would soon be a radical reform in the design.

Another matter for investigation is the use of small screws, dowels or pins on the inside of the pump. Some builders—in fact the majority—can think of only a small screw or dowel to prevent a ring or bushing from turning, but acidulous mine water eats these small parts out so quickly that they are useless, and when they give way they seem to have the habit of lodging between some stationary and rotating element, thereby cutting grooves and ridges and almost ruining the machine.

The best speed to drive centrifugal pumps is a much-debated question. Just now builders of pumps and motors seem to be advocating high rotative speeds to secure efficiency, but for mine use moderate speed is preferable wherever possible, as less trouble is then experienced with both pump and motor. Elsewhere the higher-speed pumps apparently give good service. For 75 or 100 hp. and upward 900 r.p.m. is satisfactory; for 30 to 50 or 75 hp. 1200 r.p.m., and for smaller pumps 1500 to 1800 revolutions per minute.

The head per stage is another open question; but, in general, pumps working under 100 ft. per stage have a longer life than those working over 100 ft. per stage. Consequently, until further evidence is produced, it seems best to keep close to 100 ft. per stage as the maximum.

The centrifugal is about the simplest pump to operate when a few conditions are complied with. For example, means must be provided for priming or filling the machine with water. Where the pump is placed below the source of water supply, it is primed as soon as the valve in the suction pipe is opened and all entrained air is allowed to escape from the casing; but when the pump is placed above the water supply, some provision must be made for filling it, somewhat as follows:

Where pumps are to work under heads of less than 400 ft., a foot valve is placed on the suction pipe near to, and preferably submerged in, the water (not necessarily at the deepest or lowest point of the suction pipe, where it would be hard to reach in case of any trouble) and water is admitted into the discharge pipe at a point sufficiently above the pump to completely fill the pump casing. This method is usually adopted around mines, since when the pump is shut down a valve in the discharge pipe is closed.

The tail pipe, an important part of the installation, must be air-tight and laid so as to prevent the formation of air pockets; it must also be of sufficient diameter to avoid excessive friction. No attention should be paid to the size of the suction opening on the pump, for it will usually be found that such openings are one or two sizes too small except for short suction lines and light suction lifts. To start a motor-driven pump it is necessary only to prime it and start the motor.

Don'ts for Pump Runners

The following don'ts for pump runners cover all ordinary operating points:

Do not run a pump without water.

The numerous bushings and sealing rings on the inside of a pump depend on water for lubrication, and if the pump is run without being first filled with water these parts will get hot and "freeze," doing great damage to the pump.

Do not run without oil in all the bearings.

Do not run with dirty oil in the bearings.

Do not let water get into the bearings.

Before starting up, see that the bearings are full of clean engine oil and that there is no water in the boxes. This can be done by loosening the drain plug on the bottom of the box to see if clean oil comes out and by measuring the depth of oil in the box. Do not rely altogether on the oil-level gage, as this sometimes gets choked up. To keep the bearings clean, drain all oil out of the boxes once a week and thoroughly wash out with two or three bucketfuls of water. The old oil should be filtered and used over again if it is not too gummy.

Do not run the stuffing-box glands tight.

This produces unnecessary friction, causing the boxes to heat up and the packing to burn out. Having the glands loose and allowing them to leak a little keeps the packing lubricated and the stuffing-boxes cool.

Do not run with leaky joints around pump.

This is unnecessary, and if not stopped in time will ruin the joint faces.

Do not allow water to collect around the motor.

Keep the baseplate of the pump clean, for when the motor is running the air suction produced draws the dirt and moisture into the motor.

Do not run a pump or motor that vibrates excessively.

This is caused by the machines not being in balance or line. It should be reported at once.

Do not run unless you are satisfied that all parts are in good condition.

Do not allow oil, grease or dirt to accumulate anywhere in the pumproom.

If properly cared for, a centrifugal pump will run with little trouble.

The advantages of centrifugal pumps are briefly as follows: Small floor space is required, therefore they can be installed in a small pumproom. The machine is light in weight, therefore it is easily handled in close places and requires no expensive foundation; in fact it can be set on skids. It can be quickly installed and can be direct-connected to an electric motor, dispensing with noisy and troublesome reduction gearing. It has no valves or plunger packing, therefore will have no packing or valve troubles. It gives a steady flow of water without shocks, can be started with the column line full, and furthermore, cannot do itself or pipe lines harm should the line become blocked or if someone forgets to open the valve on the discharge line before starting. Last, but by no means least, it is a reliable pump, with a minimum cost of maintenance, except possibly where the water is extremely acidulous or gritty.

Pumps Should Be Accurately Aligned with Motors

Centrifugal pumps should be set on a fairly good base and accurately lined with their motors. Although pumps are usually coupled to their motors by so-called "flexible" couplings, these are not flexible in the sense that they are a sort of universal joint. They simply permit end motion, and although they permit operation with the pump and motor slightly out of line, trouble will eventually follow. Piping should be connected to the pump squarely and accurately, for it is possible to strain and distort the pump casing if force is used to bring the piping and pump connections in line. As stated previously, provision should be made for priming the pump. Check valves should be installed in the column pipe with a bypass around so as to drain the line. When the capacity has to be regulated by throttling, a gate valve must also be installed in the discharge pipe line; in fact, when the water is not highly acidulous, it is wise to install both a gate and check valve in all column pipes. But where the water is extremely acid, it has been found that the gate valves wear out quickly and that good leather-faced check valves last so much longer that the gate valve is omitted and reliance is placed entirely on the check valve.

The strainer on the end of the suction pipe should have the mesh, or size, of the holes so small that nothing will pass through which is likely to lodge in and block the impeller. The total area of the holes should be two or three times that of the suction pipe. There should be no less than four feet of water over the strainer, for it is possible to draw air bubbles down through even four feet of water, especially if the velocity is high. Provision should be made for water-cooled bearings, water seals on the suction glands, and the air vents should be piped properly. With the larger machines, provision should be made for handling the heavy parts—that is, for taking off the top half of casings, and removing the shaft and impellers by means of a hand crane or chain hoist. If these few common-sense directions are followed and good water is pumped, the machine will run satisfactorily for years. If the water is acidulous it is necessary merely to change the sealing rings; on the quality of the water the frequency of such renewals depends. If gritty the grit gets in between the fast-moving internal parts and acts like a grindstone, cutting the normal working clearance of $\frac{1}{100}$ in. to ⅛ or ¼ in. in a very few days.

The maintenance of pumps is a simple matter as the parts most subject to wear are the shaft bearings, the shaft sleeves in the stuffing-boxes, the sealing rings on the impellers, together with the distance and stage bushings in multistage pumps. These last-mentioned parts generally wear rapidly, and it is an excellent plan to keep an extra pump rotor on hand—that is, a shaft with impellers, rings and shaft sleeves—also an extra set of bearing liners. Then, when the pump declines in capacity (which is a general sign that the sealing rings are worn, allowing too much internal leakage or short-circuiting of the water) it is an easy matter to open the machine, remove the old rotor, put in the new one and bring the pump back to its original capacity and efficiency. The old rotor is then sent to the shop to be rebushed and held in readiness for further use.

If this is done before the pump gets too badly worn, the operation can be repeated many times and the cost of repairs reduced, but the repairing must be done in a careful and painstaking manner or the repair costs and troubles will more than double.

A restricted suction will cut down the capacity of the pump and give excessive end thrust. A leaky suction pipe will also cut down the capacity and give an unsteady and fluctuating pressure and flow and produce excessive vibration and noise in the pump.

If the holes in the strainer are so large that chips of wood, coal and other substances enter the pump and block the impeller vanes, trouble ensues.

Thrust-bearing troubles can be greatly reduced if large thrust bearings provided with an efficient oiling system are used. When abnormal thrust occurs, as before mentioned, examine the suction line first; then if the trouble is not located, open the pump and see if one set of sealing rings is worn more than another.

Efficiency of Centrifugal Pumps Low

Centrifugal pumps are not recommended as a rule for capacities of less than 300 gal. per min., and even for this capacity the head should not exceed 60 ft. For heads of 100 to 150 ft. 500 gal. per min. is considered the minimum, but for capacities of 1000 gal. per min. it can be used for almost any head with fairly good efficiency. Two 1500-gal. eight-stage pumps working against a total head of 820 ft. have been in successful operation for two years, giving a pump efficiency of about 68 per cent. The efficiency of the centrifugal pump is generally low. A 300-gal. pump gives about 50 per cent., a 500-gal. pump about 55 per cent. and larger pumps give anywhere from 55 to 72 per cent. efficiency. This latter efficiency is the highest of which the writer has actual knowledge, and that was secured from a machine of large capacity working under a moderate head.

Each centrifugal pump must be built for a certain capacity and head at a given speed, and it is herein that the maximum efficiency lies, because the capacity and head cannot vary materially from these fixed conditions without a considerable loss in efficiency. This means that a centrifugal pump built for a certain head and driven by a constant-speed motor cannot be used for any other head, much greater or less, without sacrificing efficiency, and the capacity when driven at a constant speed cannot be changed or varied except by the uneconomical method of throttling. These points should always be taken into consideration.

The steam-turbine-driven centrifugal boiler-feed pump has been well received, but is not recommended for boiler plants of less than 3000 rated horsepower, since small ones are unusually run at such high speed that it does not take much to put them out of order. Furthermore, the first cost, steam consumption and upkeep will be high. For plants of 8000 hp. or over, they are superior to the plunger pump, but between 3000 and 8000 hp. the selection hinges largely upon local conditions and individual preference.

The Latent Heat of Steam

The latent heat of steam at standard pressure and temperature is a fundamental constant, the value of which has long been less satisfactorily known than was desirable. The values given in Kaye and Laly's "Physical and Chemical Constants" differ appreciably, ranging from the 537 calories of Regnault obtained in 1847 to the 540 calories found by Joly in 1895. In Callendar's steam tables the value 539.3 is adopted. A new determination is described in a paper by T. Carlton-Sutton, published in a recent issue of the *Proceedings* of the Royal Society. The plan of the experiments consisted in weighing the quantity of steam condensed upon a bulb, both when empty and when filled with water. From the two observations the latent heat can be deduced, the value found being 538.88 mean calories. It is claimed that this figure is correct to the fourth significant figure.—*Engineering.*

Some Fundamental Considerations of Power-Factor Correction*

By R. A. McCARTY
Engineer, Westinghouse Electric and Manufacturing Company

What the power factor of an alternating-current circuit is and its effects upon the capacity of generating and transmitting equipment are discussed, and the use of synchronous machines as a means of correcting the power factor is considered.

THE power factor of an alternating-current circuit may be defined as the ratio of the actual energy in kilowatts to the apparent energy in kilovolt-amperes, expressed in percentage. For example, if the kilowatt load on a circuit is 1000 and the kilovolt-ampere load 1250, then the power factor of the circuit is 1000 ÷ 1250 = 0.80, or 80 per cent. This relation between actual and apparent energy is dependent on the relative "phase" position, with respect to time, of the current and voltage of the circuit, which in turn is fixed by the characteristics of the circuit and the connected apparatus, as will be mentioned later.

In any alternating-current circuit if both the voltage and current pass through corresponding instantaneous values, that is, pass through zero and maximum points, simultaneously, they are said to be "in phase." When this condition exists, the actual and apparent energies are equal and the power factor is 100 per cent. If, however, the voltage passes through any given instantaneous value before or after the current passes through the corresponding value, the two are "out of phase." When this condition exists, the true energy is less than the apparent energy and the power factor is something less than 100 per cent. If curve *A*, Fig. 1, represents voltage and curve *B* the current in phase with the voltage, then curve *D* will represent a current out of phase with the voltage.

The latter condition is the immediate result of the reactive, or wattless, current present in the circuit. In any alternating-current circuit having a power factor less than 100 per cent., the current that flows is made up of two parts, the energy component in phase with the voltage and the reactive component, which leads or lags behind the voltage 90 electrical degrees. These two components of the current, therefore, bear a 90-deg. relation to each other and combine geometrically to give a resultant current that lags or leads the voltage by an angle less than 90 degrees.

Again referring to Fig. 1, if curve *A* represents the voltage and curve *B* the energy component of the current, then curve *C* will represent the reactive component and curve *D* the current that results from the combination of *B* and *C*. Assuming a direction of phase rotation from right to left, the current represented by curve *D* lags behind the voltage *A*.

The reactive current in any circuit is due to inherent characteristics of certain apparatus such as induction motors, transformers, reactance coils, arc lamps, etc., which make them draw from the source of supply, not only the work current which transmits the useful energy but reactive-magnetizing current as well. Since the reactive current not only transmits no useful energy but has the detrimental effect of causing increased losses, which appear in the form of heat, in the transmission line, transformers and generating apparatus, thereby reducing their useful capacity, it is obviously desirable to reduce to a minimum or neutralize the effect of such current. The very marked increased heating, for a given rating, or the reduction in rating, of the generating apparatus, which results from low-power-factor loads will be mentioned later.

In practically all commercial circuits the demand for lagging reactive current predominates to such an extent that it is seldom if ever necessary to consider the case of leading current in connection with power-factor correction alone. For that reason all further reference will, unless otherwise stated, presuppose a condition of lagging power factor.

There is at the present time but one commercially successful type of apparatus for general application of neutralizing the effects of lagging reactive current. This apparatus consists of overexcited synchronous motors used either to deliver part of their capacity in mechanical load and the remainder in corrective effect, or their full capacity as corrective kilovolt-amperes. Under the latter condition they are usually termed synchronous condensers.

Any synchronous motor, when operated with a field excitation just sufficient to set up the flux required to generate a counter-electromotive force which equals the impressed electromotive force minus the ohmic and reactance voltage drops in the armature winding, will draw from the line a current in phase with the voltage, therefore operates at 100 per cent. power factor. Other things remaining constant, if this field adjustment is varied the motor will in addition to taking the energy current required, draw from the supply a reactive current which either opposes or assists the current in the motor's field winding in maintaining the flux required for the counter-electromotive force. With the motor's field underexcited, the reactive current drawn from the line is a magnetizing current, in the same sense as that drawn by an induction motor; that is, it lags behind the line voltage, thereby tending to still further reduce the power factor of the total system. For this reason it is very important that the field excitation of a synchronous motor should always be adjusted to its proper value. If, however, the field is overexcited the reactive current drawn from the line is a demagnetizing current and leads the line voltage. Therefore it is possible to neutralize the effect of any lagging reactive current by introducing into the system a like amount of leading current. As previously indicated, the required leading reactive current may be introduced into the system by using a synchronous motor of the proper capacity, operating with an overexcited field.

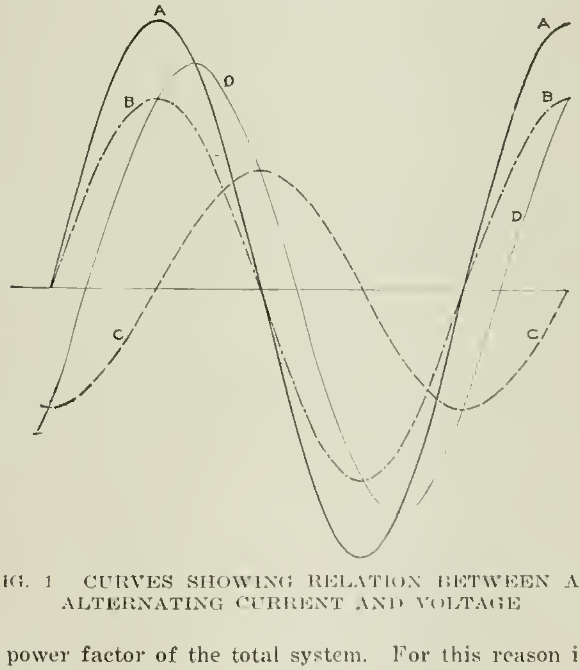

FIG. 1 CURVES SHOWING RELATION BETWEEN AN ALTERNATING CURRENT AND VOLTAGE

The questions of proper corrective capacity, its location in the system, whether it shall be in one or more units and

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*A paper presented before the Iron and Steel Electrical Engineers and the Pittsburgh Section of the American Institute of Electrical Engineers at Pittsburgh, January 12, 1918.

whether the machines shall deliver both mechanical energy and corrective effect or only the latter, have, of course, to be determined for each particular case. The detail conditions which ordinarily determine the decisions in regard to these points are beyond the scope of this discussion, but one or two principal factors may be mentioned. There are several accurate but more or less involved methods for determining the required corrective capacity for any given case, but all this becomes unnecessary and the problem extremely simple if we keep in mind the fundamental principles; namely, that the leading and lagging reactive currents are in opposition, hence the resultant reactive current is the algebraic difference; that the reactive current is 90 deg. out of phase with the energy current; that the resultant current is the geometrical sum of these two; and that the power factor of the system is the ratio of the kilowatt to the kilovolt-amperes.

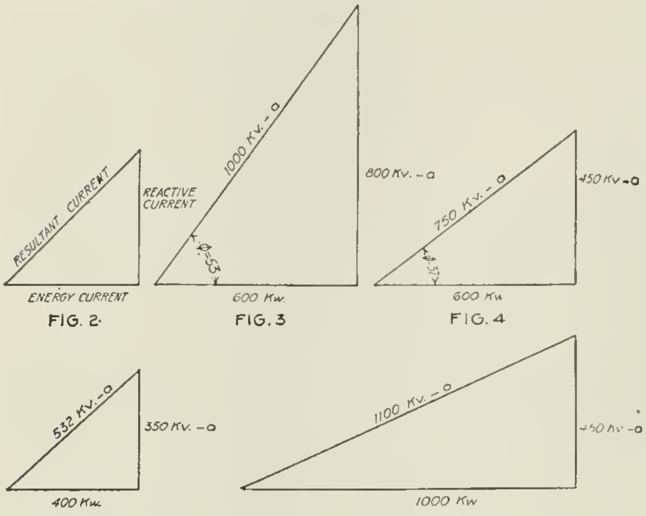


FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 2 TO 6. SHOW THE RELATION BETWEEN ENERGY, REACTIVE AND RESULTANT CURRENTS

Expressed geometrically, the energy current, reactive current and resultant current form a right-angle triangle, Fig. 2, in which the base represents the energy current, the vertical line the reactive current and the hypotenuse the resultant current, as indicated. Since, if the currents in the system bear these relations to each other, the kilowatt, reactive kilovolt-amperes and resultant kilovolt-amperes must bear the same relations, we will for convenience use the same triangle to indicate the latter quantities.

Assume, then, a system having a load of 1000 kilovolt-amperes at a power factor of 60 per cent. and it is required to find the corrective kilovolt-amperes to raise the power factor to 80 per cent., and the resultant total kilovolt-amperes of the system. To determine the lagging reactive kilovolt-amperes of the system, refer to the triangle, Fig. 3, the hypotenuse or total kilovolt-amperes is 1000, the base or energy is 60 per cent. of this value or 600 kw. and the vertical side or reactive kilovolt-amperes is found, by solving the triangle, to be 800 kilovolt-amperes. Repeating this construction for the system with a power factor of 80 per cent., the kilowatt will of course remain constant at 600, Fig. 4. Since the power factor can be expressed as the cosine of the angle between the resultant kilovolt-amperes, and the kilowatts, or in this case equals 0.80, the angle between the resultant kilovolt-amperes and kilowatts will be that having a cosine corresponding to 0.80. or approximately 37 deg. Then drawing the hypotenuse at an angle of 37 deg. to the kilowatt line and completing the right triangle, it will be found that the resultant total kilovolt-amperes will be 750 and the reactive kilovolt-amperes 450. Obviously, then, the required corrective kilovolt-amperes to produce this result is the difference between 800 and 450 or 350 kilovolt-amperes. If this corrective kilovolt-amperes is obtained by a synchronous condenser, its rating will be 350 kilovolt-amperes. If this corrective effect is to be obtained from a machine that is to deliver mechanical energy as well as the corrective effect, the rating of this machine is found as follows:

Assume that the motor is to deliver 500 hp. and at the same time supply 350 kilovolt-amperes corrective effect; determine the capacity of the motor and the final total kilovolt-amperes of the system. Allowing for the efficiency of the motor, it would have a kilowatt input of 400. Combining this as before at right angles, with the 350 kilovolt-amperes (Fig. 5) the corrective kilovolt-amperes rating of the motor is found to be 532. The total kilovolt-amperes of the system then becomes the resultant of 1000 kw. (sum of original 600 kw. and additional motor 400 kw.) and the uncompensated reactive kilovolt-amperes of 450. These, combined as before at right angles, give a total system kilovolt-amperes of approximately 1100, Fig. 6. It should then be noted that the addition of the 400 kw. energy load, in addition to the 350 kilovolt-amperes corrective capacity has resulted in raising the power factor of the total system to 1000 ÷ 1100 = 0.91, or 91 per cent.

The location in the system of the machine delivering the corrective effect should, to obtain the greatest gain, be at or near the source of the lagging reactive current. Otherwise the reactive currents have to be transmitted over the intervening lines, and through transformer, switches, etc., causing additional losses.

The question of using synchronous condensers or partly mechanically loaded motor for this service largely depends on the questions of capacity required and the relative locations of the demands for mechanical energy and corrective effect. In general, if the two are combined, the first cost of the required apparatus is less and the cost of buildings and maintenance is less.

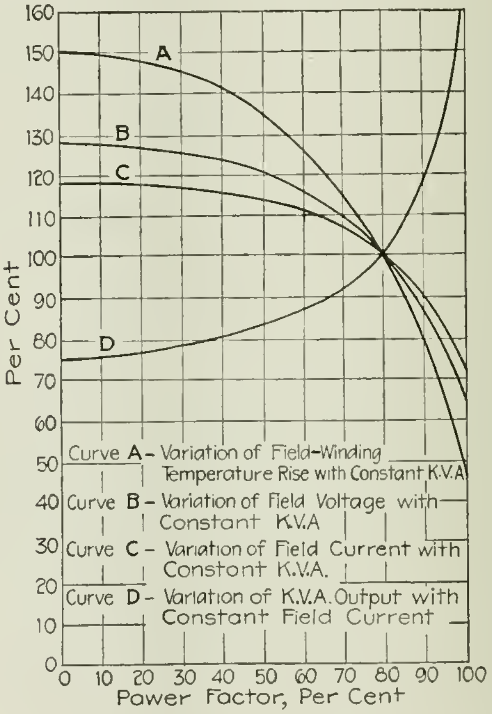


FIG. 7. SHOWS VARIATION IN ALTERNATOR PERFORMANCE WITH CHANGE IN POWER FACTOR

To show this point in a concrete way, the relative cost of a motor-generator set consisting of a 1000-kw. 250-volt direct-current generator driven by a 2200-volt three-phase 14-pole 60-cycle 80 per cent. power-factor synchronous motor was compared to the cost of a set of the same capacity except driven by a 100 per cent. power-factor motor with a separate 8-pole synchronous condenser having the same corrective capacity as the 80 per cent. power-factor motor (approximately 850 kv.-a.). This comparison showed that the 80 per cent. power-factor motor set has a first cost of 90 per cent. of the other machines and only 80 per cent. of the losses. A notable installation of this kind is now building for the Tennessee Coal, Iron and

Railway Co., consisting of five 750-kw. direct-current generators driven by 1500-kv.-a. motors. These motors, in addition to driving the generators, supply approximately 1200 kv.-a. each in corrective capacity.

The question is sometimes raised regarding the use of synchronous converters for power-factor correction. Machines of this class as normally designed are not adapted for this service, by reason of the limits from heating both in the armature and field windings. Owing to the difficulties of obtaining satisfactory commutation under load conditions with the flux distribution that results from the presence of the reactive current in the armature, designing machines with sufficient heating capacity for this service is looked upon with disfavor.

To emphasize the desirability, particularly from the standpoint of the generator, of maintaining system power factors, at, say, 80 per cent. or higher, the curves, Fig. 7, have been worked up for a normally designed generator rated at 6000 kv.-a. at 500 r.p.m., showing the variations in performances with varying power factors. These curves show, basing all performances on 80 per cent. power factor as the normal condition and assuming constant kilovolt-ampere output, that if the power factor drops to 60 per cent., the exciting amperes become 111 per cent., the exciting voltage 116 per cent., and the field temperatures rise 126 per cent. of those quantities at 80 per cent. power factor. On the basis of reducing the output to maintain the same field heating, a change from 80 per cent. power factor to 60 per cent. reduced the generator rating to 86 per cent. of the original output.

Special Joint Committee Hearing on Administration Water-Power Bill

The Special Joint Water-Power Committee of the House of Representatives held another hearing on the Administration bill on Apr. 15, with Sir Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario, as the speaker. Sir Adam delivered an exhaustive analysis from his own point of view of conditions relating to water-power development in the Dominion, and the sale of hydro-electric energy in Ontario, as compared with what he knows of conditions in the United States. He made a strong plea for monopoly in public utilities and presented figures tending to show that under government control in Toronto the rate for electricity is about half the rate at Buffalo, and made other comparisons between rates in the United States and in Ontario.

Secretaries Baker and Houston To Be Heard

The hearings before the joint committee will not be closed until the committee has heard Secretary Baker of the War Department, Secretary Houston of the Agricultural Department, and any members of Congress who desire to be heard. The framing of the final bill will therefore be delayed in the committee.

Sir Adam Beck has been identified with water-power matters in Ontario "since 1903 or 1905." He traced the growth of legislation in Canada, saying franchises were originally granted to generate power at Niagara Falls on the Canadian side, as follows: To the Canadian-Niagara Power Co., 100,000 hp.; to the Electric Development Co., 125,000 hp., and to the Ontario Power Co., 180,000 hp. He said the object of the boards of trade, merchants' associations, etc., in Ontario was to make this power available generally to the people of the district, and because of the great advance in the art of transmitting energy at high voltage, economically, to great distances, a desire was created in manufacturing districts to have this power available for them. Sir Adam pointed out that Ontario has no known coal fields at this time, and that one of the power difficulties there is the necessity for long transportation, and a duty on coal. That difficulty has long continued.

In 1902, he said, various civic bodies appointed a committee to confer with the legislature on steps to enable municipalities to undertake the generation of electricity. The legislature had two years previously refused the city of Toronto a franchise to develop power, and instead had granted such a franchise to the Electric Development Co., which had affiliated with it the Toronto Electric Light Co. and the Toronto Street Railway Company.

Finally, the legislature passed an act allowing municipalities to borrow money on their own account for power and light development, and a commission was appointed to investigate, which, after eighteen months' work, practically said that power could be delivered at cost; but the practical difficulty of raising money was encountered, and further rights for development were granted to the Electric Development Company.

Sir Adam then told of changes in the government following elections and of the passage of the present acts and amendments. He said:

> We have power to acquire by purchase or otherwise, on any terms, and hold shares in any incorporated company carrying on the business of developing, supplying and transmitting electrical energy. We have power to appropriate the land, waters, water privileges or water powers or works, machinery and plants or portions thereof of any person owning or operating under lease or otherwise or operating or using water-power privileges or transmitting electrical power or energy in Ontario which in the opinion of the commission should be purchased, acquired, leased, taken, expropriated and developed or used by the commission for the purposes of the act. Now, that is pretty drastic, but it is all subject to arbitration.

At the present time the Ontario Commission has contracts with 225 municipalities. They pay all interest charges at 4 per cent. and a sinking fund of 1.8 per cent., which retires in thirty years. They pay all charges of depreciation, operation, administration, etc. The chairman continued:

> We operate at the present time twelve systems. They will become interconnecting eventually and form one great trunk system. In this way we are attaining the object of the whole scheme; namely, that there should be one control only. . . . We want to create a real monopoly because we believe all these service undertakings should be a monopoly. There is little satisfaction in having competition in a telephone system, or a telegraph system, or even a railway system, and certainly not in an electric system in any community. The obnoxious poles and wires, the great dual cost of everything, and the great dual investment that results because of the diversity created by these various corporations covering the same field are undesirable from every standpoint.

The Power Situation at Niagara

As to the Niagara situation, Sir Adam said the principle laid down by the International Waterways Commission is that there should be an equal division of water for power purposes on all international streams, and pointed out that there is now pending an application that the United States Government shall confer with the Dominion authorities regarding a proposal to allot another 10,000 ft. per sec. to each government. This, he pointed out, is advanced as a war measure, and will be justified even though the most efficient use is not made of the water. Sir Adam said he believes that if this measure is carried through it will not be canceled after the war and will stimulate production after peace comes. He presented figures to show that the total power now being generated on both sides of Niagara is 653,500 hp. Of this amount 265,000 hp. is generated in the United States, which also receives 110,000 hp. exported from the Canadian side, making a total of 375,000 hp. available in the United States. This amounts to 40 per cent. more for the United States than for Canada, although the latter country generates 100,000 hp. more than the United States.

There is no intention on the part of either the Canadian government or the commission to interfere with the present export arrangement, even though Canada is now short 100,000 hp. In order to permit a continuance of the export, Canada has arranged to do away with all sign lighting, window lighting and other uses of energy which in some quarters have been characterized as less essential. The power generated by the province of Ontario has reduced coal consumption between 5,000,000 and 6,000,000 tons per annum. Motive power has been saved, use of cars has been saved, and duty on coal has been saved. The estimated potential horsepower of hydro-electric energy in Canada is about 50,000,000, and in Ontario alone about 5,000,000 or 6,000,000, with but 700,000 developed. At the beginning of the commission's work, in 1910, only 750 hp. was being delivered to the twelve municipalities interested. The commission has acquired up to date about 86 corporations, through friendly negotiations, and without resorting to the drastic powers given to it under the act.

Coal-Car Situation Serious

The United States Fuel Administration is gravely concerned over the serious falling off in coal production which has become apparent since the beginning of the coal year on Apr. 1. Despite the many measures adopted by the Fuel Administration to increase production and facilitate distribution, the supply of bituminous coal of the country fell off 1,500,000 tons, or 14 per cent., during the week ended Apr. 6, as compared with the preceding week, according to the reports of the Geological Survey.

Some part of this loss was due to failure of mine labor on Apr. 1, Mitchel Day, the anniversary of the enactment of the eight-hour law. With the exception of two weeks during the hardest weather of the winter, the daily bituminous production was lowered during the week ending Apr. 6 more than at any time since the Fuel Administration was organized.

A large part of this falling off in production, however, is due to the continued lack of transportation service as evidenced by the shortage of cars placed at the mine to be loaded. This is due to the general pressure of war traffic on the railroads. Car shortage reports for the week ended Apr. 6 are not yet available, but for the week ended Mar. 30 the mines throughout the country showed an average loss in production due to car shortage of 23.3 per cent.

In the fields of Illinois, Indiana and Ohio the average loss due to car shortage was 22.6 per cent. In one of these, the northern and central Ohio field, the loss was 34.2 per cent. In the Pennsylvania fields the loss in production due to car shortage averaged 32.4 per cent. In the New River and Winding Gulf and Pocahontas fields, which supply the low-volatile coal vitally needed by the Navy and the merchant marine for bunker purposes, loss in production due to car shortage was 24.4 per cent. In the high-volatile fields of southern West Virginia and the Fairmont, the average loss in production due to car shortage was 50.3 per cent.; the southern high-volatile fields lost 41.6 per cent. and the Fairmont fields 59.1 per cent. Cumberland Piedmont field showed a loss of production of 15.6 per cent., and the mine fields in Kentucky, the Southern Appalachian fields and the southwestern Virginia fields an average loss of 29.7 per cent., due to car shortage.

On the other hand, in the Alabama, Kansas, Missouri, Oklahoma, Arkansas, Iowa, Rocky Mountain and Pacific Coast fields the car service was within 5 per cent. of normal. Except for Alabama the bulk of the output of these mines goes into domestic consumption and is utilized west of the Mississippi River. It does not enter into the transportation problem in the congested Eastern territory.

This continued shortage of cars at the mines in the fields supplying the Eastern industrial territory has had the effect of keeping mine labor idle for days at a time, and in some of the fields has cut the working time to one or two days a week. Under these conditions the mine workers, unable to maintain themselves and their families on their curtailed pay, have been tempted by the steady employment offered by the war industries in the manufacturing centers.

The Fuel Administration is gravely apprehensive lest this condition result in the complete demoralization of the labor supply of the bituminous mining industry. Even a short continuance of these car-supply conditions will result in the forcing out of the mining fields the labor which the mining operators and the Fuel Administration may find it impossible to replace, even if the railroads are unable to offer a full car supply to the mines later in the summer. Reports to the Fuel Administration give evidence of unrest and dissatisfaction among the mine workers who throughout the past year have given patriotic service, even when it meant a personal sacrifice.

Among the causes of disturbance curtailing production is the unsettled situation regarding contracts for railroad fuel. This question is under consideration by the Railroad and Fuel Administrators and will be settled at the earliest moment possible.

The Fuel Administration is convinced that unless there is immediate and material improvement in car supply efficiency, the country faces the certainty of a serious shortage of bituminous coal.

The Fuel Administration will undertake to see that the preferred classes included in Preference List No. 1, of the Priority Committee of the War Industries Board are the first to receive their quota of the limited supply. This priorities list includes domestic consumers of coal.

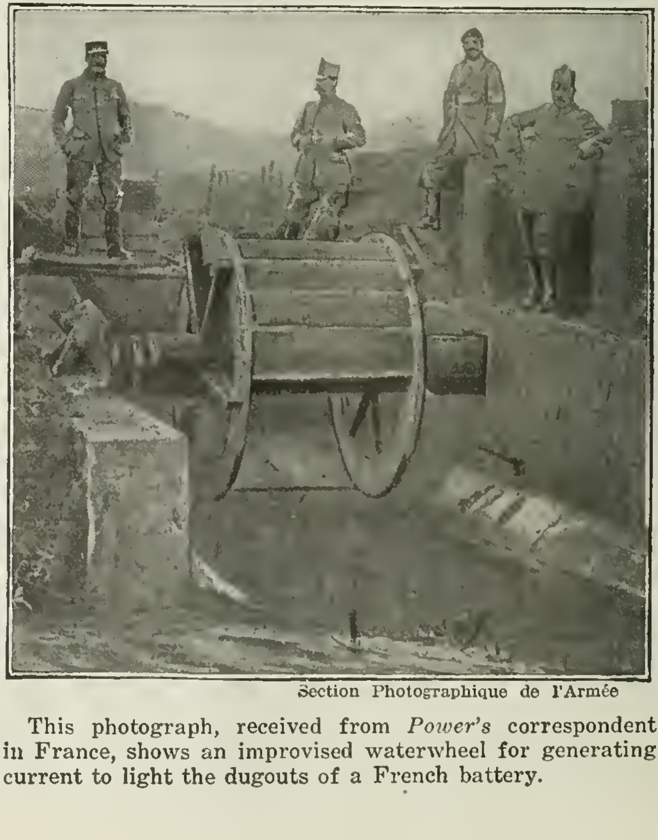
Patriotic coöperation by the domestic users of the country in the effort of the Fuel Administration to secure the "early ordering" of next winter's domestic coal supply has filled up many of the retail dealers of the country with orders that cannot be delivered for weeks or possibly months. These consumers will be given their proper preference, however, and their coal will be delivered just as rapidly as the railroads can move it. The uncertain state of the supply makes it imperative that every domestic consumer should have his order in the hands of his dealer at the earliest possible moment.

National and State Conventions

American Order of Steam Engineers	Philadelphia	June	11–13
Canadian Assn. of Stationary Engineers	London	June	25–27
Universal Craftsmen Council of Engineers	Cleveland	Aug.	12–17
National Association of Stationary Engineers	Cincinnati	Sept.	9–14
Int. Union of Steam & Operating Engineers	Cleveland	Sept.	9–14

N. A. S. E. STATE ASSOCIATIONS

California	San Diego	June	14–16
Illinois	Ottawa	June	5– 7
Indiana	Indianapolis	June	26–28
Iowa	Cedar Rapids	June	12–14
Kansas	Topeka	May	1– 3
Kentucky			
Michigan	Flint	July	10–12
Minneapolis	Duluth	Aug.	14–16
Missouri			
New England States	Bridgeport, Conn.	July	10–12
New Jersey	Perth Amboy	June	1– 2
New York	Brooklyn	June	14–16
Ohio	Cincinnati	Sept.	8– 9
Pennsylvania	Chester	June	20–21
Texas	Dallas		
West Virginia			
Wisconsin	Appleton	July	18–20



Section Photographique de l'Armée

This photograph, received from *Power's* correspondent in France, shows an improvised waterwheel for generating current to light the dugouts of a French battery.

New Publications

GRAPHICS. By H. W. Spangler. Published by John Wiley & Sons, New York City. Cloth, 6 x 9¼ in., 95 pages. Price, $1.25.

The book contains the substance of lectures on the subject of graphics given to the students in mechanical, electrical and chemical engineering at the University of Pennsylvania. They are intended to cover only fundamental principles, and those familiar with the subject will recognize that the methods of treatment used by the many writers have been utilized in their preparation. Many of the short-cuts in common use are not referred to in the text as the time allotted to this work is limited, and while such short-cuts are of special value in special work, they are readily grasped by one who has a fundamental knowledge of the entire subject.

The author states that it is intended that the book shall be used as a reference work. It should serve this purpose well.

REFRIGERATION By Milton W. Arrowood. Published by the American Technical Society, Chicago. Flexible leather, 7 x 4¾ in., 272 pages exclusive of the index.

This little book has the appearance of a handbook, but cannot be said to be a handbook of the usual type as the author has endeavored to treat the subject more from a practical than from a theoretical viewpoint, giving only enough physical theory on the problems of heat measurements, pressure, etc., to make the text understandable. On the whole the illustrations in the book, which are mostly line drawings, are well done. Good descriptions of the various systems of refrigeration are given, and the descriptions of commercial machines are very good. In that part of the book treating of ice making the author deals with the various systems, with storing and selling ice and with ice-plant insulation. About 38 to 40 pages are devoted to cold storage. Pages 143 to 160 are devoted to methods of refrigeration, proportions between the parts of a refrigerating plant, testing, operation and management of the plant.

COAL: THE RESOURCE AND ITS FULL UTILIZATION

The Division of Mineral Technology, United States National Museum (Smithsonian Institution), is producing a set of papers entitled "The Mineral Industries of the United States, six in all, the aim being to present a constructive analysis of the fuel situation in the United States. This series is known as Bulletin 102, Parts 1 to 6 inclusive. Those already issued are: Part 1, Coal Products: An Object Lesson in Resource Administration. Part 2, Fertilizers: An Interpretation of the Situation in the United States. Part 3, Sulphur: An Example of Industrial Independence. Part 4 (just out). Coal: The Resource and Its Full Utilization. Part 5 (in preparation). Power: Its Significance and Needs. Part 6 (in preparation). Petroleum: A Resource Interpretation.

Part 4, just to hand, is a splendid, dispassionate analysis of the fuel situation, pointing out in nontechnical language the things that are necessary and must ultimately be done to correct the inherent deficiencies in the utilization of coal. In spite of ample supplies in the ground, coal inadequately meets its obligations: first, because of the competitive manner in which it is mined; second, the unnecessary extent to which it is transported; and, third, the improper way in which it is used. The Bulletin contains 26 pages, 6 by 9 in., and is worthy of careful reading.

Personals

O. S. Maple, formerly purchasing assistant of the United States Shipping Board, Emergency Fleet Corporation at Washington, D. C., has recently been appointed assistant purchasing officer of that corporation.

W. Nelson Smith, who was for some years electric traction engineer with Westinghouse Church Kerr & Co., and more recently efficiency engineer of the American Agricultural Chemical Co., is at present with Sydney E. Junkins & Co., engineers and constructors, of Vancouver, B. C.

Charles Philip Coleman, who has been vice-president of the Worthington Pump and Machinery Corporation since May, 1916, and prior to that was receiver of the International Steam Pump Co. and associate companies, which have since been reorganized into the present corporation, has been elected president.

J. C. Rockwell has been promoted from manager of the light and power department to general manager of the Manila (P. I.) Electric Railroad and Light Co. He joined the operating organization of the J. G. White Management Corporation, New York City, in 1911, and was assigned to the Manila Electric Railroad and Light Co. as manager of the light and power department. He has been on a visit to the United States and is now returning to Manila.

Engineering Affairs

Plant Engineers' Club—The entertainment committee made a trip to Providence on Wednesday, Apr. 24, to visit the Narragansett Electric Light Co., and to inspect the new 50,000-kw. generator set and the new Leblanc condenser. In the evening, at the Boston City Club, they discussed the question of proper fire and police protection in large manufacturing plants.

The New York Chapter of the American Association of Engineers concluded its first year's activity with a dinner and speeches at the Grand Hotel on the evening of Apr. 20. The speakers were R. H. Vanderbrook, retiring chairman of the chapter; S. J. Stone, chairman-elect; I. L. Birner, secretary; William Serton, H. H. Bubor, W. J. Ash, C. H. Nordell, A. C. Davis and J. F. Jones.

The Combined Associations of Greater New York N. A. S. E., through the New York State Educational Committee announce a lecture by Mr. Forde, of the Westinghouse company, on the evening of May 4, on "Steam Turbines and Auxiliary Apparatus," at Ionic Hall, Terrace Garden, 155 E. 58th St., New York City. Through the courtesy of Charles S. Bavier a visit will be made to the power plant of the Metropolitan Insurance Co. Building, Madison Ave. and 23rd St., New York, on the evening of May 2.

Boston Engineers' Dinner—The ninth annual dinner of the Boston Society of Civil Engineers, American Society of Mechanical Engineers and the American Institute of Electrical Engineers will be held at the Boston City Club, Tuesday, Apr. 30, 6:15 p.m. James W. Rollins will be toastmaster. So far, two speakers have been engaged. W. H. Blood, Jr., of the American International Shipbuilding Corporation, will speak on "The Greatest Shipyard in the World"; Alfred D. Flynn, secretary of the Engineering Council, will speak on "The Engineering Council, Its Progress and Changes." Other speakers likely will follow. The presidents of the societies represented, also representatives of the Army and Navy, have been invited as guests.

Miscellaneous News

Thrift-Stamp Day Advanced to Monday, May 6—It has been decided to advance Thrift-Stamp Day in the United States from May 1 to May 6, in order to avoid conflicting with the wind-up of the Liberty Loan drive, which ends May 4. So remember your new slogan is "Sixth of May, Thrift-Stamp Day in the U. S. A." This gives you more time to put it over bigger and better than ever. Keep hustling.

Business Items

The Johns-Pratt Co., of Hartford, Conn., has appointed Lucas Blanco & Co., as its agents for Porto Rico, Virgin Islands, Dominican Republic and the Republic of Haiti.

Trade Catalogs

Centrifugal Pumps—The Wheeler Condenser and Engineering Co., Carteret, N. J. Bulletin 108-B. Pp. 8 x 10½ in. Shows the latest Wheeler turbine-driven geared centrifugal pumps, for either series or parallel operation; and special slow-speed engine-driven pumps.

NEW CONSTRUCTION

Proposed Work

Mass., Canton—The Springdale Finishing Co. will build a 1 story, 50x50 ft. engine house on Pine St., Springdale. A. H. Wright, 53 State St., Boston, Arch. Noted Apr. 16.

N. Y., Buffalo—The Donner Steel Co., 475 Abbott Rd., has had plans prepared for the erection of a 2 story, brick and steel boiler shop, locker, etc. Estimated cost, $20,614.

N. Y., Elmira—The Elmira Water, Light and Power Co. has been authorized by the Public Service Commission to build an electric transmission line from here to Montour Falls. F. H. Hill, Supt.

N. Y., Newark—The Board of Managers, State Custodial Asylum, plans to build additions and alterations to its heating plant; new equipment will be installed. Estimated cost, $35,000.

N. Y., Niagara Falls—The Board of Directors of the Niagara Falls Gas and Electric Co., 306 Niagara St., will soon receive bids for a gas plant to be erected on the Riverway. Gas making machinery including gas holders, etc., will be installed. Estimated cost, $500,000. W. L. Adams, 311 Falls St., Engr.

N. Y., Ogdensburg—The New Jersey Zinc Co. plans to rebuild its power house which was recently destroyed by fire. Loss about $300,000.

N. Y., Thiells—The Board of Managers, Letchworth Village, plans to build an additional central heating plant and install equipment. Estimated cost, $225,000.

N. Y., Utica—The Board of Managers, Utica State Hospital Comm., Albany, plans to install new boilers and make all necessary changes in the central heating plant at Utica State Hospital. Estimated cost, $130,000.

N. J., Cape May—The Vulcan Heat, Light and Power Co. plans to improve the equipment in its plant. H. H. Ross, Supt.

N. J., Newark—The Board of Freeholders, Essex Co., will receive bids until May 1 for alterations and additions to the heating, piping and mechanical equipment in the power house and throughout the various buildings of the Essex County Hospital, Overbrook. Runyon & Carey, 845 Broad St., Newark, Consult Engr. Noted June 28.

Penn., Bristol—The Town Council plans to change the motive power of the pumping station from steam to electricity.

Penn., Harwood Mines—The Philadelphia Electric Co., 10th and Chestnut Sts., Philadelphia, and the Electric Bond and Share Co., 71 Bway., New York City, plans to extend their electric power stations here and build 3 new ones.

Penn., Mauch Chunk—The Town Council has plans under consideration for improvements to its electric street lighting system.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., will soon award the contract for the installation of 3 electrically operated traveling cranes for its air craft factory. Estimated cost, $56,000.

Penn., Reading—The Reading Ry. plans to build a power house on Tulip and Somerset Sts. S. T. Wagner, Reading Terminal, Philadelphia, Ch. Engr.

Ala., Headland—City voted $10,000 bonds to improve its electric lighting and waterworks systems.

Ala., Mobile—The Moran Shipbuilding Co. plans to enlarge its electric lighting plant and shipyards.

Ky., Mount Olivet—The Mount Olivet Electric Light and Power Co. plans to install either a storage battery or a small engine and a 10 kw., 220 volt, d. c. generator. J. H. Kain, Owner.

Ohio, Massillon—Massillon Electric and Gas Co. plans to rebuild its electric lighting plant which was recently damaged by fire. Loss about $250,000. F. L. O'Connor, Supt.

Ill., Chicago—The Illinois Central plans to build a $60,000 power house at its Burnside plant, 95th and Cottage Grove Ave. A. S. Baldwin, 35 East 11th Place, Ch. Engr.

Ill., Springfield—The St. Johns Hospital plans to install wiring and a heating system. Estimated cost, $3000 and $10,000 respectively. Helme & Helme, Springfield, Arch.

Ill., Springfield—The Springfield Light, Heat and Power Co. has applied to the State Utility Commission for permission to issue $100,000 in bonds; the proceeds will be used to extend its mains and purchase boilers and mechancial equipment. J. E. Dalby, 1157 North 3rd St., Supt.

Wis., Butternut—The Butternut Electric Light and Power Co. plans to install an additional 3 wire generator. with 15 kw. capaciy. W. J. Schultz, Mgr.

Wis., Milwaukee—The C. Ansted Leather Co., 560 Commerce St., plans to install an additional 150 kw. steam generating unit and 16 electric motors of an aggregate of 165 hp. Estimated cost $10,000.

Minn., Tommald—City has plans under consideration for the installation of an electric lighting system.

Kan., Peru—City plans to install an electric lighting plant here.

Kan., Winchester—The Automatic Electric Light Co. of Kansas City plans to install an electric lighting and power plant near here.

S. D., Bradley—The Dakota Northern Power Co. plans to build a steam plant and install a 300 kw. reciprocating unit. E. H. Lewis, Secy.

N. D., Fargo—City plans to install an electric lighting plant at the water works station. J. J. Jordan, City Engr.

Mo., Kansas City—The Kenwanee Boiler Co., 1420 McGee St., is in the market for a hand power or electrically driven traveling crane on tracks, similar to locomotive type, with 20,000 lb. capacity.

Tex., Calvert—The Calvert Water, Ice and Electric Co. plans to extend its electric power transmission line from here to Bremond. A. E. Stoltz, Mgr.

Tex., Clyde—R. Cook plans to build an electric lighting and power plant here.

Tex., Dallas—Smith & Whitney, 1405 Southwestern Life Bldg., is in the market for a 300 kw., 250 volt. WX 2 or 3 wire direct current generating set, cross compound, non condensing, non releasing Corliss type engine; an engine type generator without engine but for direct connection to engine of above type would be considered.

Tex., Nixon—The Nixon Electric Light and Power Co., recently incorporated with $12,000 capital stock, plans to build an electric light and power plant. J. F. Wood, interested.

Ala., Birmingham—The Tennessee Coal, Iron and R.R. Co. plans to improve its power station at the Ensley blast furnaces. Equipment including a 7500 kw. turbo generator. J. H. Kain, Owner.

Va., Williamsburg—The Williamsburg Power Co. has increased its capital stock from $25,000 to $150,000; the proceeds will be used to build additions and make improvements to its plant.

Tex., Pleasanton—The City Council has taken over the plant of the Pleasant Ice and Electric Co. and plans to install additional equipment and machinery. F. H. Burmeister, Mgr.

Tex., Round Rock—S. E. Bergstron, Kerns, plans to build an electric lighting and power plant here.

Okla., Cyril—City plans to build an electric lighting plant.

N. M., Clovis—City voted $25,000 bonds for electrical improvements.

Wash., Chehalis—O. E. Anderson and associates plan to build a power plant here.

Wash., Mondovi—The Washington Water Power Co. plans to install electric lights here.

Wash., Snohomish—The Snohomish Dairy Products Co. plans to install an electric motor in several departments.

Que., Montreal—Lamontague, Ind., 338 Notre Dame St., W., plans to build a power house. Estimated cost, $10,000. E. Laurie & Co., 243 Bleury St., Engr.

Ont., Cobalt—The Mining Corporation of Canada, Ltd., plans to install electric driven pumps on scows and will purchase motors, pumps, pipe, etc.

Sask., Arcola—The Arcola Light and Power Co. plans to change its system from single phase 110 volts, to 3 phase 2300 volts. G. F. Robert, Mgr.

Ont., Haileybury—The Dickson Creek Mining Co. plans to install electrically driven drills at its property on Dickson Creek.

CONTRACTS AWARDED

N. H., Goffstown—The Manchester Traction, Light and Power Co. is building a new power house and a dam in the Greggs Falls district here. E. Farrell, Engr.

Mass., Boston—The Bureau of Yards & Docks, Navy Dept., Wash., has awarded the contract for the erection of a new power plant at the Navy Yard, here. Estimated cost, $35,000.

N. J., Trenton—The Crescent Insulated Wire and Cable Co., Olden and Taylor Sts., has awarded the contract for a 3 story, 83 x 103 ft. factory, to the Barclay White Co., 1713 Sansom St. Estimated cost, $100,000. The company will install an entire steam heating system, electric elevator and electric lighting system.

Penn., Philadelphia—The G. W. Smith Co., 49th and Botanic Ave., has awarded the contract for the erection of an addition to its boiler house, to J. N. Gill and Co., Otis Bldg. Estimated cost, $35,000.

Penn., Philadelphia—The L. Walther Manufacturing Co., Torresdale Ave. and N St., has awarded the contract for the erection of an addition to its boiler plant, to G. H. Thirsk, 1919 West Berks St. Estimated cost, $21,000.

Ky., Nortonville—The Norton Coal Mining Co. has awarded the contract for the erection of an addition to its central power plant, to the Ruby Lumber Co., Madisonville.

Neb., Lincoln—The State Board of Control has awarded the contract for a power house to be erected at the penitentiary, to R. C. Stake. Estimated cost, $13,380.

Okla., Park Hill—C. Sells, Commissioner of Indian Affairs, Wash., D. C., has awarded the contract for the installation of a steam heating plant in the Cherokee Training School, to the Bradley Heating Co., St. Louis, Mo.

Ore., Helix—The Helix Mill Co. has awarded the contract for wiring for the installation of electric light power plant in the mill, to J. Vaughn, 206 East Cort St., Pendleton.

Calif., Fresno—The San Joaquin Light and Power Co. is building a new substation east of the Standard reservoir farm. New equipment including four 1000 kva. transformers, switches, etc., will be installed. A. G. Wishon, Gen. Mgr.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Apr. 25, 1918	Individual Apr. 25, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	1.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—3.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Apr. 25, 1918	Individual Apr. 25, 1918
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Apr. 25, 1918	One Yr. Ago	Apr. 25, 1918	One Year Ago
Pea	$3.45	$2.80	$4.35	$3.70
Barley	2.15	1.50	2.40	1.75
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties April 25, 1918	Mt. Olive & Staunton April 25, 1918	Standard April 25, 1918
6-in. lump	$2.65-3.00	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed	2.15-2.30	2.15-2.30	2.15-2.30

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cababa.	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, MAY 7, 1918 No. 19

What Real Effort Can Do

A POORLY-DRESSED young man stood outside a massive brick building listening to the dull humming sound that emerged from the inside, and watched for the approach of a big blue touring car that he knew would soon pause to let out a big, keen-eyed individual, the general superintendent of one of the largest central stations in the Middle West. The young man, whom we will call Mr. Lane, approached the superintendent and asked for a "job." "Got a trade?" asked the superintendent. "No, sir," replied Lane, "but I'd like a chance. I am interested in electricity." Lane's sincerity of manner appealed to the superintendent and he was told to come inside.

Once inside, Lane was stunned at the magnitude of the place. Powerful electric generators were driven by massive steam engines and turbines; an overhead electric crane was lifting a huge casting off the floor to be put in its place in the assembling of a new unit; engineers and oilers were moving about, and up and down the machinery on the galleries, which were connected by narrow gangways with brass guard rails. There were whistles and bells, and colored lights and what not, and Lane's fondest hope was to help handle these monsters whose constant motion fascinated him.

"Well, young man," said the superintendent, "what do you want to do?" Lane replied: "I am not particular about what I do; what I want is an opportunity to learn and get ahead." "Any education?" asked the superintendent. "I only completed the eighth grade in public school," replied Lane; "I have been working on a farm for my brother." "Humph!" exploded the superintendent; "not very much experience behind you, young man, but I'll put you to work." So Lane was put on the payroll at one dollar per day and was told to report for work the next day.

Lane eagerly waited for his first day among those big, noisy machines. When he appeared at the office, he was immediately put to work—washing windows. Dirty, greasy, grimy windows they were, too, but he did a thorough job; he cleaned every window in that station, wiped the glazed brickwork and cleaned up some of the out-of-the-way corners around the station. He also found time to clean the office furniture and the glasswork about the superintendent's office every day. He kept his eyes and ears open and used his work as a stepping stone to something better. He was soon put in the repair gang, where he handled big sledgehammers and wrenches ten hours a day. He kept plugging along, developing his acquaintance with the operating crews. He got to know Jansen, chief operator on the switchboard, pretty well. Jansen had worked his way up, and he admired Lane and his bulldog tenacity. As time went on Lane got pretty well acquainted with the power-house gang. He worked in the "gang" on repairs for over two years, and became a first-class handy man; he got to know every pipe line in the place, and he knew just how to go about it to start overhauling the machines. By this time he decided to drop the mechanical end of the gang and specialize on electricity, so he asked for a chance on the switchboard. He was enrolled as one of the switchboard crew and put to work cleaning generators, wiping switchboards and oil switches. One day each week he was helper to the regular switchboard operator—here is where he began to develop. When one of the substation operators quit, Lane got his place. After a year in the substation he was put back in the power house as regular board operator. He now started to do things; he recommended little improvements that began to show the superintendent his capacity. After a couple of years on the board as operator he was a well-trained employee.

About this time Jansen, the chief operator, resigned to accept a better position elsewhere. He recommended Lane for his place, and Lane got to be chief operator. Here is where his troubles began, and he was called on to use extraordinary judgment in the discharge of his duties. Some of the other operators had longed to get Jansen's berth, and it did not increase Lane's prestige with his men when they saw him go around them in promotion. There was a reason for his promotion, but they couldn't or didn't see it. He studied hard, worked hard and did not know the latest cabaret singer or how many ingredients there were in a good cocktail; but he did know the value of work. He put every ounce of energy that he possessed into his work, and his love of impartiality and equal justice soon won over his subordinates. He knew the value of concentrated effort and self-reliance. He was chief operator for three years, then became load dispatcher. Here he again showed his master mind by countless new methods of load manipulation, especially during peak loads. From this he went into electric repairs, then to electric construction. He became foreman of electric construction with 100 men under him. He had personal charge of the construction of two new stations, in the electrical end, and since then has been promoted to electrical superintendent of one of the largest electrical syndicates in America. He has a thoroughly organized department of 250 men under him, a corps of assistants who have been trained just as he was, from the bottom round of the ladder. Discipline is one of his mottoes, and his department shows it.

Fearless, loyal and true as steel, severely strict, yet patient when essential—Lane has rounded into a grand old man. Loved by one and all who come in contact with him, a born leader among men, he owes his success to his keen realization of the value of hard and conscientious labor. Not a college man, but a natural-born thinker, abnormally developed through his keen insight and experience as he traveled through the college of life. He is today an acknowledged authority in his profession, has patent rights on some complicated electrical devices and is filling one of the really large electrical positions of today. He never sat down and wished for success—he got busy, and commandeered it.

Central-Station Heating in Detroit

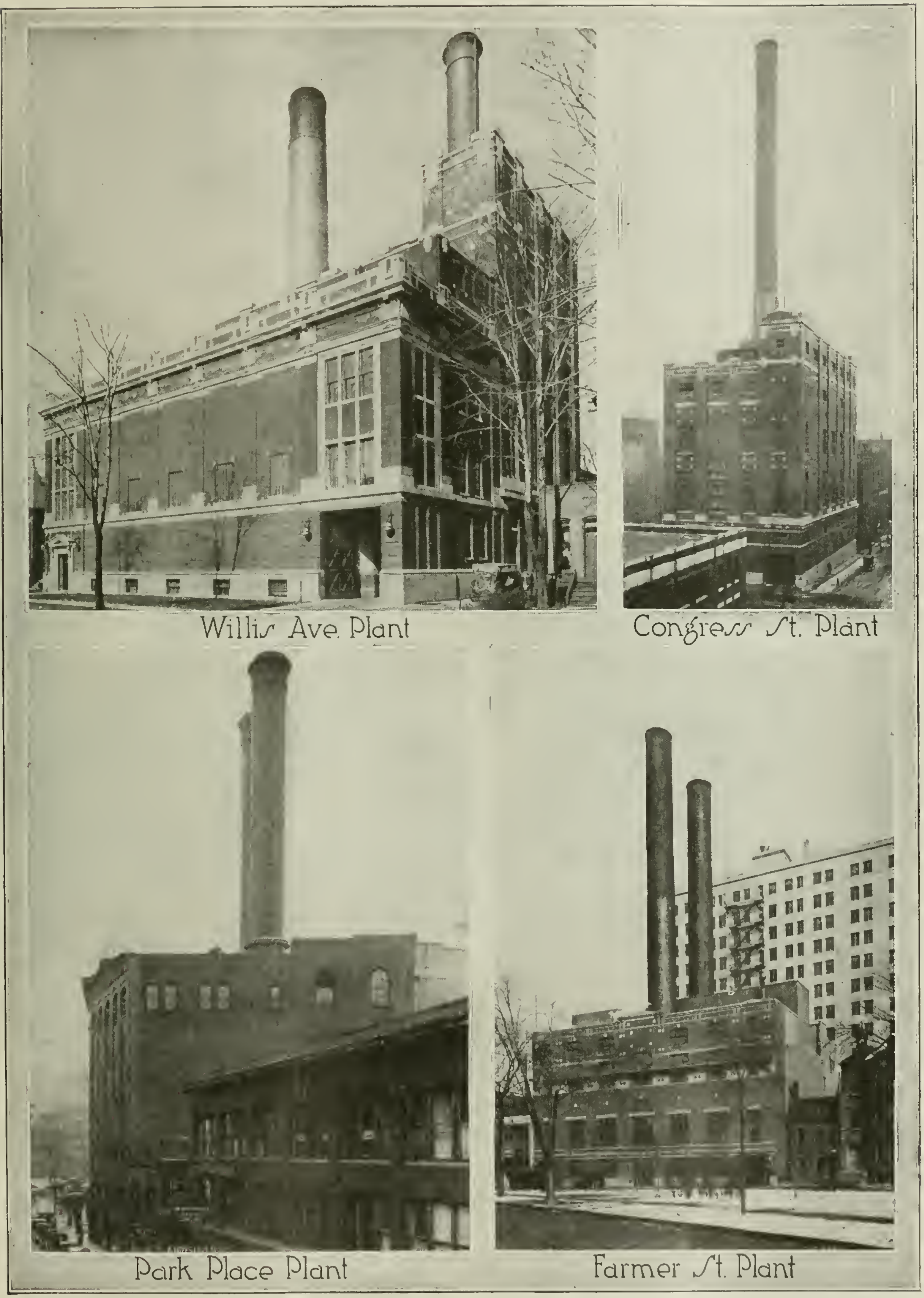
By J. H. WALKER
Superintendent of Central Heating, Detroit Edison Company

Features of the live-steam heating plants and system of the Detroit Edison Co. Reasons why live steam replaced exhaust steam for district heating.

CENTRAL heating as a public utility was originally conceived upon the idea of utilizing exhaust steam from electric generating units. The majority of the systems in operation today, excepting the numerous hot-water installations, use exhaust steam as the distributing medium and by combining the heating and electrical systems secure high thermal efficiency. In some instances, however, it has proved more desirable from a broader economic standpoint to distribute for heating live steam at a relatively high pressure instead of exhaust steam and to operate independently condensing generating plants. Such was the case in Detroit, and it is the purpose of this article to describe some of the features of the live-steam heating plants and systems of the Detroit Edison Co. and to discuss the reasons that led to the abandonment of exhaust-steam heating in favor of the live-steam method. The present heating system in Detroit is a combination of the systems of the Central Heating Co. and the Murphy Power Co., which were taken over by the Edison company in 1910 and 1914, respectively. The district served is about two miles long and one-half mile wide and includes the central business district and what was formerly an exclusive residential district, although now gradually changing to an apartment-house and business section. The total length of mains is about 22 miles, and approximately 1700 customers are served, the buildings heated being shown in Fig. 1. The amount of radiation connected aggregates about 2,600,000 sq.ft. There are four boiler plants having in all 17,470 rated boiler horsepower. In the year 1917 a total of 1,769,000,000 lb. of steam was sold. The steam is used principally for heating buildings, but a considerable amount is used for cooking and water-heating purposes. Only a small quantity is sold for power uses, and this service is being gradually discontinued.

FIG. 1. CENTRAL HEATING SYSTEM, DETROIT EDISON CO.

The pressure carried on one section of the distribution mains constituting about one-third of the total system is approximately 30 lb., while the pressure on the remaining sections, which were originally operated as exhaust-steam systems, is now from 6 to 12 lb. and is necessarily increased from year to year as the load increases. It is expected that eventually the entire system will be operated at a pressure of 30 lb. or higher. The pressure is limited at present by the low allowable pressure of the expansion fittings and in some cases by the lack of reducing valves in the consumers' buildings. All new construction is built for 125 lb. nominal working pressure. In the part of the system on which the pressure is nominally 30 lb., only 10 lb. is guaranteed at the consumer's service valve, this minimum pressure having been found to be entirely adequate for cooking purposes. Thus there is available, under extreme conditions, a pressure gradient throughout the system of 20 lb. This adds considerably to the flexibility of operation and to the capacity of the distribution mains. The boiler pressure carried in the plants is 130 lb., and the steam is delivered direct to the heating system through reducing valves. In comparing the relative advantages of exhaust-steam and live-steam operation, the obvious advantage of the former method is the ther-



Willis Ave. Plant

Congress St. Plant

Park Place Plant

Farmer St. Plant

FIG. 2. HEATING PLANTS OF THE DETROIT EDISON COMPANY

mal economy made possible by utilizing the heat in the exhaust steam instead of throwing it away, as is done to a great extent in a condensing plant. Or, looking at the matter from the opposite viewpoint, to carry the steam through electric generating units before delivering it to the heating system makes possible the generating of electrical energy at a low fuel cost. One great disadvantage in distributing exhaust steam, however, is the size of the distribution mains required. If turbines are installed, exhausting into the heating system at a relatively low pressure, the pressure differential throughout the system is, of necessity, very small, and this, together with the higher specific volume of the steam, requires the use of much larger pipes than is the case when steam at a higher pressure is used.

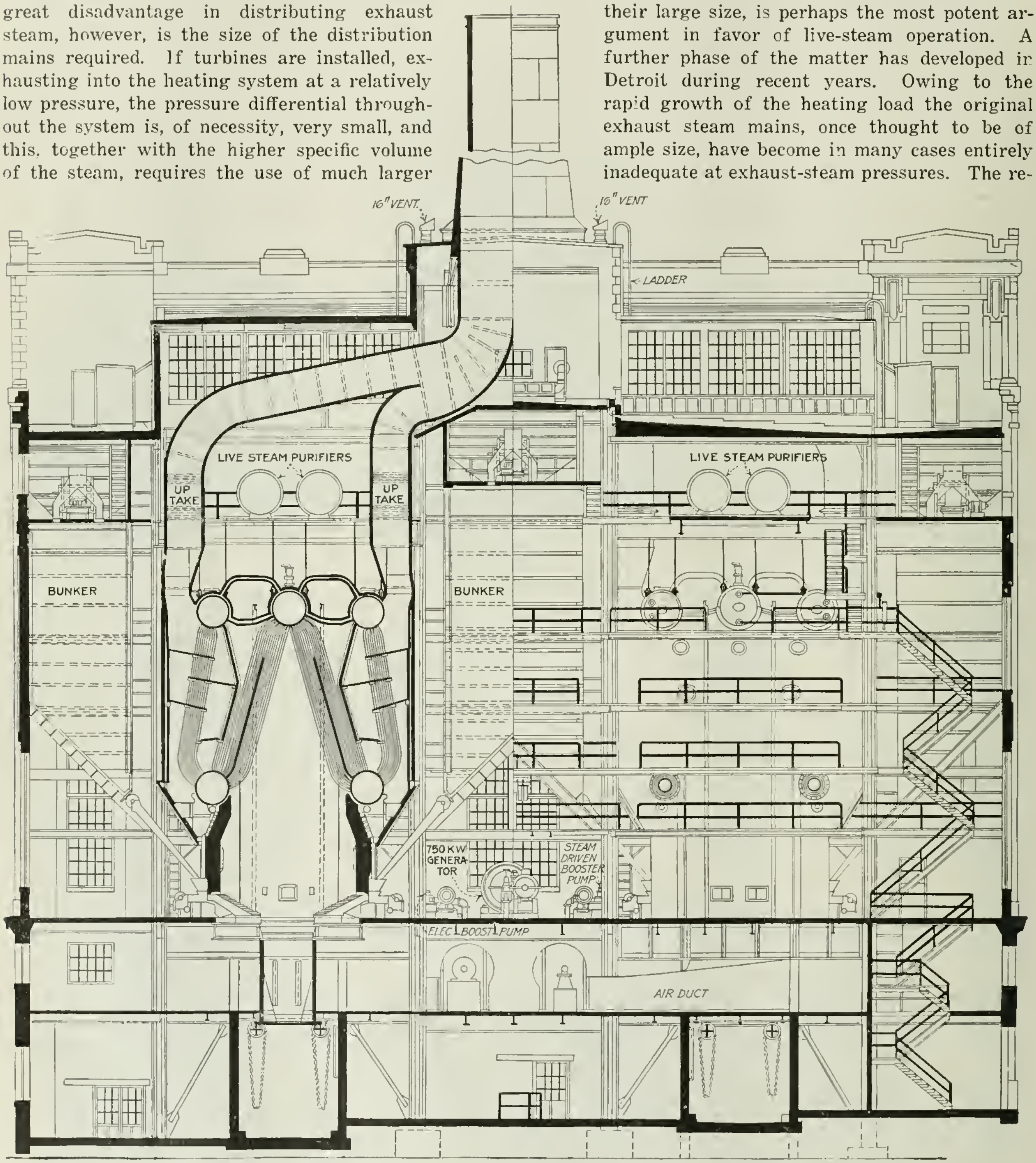


FIG. 3. SECTIONAL ELEVATION OF THE CONGRESS STREET HEATING PLANT

A good example of this condition exists in Detroit. The largest pipes in the portion of the system operated at 30 lb. pressure are 12 and 10 in., while the system formerly operated by the Murphy Power Co. and laid out as an exhaust-steam system, has several hundred feet of 20- and 16-in. pipe and the pipes throughout are considerably larger than in the live-steam system. The two systems cover nearly equal areas and serve about equal amounts of radiation.

The much greater investment in underground lines required in an exhaust-steam system, due to their large size, is perhaps the most potent argument in favor of live-steam operation. A further phase of the matter has developed in Detroit during recent years. Owing to the rapid growth of the heating load the original exhaust steam mains, once thought to be of ample size, have become in many cases entirely inadequate at exhaust-steam pressures. The recent change to live-steam operation with a higher pressure gradient has increased the capacity of the system. Had this not been done, it would have been necessary to replace the large trunk mains with still larger ones.

The installation of high-pressure feeders, as will be described later, has also been of inestimable value in the transmission of steam, and their use would be impossible with complete exhaust-steam operation.

Another equally important point against exhaust-steam operation concerns the investment in plant equipment. The amount of generating capacity that could be installed in the heating plants might aggregate, at the outside, 5000 kw. This capacity would not affect in the slightest degree the actual size of the company's main generating stations, in which the unit most recently added is of 45,000 kw. capacity. The investment represented by the units in the heating plants, together with the building space occupied, would therefore represent additional investment, the annual charges for which, because of the poor annual load factor of the units, would be relatively high per kilowatt-hour generated. Nor would the investment in transmission lines from the main generating stations be in any way reduced. These factors, together with the cost of the necessary attendance per kilowatt-hour—much greater than that in the main generating stations—would also tend to offset the saving due to the lower fuel cost of the current generated.

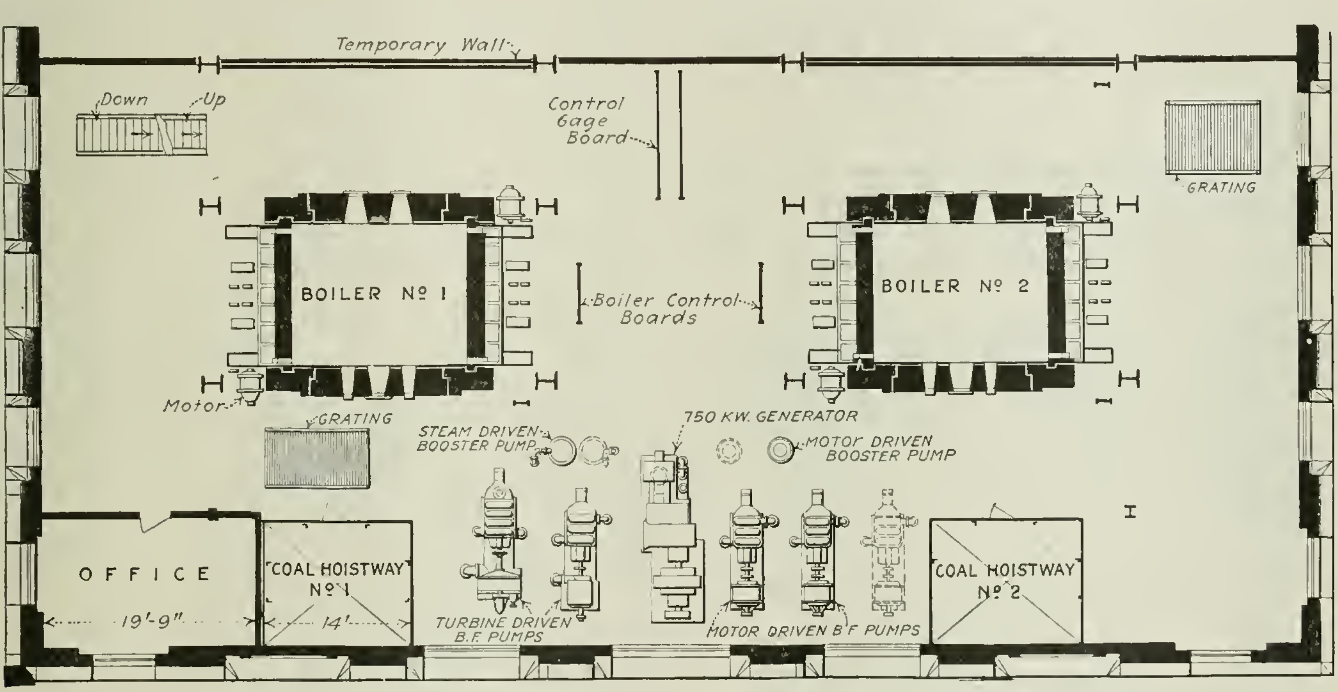


FIG. 4. PLAN OF PRESENT SECTION OF CONGRESS STREET STATION

The four heating plants are shown in Fig. 2. They are equipped, for the most part, with Stirling boilers and underfeed stokers. The newest is the Congress Street plant, the first boiler unit of which was put into service in December, 1917. This plant is designed to contain, eventually, 10,000 rated boiler horsepower, consisting of four 1300-hp. units and two of 2400 hp., capable of being operated at 200 per cent. of rating continuously. The present section contains the first two of the smaller boilers. They are Stirling boilers of the "W" type, quite similar in cross-section to the large Delray and Connors Creek boilers. They are fired from both sides with Taylor stokers.

In the design of the plant an effort was made to select and arrange the equipment so that the size of the operating crew would be reduced to a minimum. To this end the various auxiliary machines are located in so far as possible so as to be within easy reach of the operating engineer, and the operation of the plant is controlled almost entirely from the firing floor. Fig. 3 is a cross-section of the plant, and Fig. 4 is a plan view of the present section.

In any steam-power plant an appreciable economy can be gained if the power for driving the auxiliaries is obtained from a prime mover whose exhaust is utilized in heating the feed water. Ordinarily, this is accomplished by the use of steam-driven auxiliaries. The advantages of motor drive, however, as regards speed regulation, low maintenance cost and little attendance are well recognized. In the Congress Street plant the advantages of both kinds of drive will be secured by means of a house-service turbo-generator whose exhaust will be utilized in heating the feed water and which will supply current to the motor-driven auxiliaries. The size of the unit, 750 kw., is such that a good annual load factor will be secured, when the plant is completed, with all the exhaust used in heating the feed water. A considerable amount of current in excess of the requirements of the auxiliaries will be generated and will be fed to the Edison distribution system. The load on the generator will be adjusted as required, so as to furnish the proper amount of exhaust steam. By this means a large quantity of electrical energy will be generated at a low unit cost, without the disadvantages of an exhaust-steam distribution system. The size of the unit is not such that any additional attendance will be required, nor will it occupy any considerable building space.

The turbo-generator and the boiler-feed pumps are located on the firing floor. Both motor-driven and turbine-driven pumps are provided, the former being the ones ordinarily in use and the steam-driven pumps being reserved for emergency service. No injectors are provided.

Like the others, the Congress Street plant is dependent for its water supply upon the city mains. To insure against interruption of the supply in case of failure of the city water pressure, "booster" pumps are provided to augment, when necessary, the pressure in the mains, sufficiently to raise the water to the boiler-feed pumps. The booster pumps are in the subbasement and are driven through vertical shafts by vertical turbines and motors on the firing floor. As long as the city mains are full of water, even though the pressure be low, the plant will not be without water.

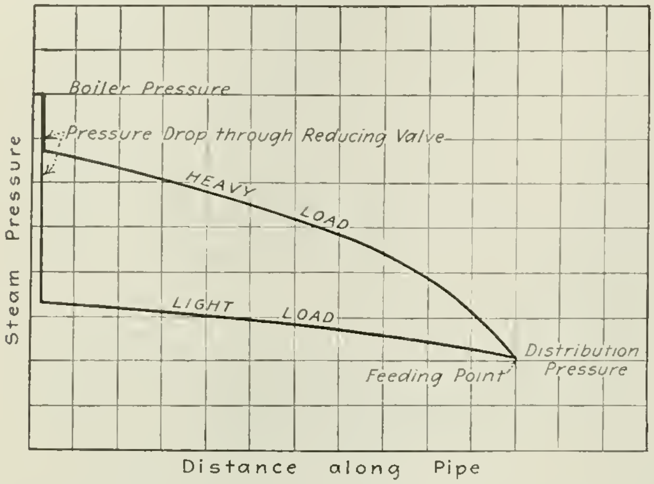


FIG. 5. PRESSURE DROP IN FEEDER

Storage tanks of a capacity sufficient to supply the plant for about one hour when operating at maximum capacity are provided as an additional safeguard.

As very little of the condensation is returned to the plant from consumers' buildings, purification of the large amount of raw water was considered advisable. The Detroit River water is not a bad boiler water, containing but seven grains of total solids per gallon.

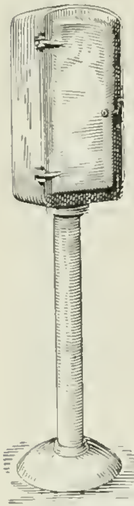


FIG 6

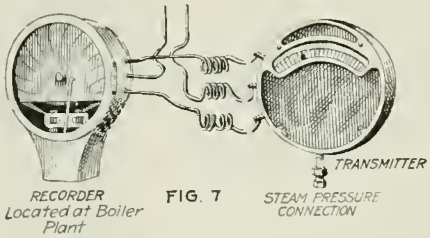


FIG. 7

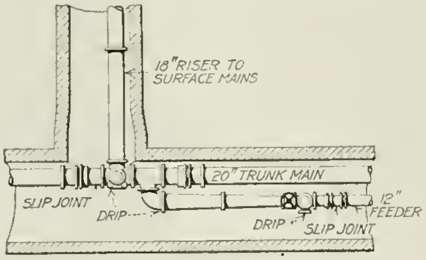


FIG. 8

FIG. 6. BOX FOR TRANSMITTER. FIG. 7. LONG-DISTANCE GAGE. FIG. 8. ENLARGEMENT OF FEEDER AT FEEDING POINT

Live-steam purifiers, two to each boiler, are employed to precipitate the scale-forming materials. Careful research in one of the older plants has demonstrated that there is a small amount of additional precipitation of calcium sulphate in the boiler itself due to the concentrating action that takes place. Though relatively small in amount, the scale deposited on the tubes has been sufficient, at high evaporation rates and under certain extreme conditions, to cause overheating and failure of the tubes. In all the plants sodium carbonate is now injected into the boiler-feed water in carefully graduated amounts just sufficient to insure the complete conversion of the scale-forming sulphate to the nonscale-forming carbonate which is removed in the blowoff.

Since the plants are situated, perforce, at some distance from the railroads, it is necessary to haul the coal to them by motor truck. The fuel is received at two coaling stations located on railroad sidings and is there crushed and raised to overhead bunkers, from which it is taken by the trucks. Each truck carries a bucket of six tons capacity and pulls a trailer similarly loaded.

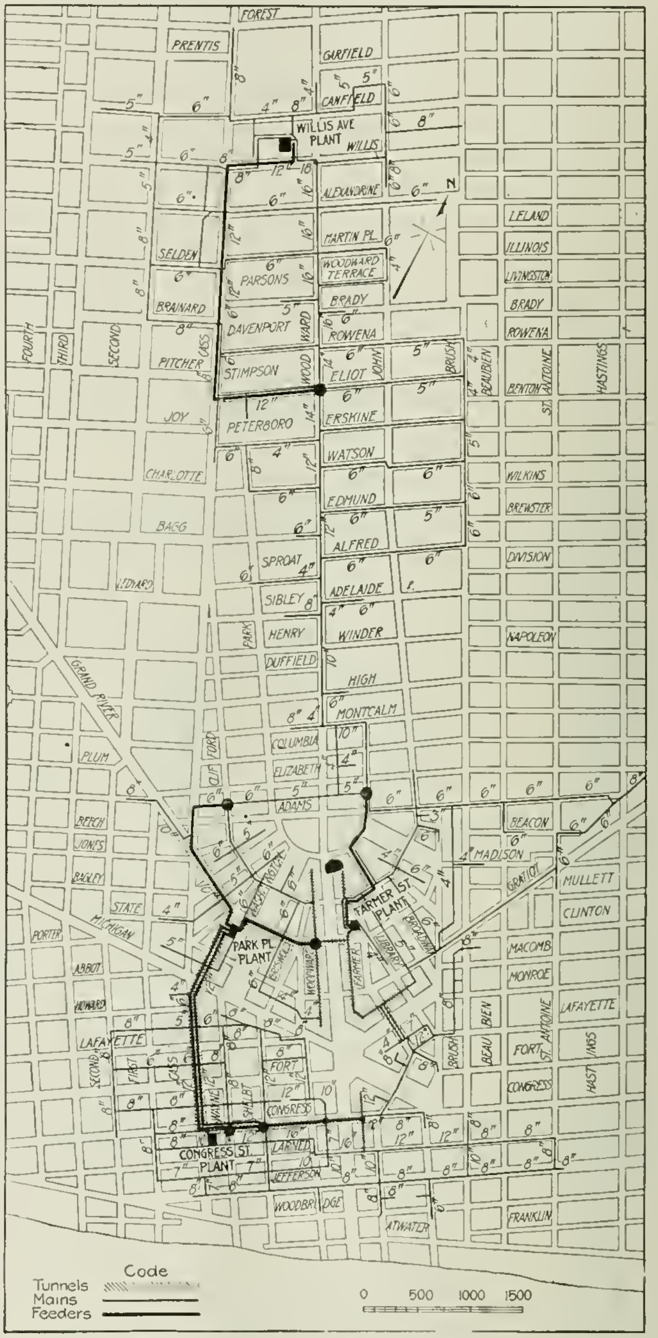


FIG. 9 STEAM DISTRIBUTION SYSTEM, SHOWING FEEDERS

At the Congress Street plant the buckets are hoisted by an overhead traveling crane and are emptied into hoppers from which belt conveyors distribute the coal to the overhead bunkers.

Elimination of all ash-conveying machinery is made possible at Congress Street, by the placing of the boilers at a sufficient height to permit the ash hoppers beneath them to be emptied directly into the trucks that haul the ashes away.

One rather unusual feature of the Detroit system is the method employed for distributing the steam. Although the first mains were installed but fifteen years ago and the majority of them much more recently, the rapid growth of the city and the connecting of large buildings at remote parts of the system have rendered the mains entirely inadequate. To meet this condition the original pipes are treated as distribution mains, from which the service connections are made, and feeders are installed to transmit the steam from the plants to certain points in the distribution network. No buildings whatever are served from these feeders, their function being simply to transmit steam to the various centers of load. The scheme may be compared to that used in electrical distribution in which feeders, radiating from the generating station, carry current with a large voltage drop to various points in the network of mains.

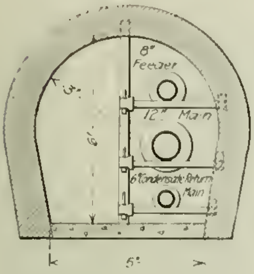


FIG. 10. SIX-FOOT TUNNEL

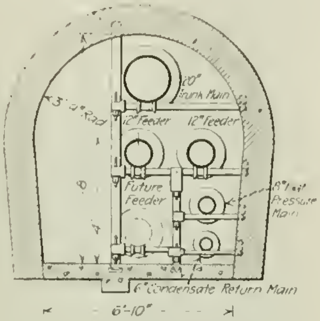


FIG 11. EIGHT-FOOT TUNNEL

In selecting the pipe sizes for such feeders, advantage is taken of the large differential between boiler pressure and distribution pressure to reduce the size of the pipes by allowing the pressure drop to take place largely along the pipe itself. In fact, under maximum conditions the entire pressure drop could be allowed to take place in the pipe instead of in the reducing valve. This greatly increases the capacity of the feeder and allows the use of relatively small pipes. The steam is delivered from the boiler header to each feeder through a reducing valve, and the pressure carried is adjusted so as to maintain the required distribution pressure at the remote end of the feeder. The pressure drop in such a feeder is illustrated graphically in Fig. 5. For a light load the pressure drop takes place largely in the reducing valve, while for a heavy load the greater portion of the total drop occurs in the pipe itself.

A record of the pressure existing at the feeding point is furnished to the engineer at the plant by means of an electrically operated long-distance recording gage, and the pressure on the feeder is adjusted as required so as to maintain the proper pressure at the feeding point. A gage of this type is shown in Fig. 7. The street box in which the transmitter is placed is shown in Fig. 6.

The velocity of the steam in feeders of this kind becomes extremely high under conditions of heavy load, reaching, in some actual cases, 75,000 ft. per min. Owing to the large quantities of steam flowing, the radiation loss per pound of steam is practically negligible and the expansion is nearly adiabatic, the steam reaching the feeding point in a superheated condition. It is possibly due to this fact that, in spite of the high velocities attained, there has been no noticeable erosion of the pipe.

To reconvert some of the velocity head of the steam into static head, the velocity of flow is reduced at the end of the feeder by a gradual enlargement of the pipe. A typical connection of this sort is shown in Fig. 8.

There are, in all, six of these high-velocity feeders in service, as shown in Fig. 9. Each is equipped with a long-distance gage and is operated in the manner described.

The heating system includes, in all, about 10,000 ft. of walking tunnels. Tunnels are almost a necessity where several pipes are to be installed, particularly in the congested districts where the blockading of streets for the construction or maintenance of the pipes would be a burden upon the public. The tunnels are all of brick with concrete floors and are built in the horseshoe shape, as in Fig. 10. They are from 30 to 40 ft. below the surface. The greater part of the tunnels is about 6 ft. high by 6 ft. wide, and they contain from one to three steam pipes and a return line. One section is 8 ft. high by 8 ft. wide and contains room for several pipes, as illustrated in Fig. 11. Under the rather favorable soil conditions existing in Detroit, waterproofing of the tunnels, except in a few locations, is unnecessary.

About two-thirds of the total length of surface mains is installed in wood casing and the remainder in a concrete conduit of the form shown in Fig. 12. The latter type of construction has proved very satisfactory and is being used on all new work. It is made of common materials, is simple to install and is undoubtedly long-lived. Though not entirely waterproof, it is sufficiently so for ordinary conditions.

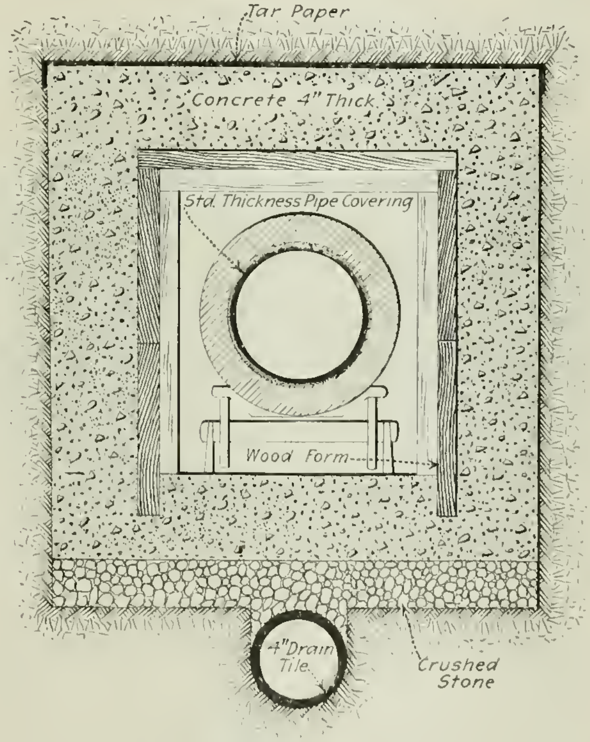


FIG. 12. CONCRETE CONDUIT FOR UNDERGROUND PIPES

A test was made in 1913-14 to determine the amount of condensation formed in the distribution mains. In a part of the system operated at that time at a pressure of about 5 lb., the condensation per hour per square foot of external pipe surface was 0.0511 lb. For a section operated at 25 lb. pressure, the corresponding figure was 0.0593 lb. Both sections were laid partly in wood casing and partly in the concrete construction.

Expansion is taken care of by slip joints in all recent construction. The older lines have joints of the copper-diaphragm type.

Consumers' installations are of no standard design, any well-constructed system being acceptable to the company, subject to certain regulations. New installations are provided with reducing valves. Consumers are urged to install economizing coils to utilize the latent heat in the condensation. These are constructed in the form of an indirect radiator or as a preheater for the domestic water. The steam is sold entirely on a condensation-meter basis.

Luitwieler Single-Plunger Double Acting Pump

Almost any engineer would be skeptical if he were told that a single-cylinder double-acting pump could be designed to operate as high as 100 r.p.m. and deliver a steady stream of water. He knows that a simplex pump delivers its water in a pulsating stream, the water coming from the discharge at its lowest velocity and volume when the piston is reversing its stroke, and he also knows that when a pump is run at a high speed it will pound.

Readers of *Power* will remember that nearly five years ago a description of a Luitwieler double-acting triplex pump was published (p. 53, July 8, 1913). A similar pump is illustrated in Fig. 1. It differs in that it has a single cylinder and plunger. The mechanism, however, is the same; that is, the plunger derives its motion through a cam that is secured to the driven shaft. Rollers carried by the crossheads work against this cam from opposite sides, and the cam is so shaped as to cause the plunger to produce an even flow of water at the discharge throughout the cycle. This pump is manufactured by The Luitwieler Pumping System Company of New York, Rochester, N. Y.

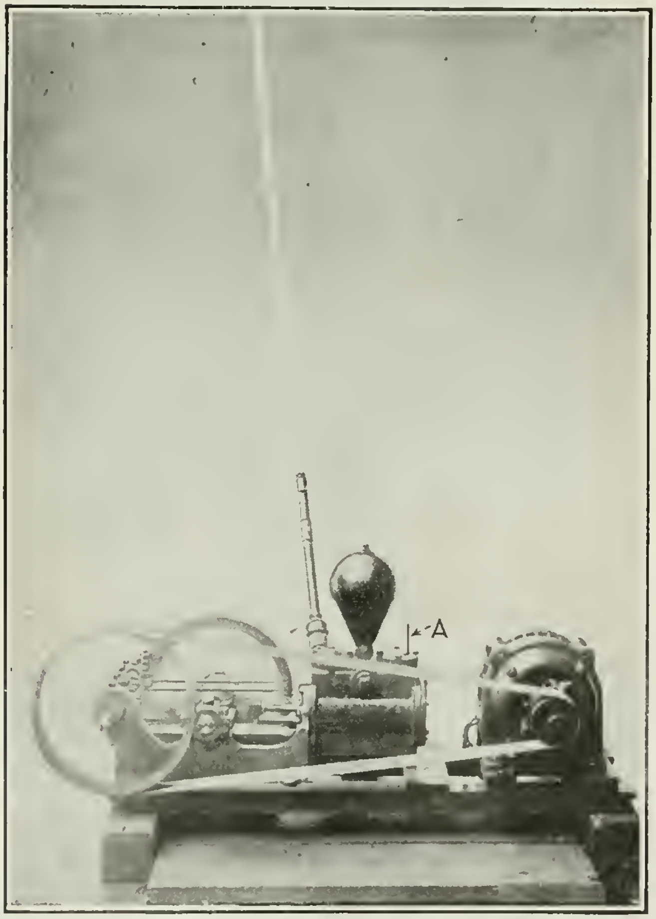


FIG. 1. SINGLE-PLUNGER DOUBLE-ACTING PUMP

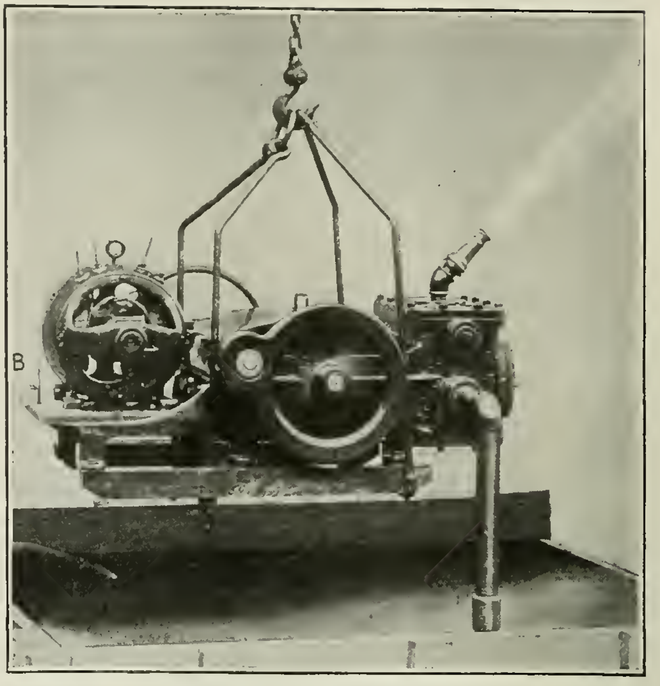


FIG. 2. TRIPLE-PLUNGER PUMP OPERATING ON SUSPENDED PLATFORM

An idea of the steadiness of the discharge stream can be obtained from Fig. 1, where a cam-driven, single-cylinder, double-acting pump is shown in operation. The bore is 5 in., the stroke 5 in. and the revolutions 48 per minute; discharge pressure, 70 lb. The pump and motor are mounted on skids which rest on 6-in. blocking spaced 5 ft. apart. A 4-in. wire nail is shown standing on end at the top plate at *A*, thus indicating the absence of vibration. This pump has been operated at a speed of 100 r.p.m. Water is taken from the reservoir below the pump.

One can hardly conceive of a reciprocating pump being operated without being bolted to a solidly constructed foundation, because of the jar, and yet this has been done with the Luitwieler design, as is shown in Fig. 2, where the pump is suspended from a chain above a tank of water. This pump, which is of the triple-plunger design with 3 x 3-in. cylinders, is shown delivering 82 gal. of water per minute with a pressure that throws a stream 100 ft. through a 1⅛-in. nozzle. The motor speed is 1600 r.p.m., and the pump is running at 150 r.p.m. It will be noticed that there is no air chamber on the water end. The weight of the unit is 1020 lb. The absence of vibration is indicated by the 5-in. wire spike shown standing on end at *B*.

Before you spend money for yourself, think whether your country can afford to have you spend that money. Every dollar saved helps twice, first when you refrain from spending it for nonessentials, and again, when you lend it to the Nation.

The Electrical Study Course—Compound-Wound Generators

It is shown that, owing to the resistance of the armature windings, the voltage at the terminals of a shunt generator will decrease as the current increases, and this variation can be compensated for by the addition of a series winding on the polepieces, making a compound-wound machine.

IN FIG. 3 is a diagram of a shunt generator or motor. In this all that is indicated is the circuits; the armature is indicated as a segmental ring and the field winding as a spiral. However, it will be seen that the field circuit in Fig. 3 is in parallel with the armature, as in Fig. 1. In Fig. 4 the field winding is connected in series with the armature as in Fig. 2, making one circuit through the machine in either case. The diagrams, Figs. 3 and 4, provide a convenient means of representing the circuit through electrical machinery, and will be used many times in future lessons.

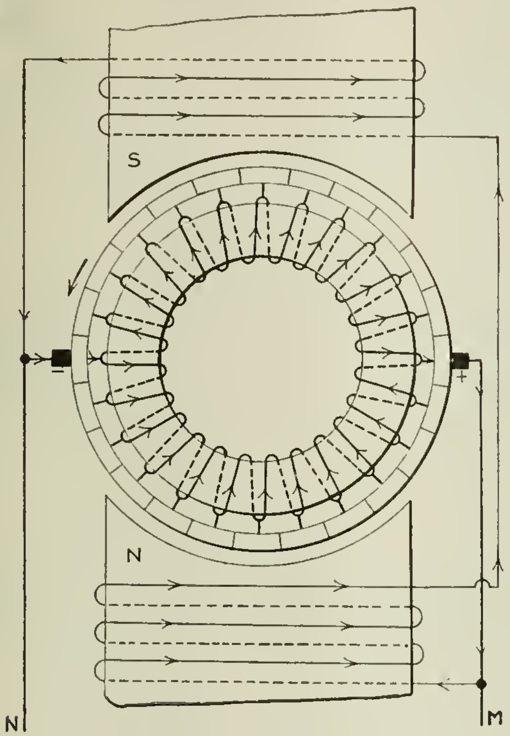


FIG. 1. SHUNT-CONNECTED GENERATOR

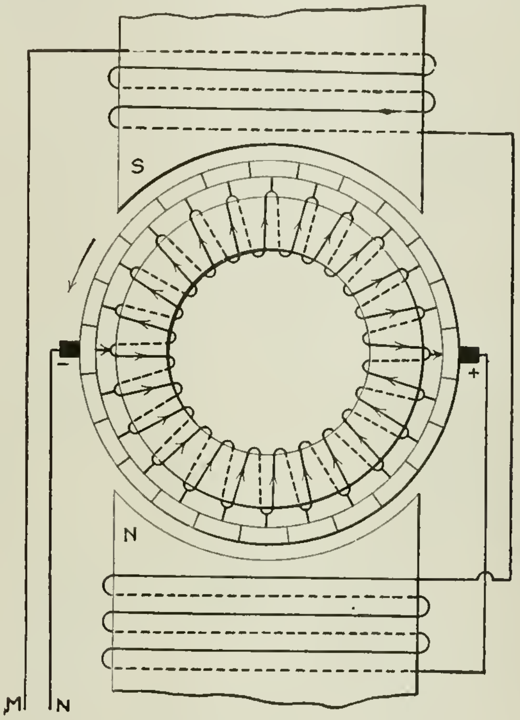


FIG. 2 SERIES-CONNECTED GENERATOR

In Fig. 5 the field coils are shown excited from a source separate from the armature, so that any variation in the voltage at the armature terminals will not affect the strength of the magnetic field. Assume that the armature has 0.23 ohm resistance and generates 115 volts on open circuit, as in Fig. 3 Now, if a resistance of $R' = 5$ ohms is connected across the terminals of the generator, as in Fig. 5, the total resistance of the circuit will be R equals that of the armature and external circuit in series, or $R = r + R' = 0.23 + 5 = 5.23$ ohms, and the current that will flow in the circuit is

$$I = \frac{E}{R} = \frac{115}{5.23} = 22 \text{ amperes.}$$

As has been explained in previous lessons, part of the voltage produced in the armature will be used up in the armature winding to cause the current to flow through this section of the circuit. This voltage e is equal to the resistance of the armature times the current; that is, $e = rI = 0.23 \times 22 = 5.06$ volts. From this we see that when 22 amperes is flowing in the circuit, there is 5.06 volts drop in the armature winding. Hence the available voltage at the armature terminals is $Ea = E - e = 115 - 5.06 = 109.94$ volts, as shown.

Consider what would be the effect of connecting a second resistance of 5 ohms across the generator terminals, as shown in Fig. 6. The joint resistance of r' and r'' is R' equals one-half that of r, or $R' = 5 \div 2 = 2.5$ ohms. Then the total resistance of the circuit is the joint resistance of the external circuit and that of the armature winding, from which $R = R' + r. = 2.5 \times 0.23 = 2.73$ ohms, and the current $I = \frac{E}{R} = \frac{115}{2.73} = 42$ amperes approximately. To cause the current to flow through the armature will require a voltage $e = rI = 0.23 \times 42 = 9.66$ volts. This will leave a voltage of $Ea = E - e = 115 - 9.66 = 105.34$ volts available at the armature terminals, as indicated.

From what we have seen in Figs 5 and 6, it is evident that as the load is increased on a shunt generator the voltage at the armature terminals decreases. The voltage generated by the armature would also, to a certain extent, decrease if the field coils are connected to the brushes, as shown in Fig. 3. For the reason that as the voltage decreases across the armature terminals the current will be decreased in the field coils, consequently the number of lines of force will be reduced. In Fig. 5 with a resistance of 5 ohms connected across the armature 22 amperes flowed through the circuit, while in

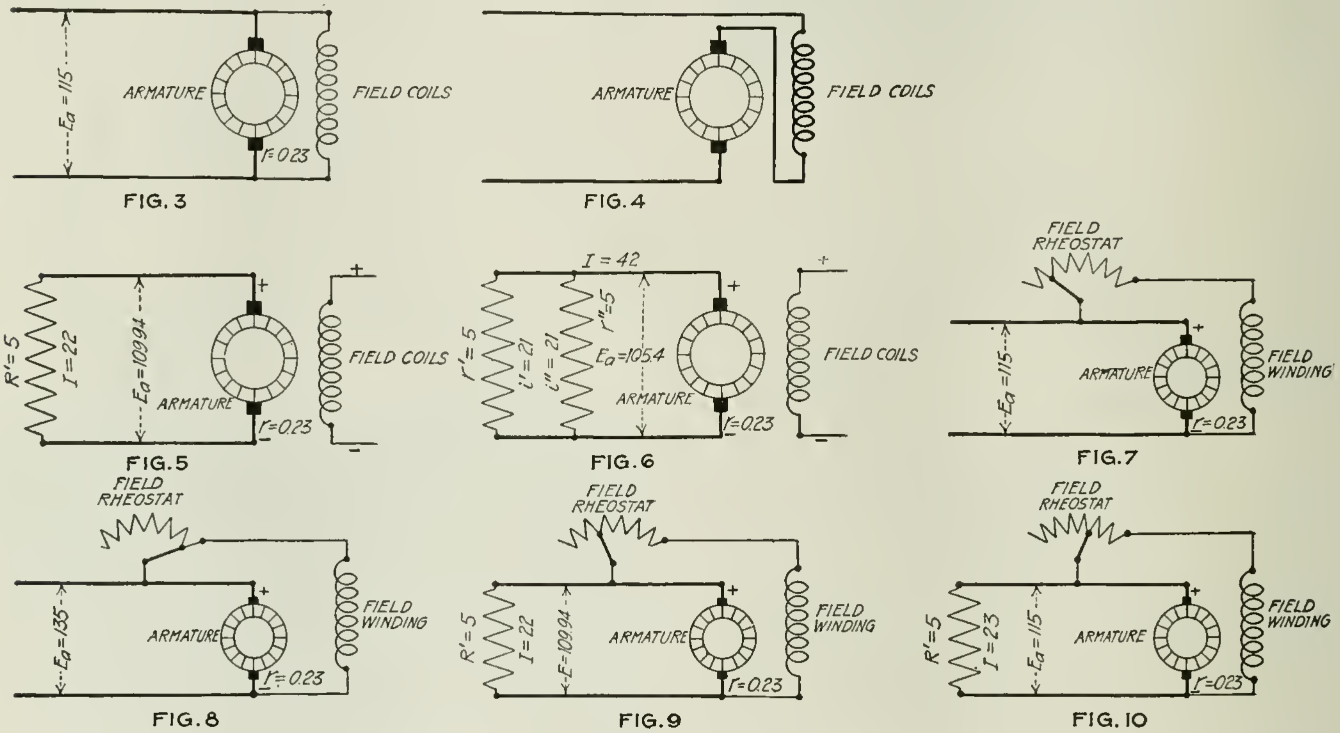
Fig. 6, where two resistances of the same value are connected in parallel, only 21 amperes is sent through each resistance, showing that as the load increases on a shunt generator, unless some means is taken to maintain the voltage constant, the current will decrease in each circuit as more load is connected to the generator.

One way of maintaining the voltage practically constant would be to design the generator for about 20 per cent. over voltage and connect a rheostat in series with the field winding, as in Fig. 7, to reduce the field current to a value where normal voltage would be generated at no load; then, as the voltage falls off because of an increase in load, sections of the rheostat can be cut out of circuit so that the field current will increase to a value that will cause the generator to produce sufficient pressure to maintain the voltage at the armature terminals constant.

For example, with the field rheostat cut out of circuit, as in Fig. 8, assume that the machine will generate 135 volts, and with part of the rheostat cut in series with the field windings, as shown in Fig. 7, the voltage decreases to 115. Then, neglecting the effect of the decrease in voltage at the armature terminals, due to increase of load, on the field winding and connecting a 5-ohm resistance across the armature terminals, as in Fig. 9, the current in the circuit will be approximately 22 amperes and the voltage will drop to 109.94, as in Fig. 5. Now to bring the voltage back to normal, some of the field rheostat can be cut out, as in Fig. 10. This will increase the current in the field coils and in turn increase the field strength, so that the armature conductors will be cutting a greater number of lines of force and producing a great voltage; as is shown in the figure, the voltage has been increased to normal, or 115.

With 115 volts available at the armature terminals, the current in the external circuit is $I = \frac{E}{R'} = \frac{115}{5} = 23$ amperes, instead of 22 as in Fig. 9, and the volts drop in the armature is $e = rI = 0.23 \times 23 = 5.29$ volts. Therefore, for the armature to maintain 115 volts at its terminals with a 23-ampere load, it will not only have to generate the 115 volts available at its terminals, but also 5.29 volts to cause the current to flow through the resistance of the windings, or a total of $E = Ea + e = 115 + 5.29 = 120.29$ volts.

After the voltage had been adjusted to 115 at the armature terminals with a load of 23 amperes, if the load was taken off and the field rheostat not changed, the voltage would increase to 120.29 volts, or the total of that generated in the armature. Although, in Fig. 10, only 115 volts is available at the armature terminals, nevertheless, the machine is generating 120.29 volts; 5.29 volts is used up in the armature winding. As soon as the load is taken off, there is no current flowing through the winding to use up the 5.29 volts and it becomes available at the brushes. To bring the volts back to normal again it will be necessary to cut the resistance back into the field circuit, as in Fig. 9.



FIGS. 3 TO 10. DIAGRAMS OF SHUNT-CONNECTED AND SERIES-CONNECTED DIRECT-CURRENT MACHINES.

From what we have seen it is evident that if the load on a shunt generator is varying, the voltage will fluctuate according to the load. Of course, these fluctuations, if they do not occur too rapidly, can be taken care of by the operator adjusting the field rheostat. However, a better way of doing this, if possible, would be to incorporate some automatic means in the construction of the machine to maintain the voltage constant.

In the last lesson we found out that if the load is increased on a series-connected generator the voltage will increase, and decrease as the load decreases. Taking advantage of this fact provides a means of obtaining a close voltage regulation on direct-current generators. This is done by constructing what may be called a combination of a shunt and series machine, or, as it is known, a compound-wound generator. This connection is shown in Fig. 11. From this figure it will be seen that one field winding is connected in series with the armature, as in Fig. 2, and a second field winding connected across the armature, as in Fig. 1. The shunt-field winding provides the flux to generate about 110 to 115 per cent. normal voltage, the 10 or 15 per cent. excess volts being taken by the field rheostat. The series-field winding sets up the flux necessary to generate the additional voltage to compensate for the volts drop through the armature due to the load current and the resistance of the winding.

In Fig. 11, if the armature is revolved in the direction of the curved arrow, a voltage will be generated in the winding of a polarity as indicated and a current will flow through the shunt-field windings in the direction shown by the arrowheads. This voltage can be regulated to normal by adjusting the field rheostat, or as we will assume, to 115 volts. With no load on the machine no current is flowing through the series-field winding, although some machines are connected so that the shunt-field current flows through the series-field winding.

If a resistance is connected across terminals *M* and *N*, as in Fig. 12, of such value as will allow a current of, say, 25 amperes to flow, as indicated, this current passes through the series-field winding and will increase the number of lines of force entering and leaving the armature, consequently the voltage generated in the armature conductors will be increased. On the other hand, the current flowing through the armature will cause a certain voltage drop in the winding. Now if 5 volts is required to cause the current to flow through the armature winding, and the series-field amperes-turns cause the magnetic field to increase in value to where the armature will generate 120 volts, then the 5 additional volts will just compensate for the loss in the armature and the volts at the armature terminals will be maintained constant. If the current supplied to the load is increased to 50 amperes, then the current through the series-field winding will increase to 50 amperes, which in turn will increase the number of lines of force entering and leaving the armature and again cause the volts generated to build up and compensate for the drop in the armature, thus maintaining the e.m.f. constant at the brushes.

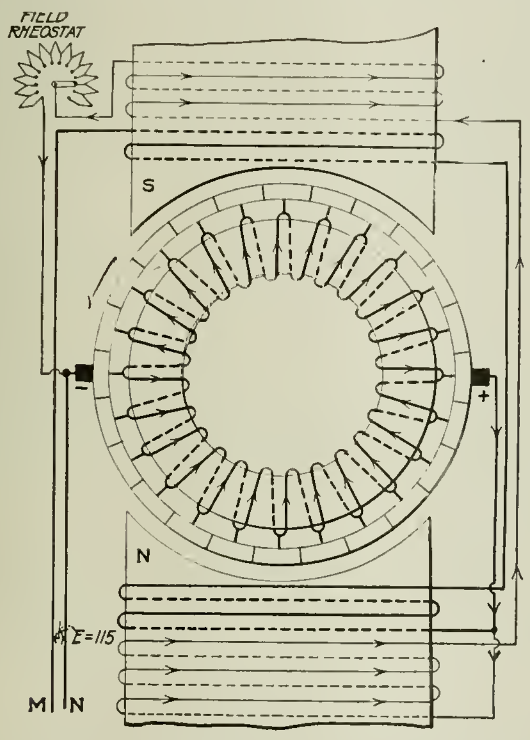


FIG. 11. COMPOUND-WOUND GENERATOR

The foregoing characteristic of the compound generator, which is nothing more nor less than a shunt generator, having in addition to the shunt winding, a series-field winding on its polepieces, to automatically maintain the voltage approximately constant at its terminals, has caused this type of machine, with certain modifications, to be adopted almost universally for generating direct current. Due to the iron in the polepieces becoming saturated, the lines of force do not increase in proportion to the ampere-turns on the field coils, thus making it impossible to design a compound generator that will maintain absolutely constant voltage from no load to full load. This subject will be discussed in the next lesson.

In problem 1 of the last lesson the copper cable was 1500 ft. long and made up of 37 wires 90 mils in diameter. The cross-section in circular mils of such a cable is equal to the cross-section of one strand times the number of strands. The cross-section of any round conductor in circular mils is equal diameter in mils squared, or in this case, $90 \times 90 = 8100$ cir. mils, and the cross-section of the cable is $8100 \times 37 = 299{,}700$, approximately 300,000 cir. mils. The conductor's resistance is

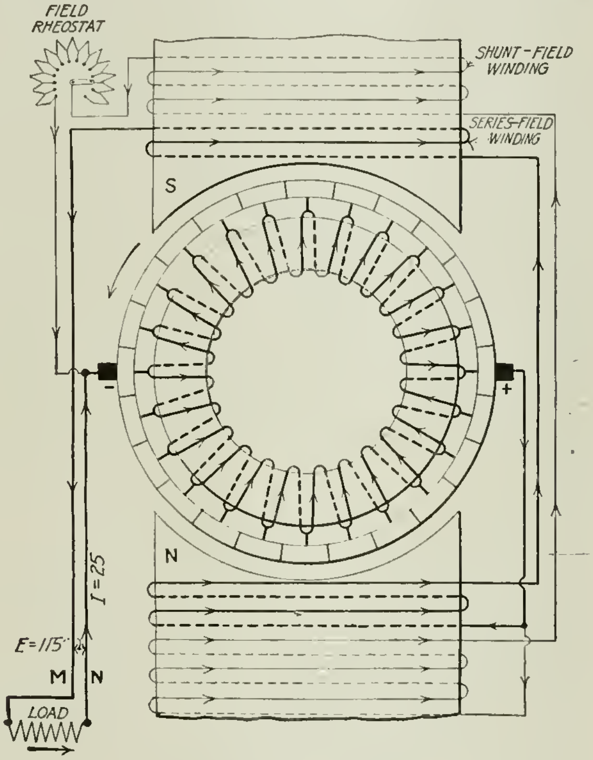


FIG. 12. COMPOUND GENERATOR CONNECTED TO LOAD

$$R = \frac{10.7}{cir.mils} = \frac{10.7 \times 1500}{300{,}000} = 0.0535\ ohm$$

In problem 2 the sizes of the conductors were required to transmit 350 kw. 75 ft. at 250 volts, with 0.5 per cent. drop. The current

$$I = \frac{kw. \times 1000}{E} = \frac{350 \times 1000}{250} = 1400\ amperes$$

Volts drop $E_d = E \times$ per cent. drop $\div 100 = 250 \times 0.5 \div 100 = 1.25$ volts. Then

$$Cir.mils = \frac{21.4DI}{E_d} = \frac{21.4 \times 75 \times 1400}{1.25} = 1{,}800{,}000$$

In transmitting 540 amperes over a circuit 425 ft. long, there is a drop of 16.4 volts in the line. How large is the conductor in cross-section? By how much would these conductors have to be increased in cross-section to transmit the same current with a drop of 10 volts?

Capitalization Value of Steam Leaks

BY R. VON FABRICE

Proper consideration of the capitalization values of thermal losses in power plants are too often neglected, although they are ever existent in the best of plants and represent staggering results. Leaky joints in steam lines are given consideration primarily because of the inherent dangers from explosions and destruction of life and equipment. The most numerous steam leaks are from stuffing-boxes, gaskets, leaky valves and free-blowing drips.

THE cost of generating steam represents the greater part of the ultimate cost of power production, and therefore its conservation is of prime importance in reducing the cost of the station output. Economical operation represents a value or bears a direct relation to capitalization, so that an outlay that results in the elimination of losses can be classified as an investment. Steam is the product of expenditures, and the cost is dependent upon the cost of fuel and water, the boiler efficiency and fixed charges made up of interest, taxes, insurance and depreciation. Therefore in a year a pound of steam saved per hour represents a considerable capitalization value to the station; or in other words, it would justify a certain expenditure in order to save the steam.

To ascertain the capitalization value of a pound of steam the cost of the steam must first be determined. Let

K = Cost of steam per 1000 lb. $= \frac{C}{E} + W$;

H = B.t.u. in one ton (2240 lb.) of coal $= 2240 \times h$;

h = B.t.u. in one pound of coal = 13,500 B.t.u.;

C = Cost of coal per ton (2240 lb.) = \$4;

L = Latent heat or B.t.u. required to evaporate one pound of water from and at 212 deg. F. = 970.4 B.t.u.;

F = Boiler efficiency = 70 per cent.;

e = Evaporation per pound of coal $= \frac{hF}{L}$;

$e = \frac{hF}{L} = \frac{13{,}500 \times 0.70}{970.4} = 9.74$ lb. of water evaporated per pound of coal;

E = Evaporation per ton of coal (2240 lb.) $= 2240 \times e = 2240 \times 9.74 = 21{,}818$ lb. of steam;

W = Cost of water (10c. per 1000 gal. = approximately 1.2c. per 1000 lb.);

$K = \frac{C}{E} + W = \frac{4}{21{,}818} + 1.2 = 19.53$c. per 1000 lb. of water from and at 212 deg. F.

Having determined the cost of the steam, in order to find the capitalization value the following conditions and assumptions must be kept in mind: (1) Assume a load factor of 100 per cent., that is, that the leak is a continuous drain on the station both day and night; (2) working year to be taken as 8640 hours or 360 days of 24 hours; (3) fixed charges, 17 per cent. of investment per year. The amount of steam lost by a leak is dependent upon the pressure of the steam and the size of the contracted orifice through which the steam escapes.

According to Napier's approximate formula for the outflow of steam through an orifice into the atmosphere

$$W = \frac{Pa}{70}$$

where

W = Weight of steam in pounds per second;
P = Absolute pressure of steam;
a = Contracted orifice (area in sq.in.);
70 = Constant.

Prof. C. H. Peabody conducted a series of tests to check the foregoing formula with pipes ¼ to 1¼ in. long, and the results were close to those obtainable with the Napierian approximate formula.

To illustrate the capitalization value of a steam leak, the following assumptions will be made: (1) Contracted area, or summation of leaks, 0.5 sq.in.; (2) boiler pressure, 250 lb. gage. Then $W = \frac{Pa}{70}$ (weight of steam per second) $= \frac{264.7 \times 0.5}{70} = 1.89$ lb., since

$P = 250 + 14.7 = 264.7$; $a = 0.5$ sq.in.; 70 = constant.

Then the loss of steam per hour is $1.89 \times 3600 = 6804$ lb. and for one year of 8640 hours is $8640 \times 6804 = 58{,}786{,}560$ lb.; and the cost per year at 19.53c. per 1000 lb. is $58{,}786.56 \times 19.53 = \$11{,}481$. The capitalization value of the steam lost can be determined as follows:

C = Capitalization value;
F = Fixed charges, assumed to = 17 per cent.;
K_2 = Total cost of steam lost.

Hence

$$C = \frac{K_2}{F} = \frac{11{,}481}{0.17} = \$67{,}535$$

The accompanying chart has been worked out, by means of which similar problems may be readily solved, and to illustrate its use the foregoing problem has been plotted on it. Beginning with the upper left-hand section, selecting the B.t.u. or heating value of the coal, say 13,500 B.t.u., follow vertically down to the diagonal line representing the over-all boiler efficiency (70 per cent.), thence horizontally to the right, crossing the vertical scale, showing the pounds of water evaporated per pound of coal, which in the problem given is 9.74 lb.; then continue to the upper right-hand section to the intersection of the curve giving the cost per ton (2240 lb.) of coal (\$4) and thence downward parallel with the vertical lines at the top of which is given the cost, in cents, of evaporating 1000 lb. of water from and at 212 deg. F. (in this case 18.33c.). Then continue downward, intersecting the diagonal line in the middle right-hand section, representing the cost of water (in this case 10c. per 1000 gal.), thence to the left to the vertical scale, where the cost of one pound of steam per hour per year (of 8640 hours) is given as \$1.69; then

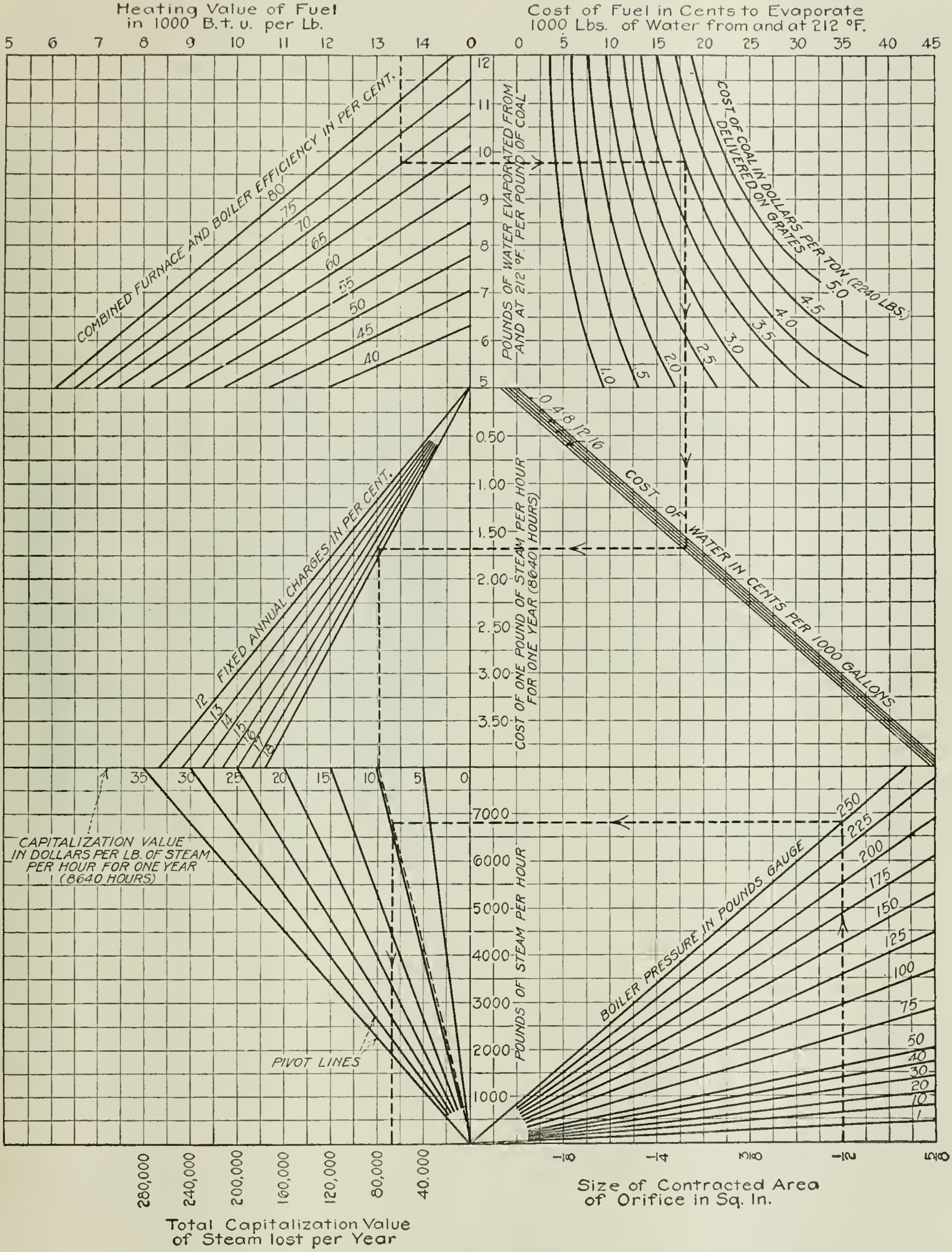


CHART SHOWS ANNUAL LOSS FROM STEAM LEAKS AND ITS CAPITALIZATION VALUE

continue to the left to the diagonal lines representing the fixed charges (taken at 17 per cent.), thence downward to the horizontal base line, giving the capitalization value per pound of steam per hour per year of 8640 hours (which is $9.94). From this point of intersection draw a diagonal line through the lower left-hand section of the chart to the point of intersection of the vertical scale, or center line. Then start on the base of the lower right-hand section of the chart at the point giving the contracted area of orifice (or the sum of all), which in this case is ½ sq.in., and follow upward to the intersection of the diagonal line, giving the steam pressure in pounds gage (in this case 250 lb.). From this intersection turn to the left, intersecting the vertical scale between the lower sections, giving the pounds of steam per hour (6804 lb. in this case), then continue across to the diagonal pivot line previously referred to (drawn from the capitalization value per pound of steam per hour for a year to the apex) and drop down to the horizontal base of the lower left-hand section, giving the total capitalization in thousands of dollars, which in the given case is $67,535.

The heat values for the foregoing problem have been reduced to feed water at 212 deg. and steam at 212 deg. F., or "cost of steam from and at 212 deg.," as is done in boiler-evaporation tests, because proper corrections must be made for the additional B.t.u. absorbed for the given conditions. The factor for reducing the weight of water actually converted into steam at any given pressure and feed-water temperature to the equivalent evaporation "from and at 212 deg. F." is called the "factor of evaporation," which is the ratio of the total heat necessary to produce one pound of steam "from and at 212 deg. F." to the heat used in heating the feed water from a lower temperature to steam at the temperature corresponding to the higher pressure, or is the difference between the total heat of evaporation under different conditions. Thus in the given case, for feed water at 160 deg. F. and steam at 250 lb. gage (264.7 lb. absolute) the factor of evaporation is found to be 1.1073, as per tables, or it can be determined by the following formula

$$F = \frac{H - h}{970.4}$$

when

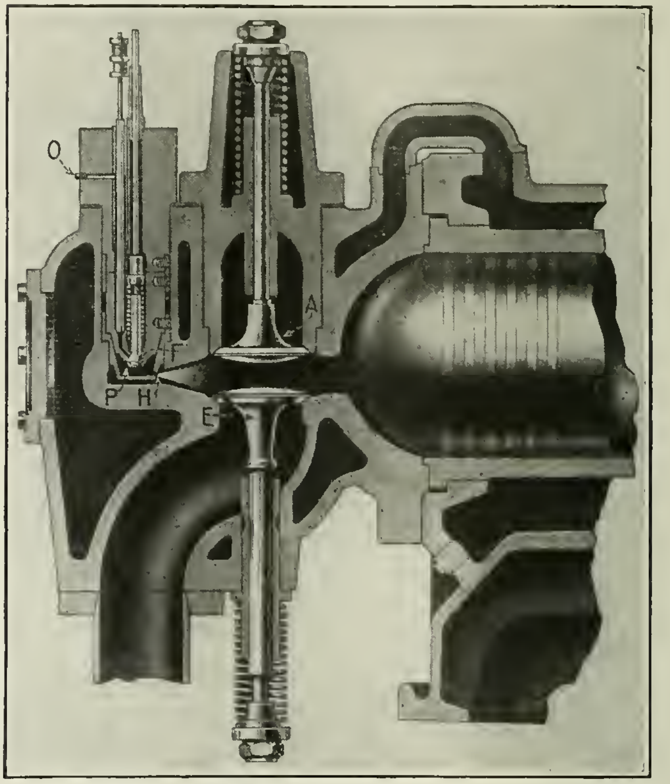
F = Factor of evaporation;
H = Total heat of steam above 32 deg. F. (from steam tables);
h = Sensible heat of feed water above 32 deg. F.;
970.4 = Latent heat of evaporation "from and at 212 deg. F."

Lyons Atlas Heavy-Oil Engine

A new type of heavy-oil engine has recently been placed on the market by the Lyons Atlas Co., Indianapolis, Ind. This engine, in contradistinction from many other types of heavy-oil engines, uses no air compressors or fuel pumps. The figure gives a cross-sectional view of the cylinder head, showing the position of the air, fuel and exhaust valves and the location of the piston at the end of the compression or the beginning of the power stroke.

On the first outward stroke the air valve A opens, and a charge of pure air is drawn into the cylinder during this stroke. Simultaneously with this operation, the fuel valve F opens and allows a small quantity of fuel oil to flow into the primary cup P, located in the combustion chamber attached to the cylinder head. The oil flows by gravity into the opening O, the amount being controlled by the governor according to the load and speed. On the return stroke all valves are closed and the charge of air in the cylinder is compressed into the combustion chamber to a pressure of about 450 lb. per. sq.in. This increases its temperature to about 900 deg. Fahrenheit.

When the piston has about completed its return stroke, the temperature of the air in the combustion chamber becomes high enough to vaporize the lighter hydrocarbons in the fuel, in the primary cup P, exactly the same way as in an oil-refinery still. This vapor is ignited by the high temperature and expands, creating a high pressure on the oil in the primary cup at almost the same instant that the piston reaches the end of the combustion stroke and is about to start on the power stroke. The pressure created in the primary cup, due to the burning of the lighter hydrocarbons, is sufficient to force the remaining liquid in the primary cup out through small holes H in the cup, causing the fuel to be broken up into fine spray as it enters the combustion chamber. Here the atomized fuel encounters the high temperatures due to compression, ignites and burns during the entire power stroke. The oxygen in the air admitted to the cylinder on the previous suction stroke is sufficient to result in very efficient combustion during the entire power stroke.



SECTION THROUGH ENGINE-CYLINDER HEAD

The combustion is gradual, no explosion taking place. Indicator diagrams show that the pressure in the combustion chamber rises very little above that due to compression of the air on the first return stroke. The force on the piston during the power stroke is similar to that on the piston of a steam engine.

During the second return stroke, or last stroke of the cycle, the exhaust valve E opens and the piston drives the burnt gases out to the atmosphere, thus completing the cycle when the piston reaches the end of the stroke. The amount of vapor burned in the primary cup is small, and its effect upon the pressure in the combustion chamber, as shown by an indicator diagram, is scarcely perceptible.

These engines are built in two sizes, 20 and 30 hp., and will burn crude and fuel oil, kerosene and intermediate distillates of such characteristics as to be thoroughly combustible and sufficiently liquid to flow freely at ordinary temperatures to the primary cup by gravity under a head of two feet. The fuel consumption, based upon a minimum net or effective heat content of 18,500 B.t.u. per lb., is guaranteed not to exceed 0.6 lb. at full load, 0.66 lb. at 75 per cent. full load and 0.78 lb. at 50 per cent. full load.

The engines are started by compressed air from a storage tank, on the oil they use for fuel, without any preheating or other preparation, and can start from a cold standstill and attain full speed in less than two minutes, regardless of climatic conditions.

A Breakdown Aboard Ship

By John Melville

The following account of a breakdown which happened to the engines of a steamer on which I was chief engineer may be of interest to *Power* readers in view of the active interest being taken in marine engineering at the present time.

We left Rotterdam (pre-war days) with a cargo of coal and proceeded down the river, everything running smoothly and well. Shortly after we had dropped the pilot and were heading at full speed for the Straits of Dover, a tremendous bumping caused me to rush to the engine room, where the second engineer already had the engines stopped. It had all happened so suddenly that there was no chance to locate the cause of the trouble, and nothing unusual showed to give us a clue. Being satisfied that something was wrong inside one of the cylinders, we proceeded to open them up. Their dimensions were: High-pressure, 25 in.; intermediate, 41 in.; low pressure 67 in.; stroke, 45 in. As far as the second engineer could judge, the noise came from the intermediate cylinder, but on opening it we found it in good condition. On opening up the high-pressure cylinder, however, we found a sorry mess; the piston was smashed into "a thousand and one" pieces, caused by one of the junk-ring bolts breaking at the end of the thread. There being insufficient clearance between the piston and cylinder cover, something had to go, and apparently the piston was the weakest part. Fortunately, after a few strokes the broken bolt got opposite one of the core plugs on top of the piston, and on the next stroke the core plug was forced in and the broken bolt jammed in the hole, thus preventing any further damage.

To operate the engines as a triple-expansion set was out of the question, so we made ready to run on two cylinders. The pieces of the broken piston were removed, but the piston rod with the crosshead and guide shoes was left in place, the piston rod thus serving to keep the gland steam-tight. With the piston valve and valve gear removed and the covers replaced, we were ready to proceed. The boiler pressure was reduced from 175 to 100 lb. No trouble was experienced in starting the engines, and we headed for Deal, where we could report the accident to headquarters. Orders were received there to proceed to Plymouth, where a new piston would be sent us.

The trip down the English Channel was uneventful though somewhat slow, but the engines gave no trouble, even though they were somewhat out of balance due to the cranks being at 120 deg. The coal consumption on the "pounds per indicated horsepower" basis was largely increased, but that was to be expected with a reduced initial pressure and the consequent reduction in the number of expansions by the loss of one cylinder. The limits of the valve gear prevented us cutting off early enough in the new high-pressure cylinder to give the previous ratio of expansion.

On arriving at Plymouth, the first job was to get the piston rod out to find out whether it had become bent in the smash. The limited means we had on board ship for testing proved that the rod was damaged, so it was sent ashore to a repair shop. When placed in the centers of a lathe, a double bend was found at the tapered part which fitted into the piston. The straightening of the rod, which was 6⅜ in. diameter, proved to be a difficult job, but by means of a charcoal fire, wooden blocks and mallets the blacksmith managed to get it nearly true and comparatively free from marks and scaling. When tested in the lathe again, only a slight cut was required to bring the tapered part true. This allowed the piston to go ⅛ in. farther on the rod, but there was sufficient clearance in the cylinder to allow for this.

Having got the new piston fitted to the rod, no time was lost in having it placed on board, where everything was ready to handle the job with dispatch. It was 2 p.m. when the piston and rod were on deck, but we were ready to sail by 10 p.m. On the voyage out and home again no defects developed, and so far as I know the same engines are doing duty still.

Some of the things we did, or rather the things we omitted to do, in connection with this job are open to criticism, such as neglecting to close up the steam ports in the high-pressure cylinder and not changing the cranks to 90 deg.; but the distance we had to travel to the nearest port was not great, and we were anxious to get under way again in the shortest possible time.

Another Coal and Liquid Fuel Mixture

A substitute for coal has been patented by the Industrial Fuel Corporation, of Long Island City, N. Y. The underlying scientific theory is, as outlined in the letters patent, the first claim being as follows:

> A fuel composition consisting of loose coal dust or screenings and a high boiling liquid fuel having low viscosity at ordinary temperatures, the amount of such liquid being merely such as will wet the faces of the coal particles without filling the voids therebetween to a substantial extent, and such liquid fuel being of sufficiently high boiling point to insure persistence of a substantial amount of liquid fuel in the mixture until such mixture is at or near the ignition point of the coal.

The composition is fired loose, the same as ordinary coal.

In other words, a liquid having the easy flowing qualities of water is mixed in the proportion of 1 to 20 with anthracite screenings. Because of the high boiling point of the liquid, it remains with the screenings, keeping the mass moist, up to the point at which the carbon in the coal ignites, and once the loose material actually begins to burn, the problem of stability in the fire is solved.

According to the New York *Sun*, this idea of burning low-grade fuel was anticipated by the New York Architectural Terra-Cotta Co., of Long Island City.

> Many months ago this company was unable to buy any soft coal in the New York market, but had no difficulty in securing culm. Prior to that time, an officer of the company had found that by mixing about 5 per cent. of a special liquid fuel with 95 per cent. of this coal dust a fuel might be obtained of such consistency that it would neither fall through the grate bars nor go up the chimney under forced draft.
>
> The experiment was tried out in practical use and proved to be a complete success. For many months this company has used no other fuel under its boilers and has obtained a maximum of efficiency with a saving of nearly 50 per cent. in expense.
>
> The new fuel was examined by Dr. C. E. Davis in the laboratories of the Columbia University Department of Chemical Engineering and upon calorimeter test showed a calorific value of 13,950 B.t.u. to the pound, or a heating value about equal to that of anthracite.
>
> The special liquid referred to is a byproduct obtained in the manufacture of carburetted water gas and has always been considered of minor importance. Millions of gallons are produced annually in the United States.

It would seem from the foregoing that this fuel is along the line of similar fuels in which a binder is mixed with fine coal before it is pressed into briquets. In this instance, however, the coal and binding mixture is fired in a loose state.

Oil Lantern Jammed on Piston Rod

By E. W. Miller

The machine was of 50-ton capacity, having two double-acting ammonia compressors with the steam cylinders between the two, the entire unit being vertical. A knock developed and gradually grew worse, sounding like that produced by striking a large piece of metal with a light hammer.

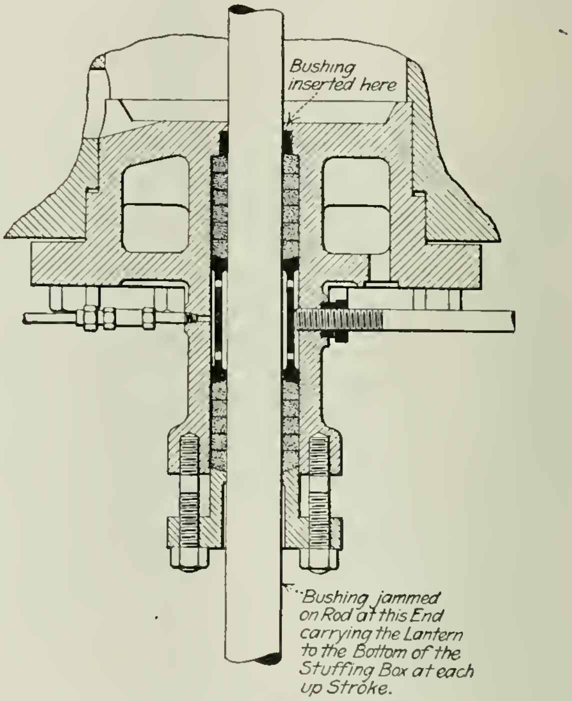
The engineer concluded that it was in one of the compressor valves. He had expected by the sound of the machine to find that one of the springs had broken or become too weak, but was surprised to find that the valve and spring were in good order. He oiled the valve liberally and took particular care in replacing it to make sure that there should be nothing to interfere with its operation.

When he started the machine, the knock was as bad as before. It seemed impossible to find the source—so much so that he thought at times that it was somewhere in the steam cylinder or its valve gear. Finally, he shut the machine down and went over every part of the compressor, removing the valves, testing the clearance and keying up on all the bearings and taking up all lost motion.

The knock was still there when he started the compressor again, and the machine was once more shut down and pumped out and the piston removed from both the one ammonia compressor and the engine. The engine piston was removed first and nothing wrong was found. When he came to remove the compressor piston, he found that it came out with difficulty, and to facilitate its removal it was decided to remove the packing.

When the packing had been removed up to the oil lantern, it was found that the lantern refused to budge. The piston was lowered in the cylinder, and at the same time one of the men maintained a steady pull on the lantern. It came down without any trouble. When the piston was lowered sufficiently to bring the lantern out of the stuffing-box, it was found that the lantern was jammed fast on the piston rod at this point. The lantern had been babbitted and turned to a snug fit on the rod, and at some time the rod had become hot enough to partly melt the babbitt. At the same time some shreds of packing had worked through some of the holes in the center of the lantern and squeezed into the molten babbitt, and when the babbitt set again, probably due to a sudden cooling of the machine from a slug of liquid in the suction gas, it had formed a tight fit on the rod. The packing had wedged between the rod and lantern and practically clamped the lantern on the rod.

When the lantern had finally been removed from the rod, the engineer turned his attention to removing the rest of the packing that should be above the lantern in the stuffing-box. To his surprise there was not a shred of it left. The reason for the pound or knock was now plain to him. With no packing in the top half of the stuffing-box and the lantern jamming hard on the rod at the crank end, the lantern had struck the bottom of the stuffing-box at every up stroke of the compressor, and of course the knock resulted.



STUFFING-BOX FOR AMMONIA COMPRESSOR

The engineer was at first badly puzzled to account for the disappearance of the packing above the lantern, but when the rod was again inserted, he found that there was nearly $\frac{1}{8}$ in. clearance between the rod and the neck of the stuffing-box. The rod had been turned down some time previous to this, and no provision had been made to make up for the reduced diameter. This was now provided for by making a junk ring $\frac{3}{4}$ in. thick and a snug fit in the stuffing-box and $\frac{1}{32}$ in. larger inside diameter than the rod. This was slipped over the rod and placed at the bottom of the box. It prevented the packing from working out between the rod and the neck of the stuffing-box and ended the trouble with this stuffing-box as well as eliminating the puzzling knock.

Future Location of Central Power Stations

By DEVER C. ASHMEAD

The coal mines are able to produce all the coal required, but the transportation facilities are not adequate; therefore, it is suggested that the country be divided into districts, each served with electric power generated by central stations located at the sources of fuel supply. The advantages of the plan are outlined, and estimates of the probable saving are given.

THE fuel problem does not lie in the inability of the mines to produce the coal, but rather in the inability of the railroads to transport it. The matter is one of transportation instead of production. The country requires 600,000,000 tons of coal per year, and the mines can furnish 750,000,000 tons in that time; but the railroads cannot handle more than 550,000,000 tons a year, or 50,000,000 tons less than the normal demand.

The failure of the railroads to handle the required quantity of coal is due to three factors: First, lack of motive power; second, shortage of cars; and third, delay of the consignee in unloading cars. This article is not concerned with the last of the foregoing causes, but it is vitally concerned with the other two. Any practicable method of relieving the shortage of locomotives and cars must be of interest to the whole country; therefore, it will be advisable to investigate at least one phase of the situation.

Increase in Use of Electrical Energy

According to the United States Census Reports, the electrical energy generated in 1907 is estimated as 10,621,407,000 kw.-hr., and in 1912 as 17,585,622,000 kw.-hr. In 1917, according to careful estimates, over 27,000,000,000 kw.-hr. was sold by central stations, which is 16,378,593,000 kw.-hr. more than was generated in 1907, or an increase of approximately 155 per cent. in ten years. It is realized that the figures for 1907 represent current generated and those for 1917 represent current sold, so that they are not strictly comparable. However, the amount of energy generated in 1907 is not obtainable; and furthermore, if losses were included, the value 27,000,000,000 kw.-hr. would be considerably increased. This increase would serve only to strengthen the argument put forth in this article; consequently, the two values are compared as shown.

It is not unreasonable to assume that in the next ten years the use of electricity will increase in the same ratio, which means that in 1927 the output would be 68,850,000,000 kw.-hr. About one-third of the electrical output in 1917 was produced by hydro-electric plants; therefore, at the same ratio, 46,000,000,000 kw.-hr. would be generated by steam in 1927. It requires from 2 to 10 lb. of coal to produce a kilowatt-hour. If an average of 3 lb. is assumed, which certainly is conservative enough, it follows that the 18,000,000,000 kw.-hr. produced in 1917 required 54,000,000,000 lb. of coal, or 27,000,000 short tons.

To handle this tonnage, the railroads had to move 675,000 carloads of coal averaging 40 tons to the car. By 1927 these figures will have increased to 138,000,000,000 lb. of coal, or 69,000,000 short tons; and estimating 50 tons of coal to the car, since by that time all the small cars will be scrapped, there will be 1,380,000 carloads.

In 1917 there were approximately 950,000 coal cars in the United States and more than two-thirds of the number were required to make one trip from the mines to the power plants to furnish the needed coal. The money paid to the railroads for freight on this coal, taking a freight rate of $1.50 a ton, amounted to $40,500,000, which is interest at 5 per cent. on $810,000,000.

Assuming the same freight rate, producers of electricity in 1927 would pay the railroads $103,500,000 a year, which is the interest at 5 per cent. on $2,070,000,000. If the latter sum were used to develop the electrical industry, a wonderful advance could be made. It is advisable, therefore, to investigate the distribution of the use of electricity and its relation to the coal fields of the United States.

Generation of Power at Coal Mines

Table I gives the production of coal and coke in the several states in 1916. Table II shows the amount of current generated in the several states and the coal required to produce this current, in 1917 and 1927. The greater part of the electrical production is comparatively near the different coal fields, which naturally suggests the idea of generating current at the source of fuel supply instead of at the point where the power is used. In these days of high-tension electrical transmission over long distances, this suggestion has greater force.

As shown on the accompanying map, the writer divides the country into 23 districts, each supplied with electricity generated from one or more central stations, which are indicated by black dots. Table III gives the total kilowatt-hours and the quantities of coal to produce them in these districts, for both 1917 and 1927. Of course the actual working out of a plan of this kind would probably differ greatly from the districting here shown, but the latter will serve to illustrate the idea.

Objections to Plan as Outlined

The first objections to such a plan would probably be the cost of the necessary transmission lines and the loss due to the abandonment of existing central stations. Approximately 100,000 miles of transmission lines at about $15,000 a mile would be required, involving the huge sum of $1,500,000,000. Plants now in operation would be worth only their scrap value, which would entail a loss of another $1,500,000,000. Thus, the total investment required would be $3,000,000,000.

It was shown that the saving in the cost of transporting coal in 1917 would have amounted to $40,500,000, and that in 1927 it would amount to $103,500,000 if the power were generated at the mines. In Pennsylvania, 88,312,000 tons of anthracite was mined in

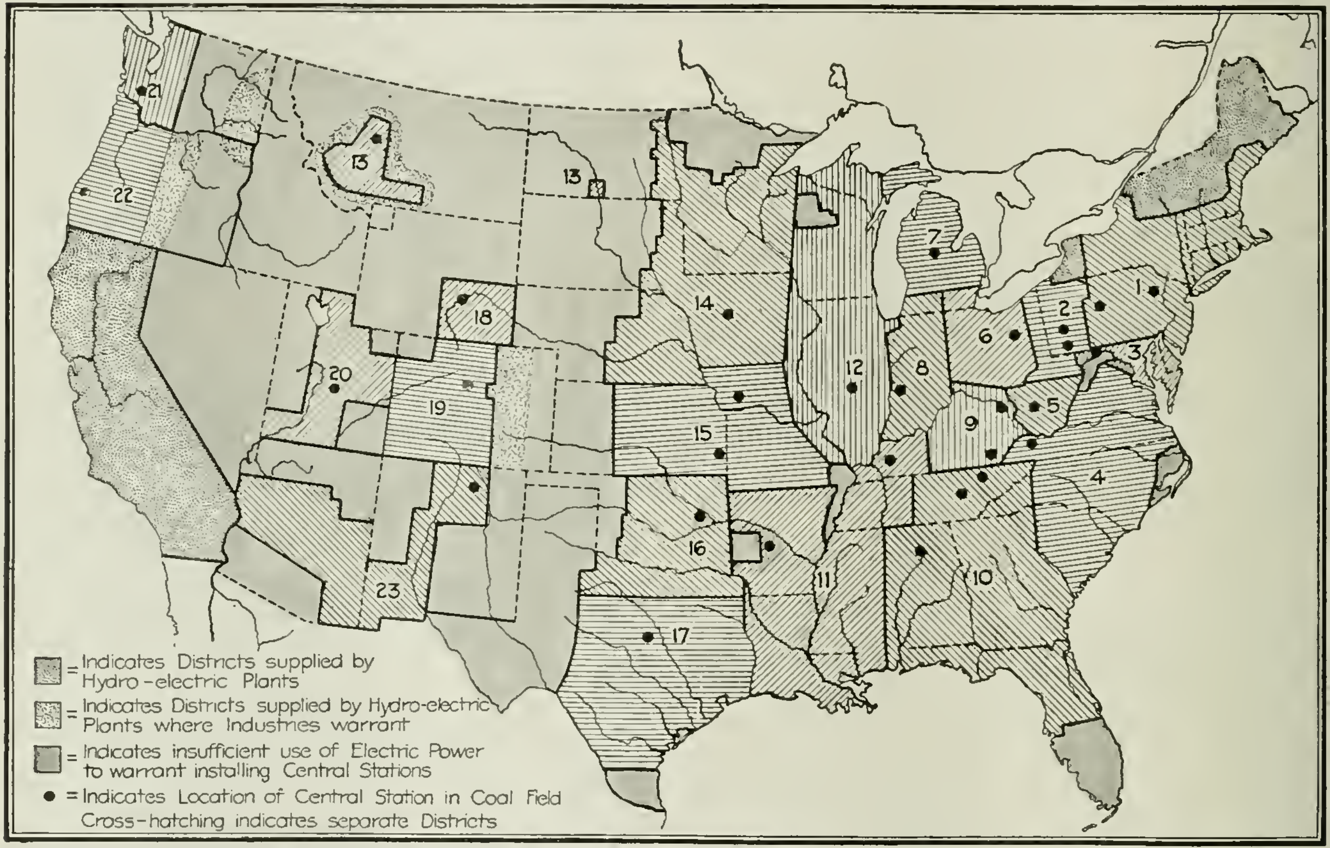
1916, of which 8 per cent. was too fine to ship. This 8 per cent., amounting to 7,000,000 tons, would generate one-fourth of the electricity used in the United States in 1917. This grade of fuel, which can be burned successfully on chain-grate stokers, could be flushed with water and pumped through pipes from the mines to the power stations, where the water could be drained off and the coal dried for burning. Such silt could be obtained at the central station for approximately 75c. a ton less than No. 2 buckwheat or bird's-eye coal at the mine, and its use would save $5,250,000 a year.

Another saving could be made in the coke regions. In 1916 approximately 37,000,000 tons of coke was produced from beehive ovens. Each ton of coke produced about 5 per cent. of coke breeze, or nearly 1,900,000 tons, in 1916. Manufacturers of coke now pay to have it hauled away; but if it were sold for even 40 or 50c. a ton, replacing coal at $2.50 a ton, there would be a saving of about $3,800,000 a year to the fuel user.

Further saving would be effected by reducing the loss of coal in transportation, due to leakage, wrecks and stealing. This loss may run from 2 to 5 per cent. Taking the lower value, the loss in 1917 was 540,000 tons and in 1927 it would be 1,380,000 tons. Assuming a price of $2.40 a ton at the mine, the loss would be $1,300,000 in 1917 and $3,300,000 in 1927.

In mining bituminous coal by machines, an undercut about 6 in. deep is made, and the fine coal, or "bug dust," thus formed is about 8 per cent. of the coal mined, or 39,500,000 tons in 1917. Subtracting the 5,500,000 tons used in the production of coke, 34,000,000 tons remain, and if it were screened out of the coal and used for the production of power, the value of the remainder of the coal would be increased. If the saving amounted to only 10c. a ton, the saving in 1917 would be about $3,400,000.

Further saving would result from the more economical burning of fuel and generation of power, since electricity can be generated more cheaply in a large plant than in a small one. At present there is great waste of coal in hand-fired plants; much is wasted by the old types of mechanical stokers, and more is wasted by the use of unsuitable grates. The reduction of these losses would probably save millions. The reduction in cost of labor and supervision by substituting a few large plants for many small ones would also run into millions.



MAP SHOWING TENTATIVE DISTRICTING, WITH LOCATIONS OF CENTRAL STATIONS SUPPLYING VARIOUS DISTRICTS WITH POWER GENERATED AT MINES

The various estimates that have thus far been considered may be summarized as follows:

	1917	1927
Tons of coal required for estimated kw.-hr.	27,000,000	69,000,000
Freight paid to railroads	$40,500,000	$103,500,000
Saving by using anthracite silt	5,250,000	5,250,000
Saving by using coke breeze	3,800,000	3,800,000
Saving by using bug dust	1,750,000	3,400,000
Reducing loss of coal in transportation	1,300,000	3,300,000
Total	$52,600,000	$119,250,000
Equivalent principal, taking interest rate of 5 per cent	$1,052,000,000	$2,385,000,000

If the foregoing economies could be put into effect at once, the saving would pay the interest at 5 per cent. on more than a billion dollars, while in 1927 it would pay the interest on almost two and a half billions. These figures do not take into account the other savings mentioned. If their values were added, the total saving in 1927 would probably be more than enough to pay the interest on the required three billions of investment. The feasibility of the scheme, from a financial viewpoint, is thus demonstrated. It remains to see whether it is practicable.

A careful study of Tables I and IV, in connection with the districts shown on the map, indicates that each district produces enough coal of the right grade or quality to meet its demand for power. Table IV gives the coal and coke production, by districts, in 1916.

TABLE I. PRODUCTION OF COAL AND COKE IN 1916, IN SHORT TONS

	Coal	Coke
Alabama	16,250,000	4,250,000
Arkansas	2,000,000	..
California	12,000	
Colorado	10,260,948	1,320,000
Georgia	140,000	25,000
Illinois	63,500,000	2,500,000
Indiana	18,738,256	3,100,000
Iowa	7,600,000	
Kansas	8,000,000	
Kentucky	25,106,500	980,000
Maryland	4,930,000	395,000
Massachusetts		600,000
Michigan	1,056,393	
Minnesota		250,000
Missouri	4,000,000	
Montana	3,688,307	
New Mexico	3,893,185	479,153
North Dakota	620,000	
Ohio	30,500,000	725,000
Oklahoma	3,053,543	
Oregon	39,230	
Pennsylvania (bit.)	170,270,000	30,746,000
Pennsylvania (anth.)	88,312,000	
South Dakota	14,000	
Tennessee	6,589,915	275,000
Texas	2,300,000	
Utah	3,621,935	224,294
Virginia	9,300,000	700,000
Washington	3,000,000	140,000
West Virginia	87,989,000	1,900,000
Wyoming	7,650,000	2,300,000
	582,435,212	50,909,447

TABLE II. CURRENT GENERATED BY STEAM, AND SHORT TONS OF COAL BURNED, BY STATES

	1917		1927	
	Kw.-Hr.	Coal	Kw.-Hr.	Coal
Alabama	202,000,000	303,000	515,100,000	772,650
Arizona	8,000,000	12,000	20,400,000	30,600
Arkansas	63,000,000	95,000	160,650,000	242,250
California *				....
Colorado	316,000,000	474,000	805,800,000	1,208,700
Connecticut	179,000,000	268,000	456,450,000	683,400
Delaware	39,000,000	59,000	99,450,000	150,450
Dist. of Columbia	179,000,000	268,000	456,450,000	683,400
Florida	78,000,000	117,000	198,900,000	298,350
Georgia	116,000,000	174,000	295,800,000	443,700
Idaho †			..	..
Illinois	2,070,000,000	3,105,000	5,278,500,000	7,917,750
Indiana	700,000,000	1,050,000	1,785,000,000	2,677,500
Iowa	185,000,000	278,000	471,750,000	708,900
Kansas	142,000,000	213,000	362,100,000	543,150
Kentucky	229,000,000	343,000	583,950,000	874,650
Louisiana	163,000,000	245,000	415,650,000	624,750
Maine	100,000,000	150,000	255,000,000	382,500
Maryland	358,000,000	537,000	912,900,000	1,369,350
Massachusetts	1,200,000,000	1,800,000	3,060,000,000	4,590,000
Michigan	329,000,000	493,000	838,950,000	1,257,150
Minnesota	232,000,000	348,000	591,600,000	887,400
Mississippi	58,000,000	87,000	147,900,000	221,850
Missouri	772,000,000	1,158,000	1,968,600,000	2,952,900
Montana	17,000,000	26,000	43,350,000	66,300
Nebraska	147,000,000	220,000	374,850,000	561,000
Nevada †	......	....		
New Hampshire	62,000,000	93,000	158,100,000	237,150
New Jersey	640,000,000	960,000	1,632,000,000	2,448,000
New Mexico	9,000,000	14,000	22,950,000	35,700
New York	3,350,000,000	5,025,000	8,542,500,000	12,813,750
North Carolina	50,000,000	75,000	127,500,000	191,250
North Dakota	19,000,000	29,000	48,450,000	73,950
Ohio	1,459,000,000	2,188,000	3,720,450,000	5,579,400
Oklahoma	100,000,000	150,000	255,000,000	382,500
Oregon	293,000,000	439,000	747,150,000	1,119,450
Pennsylvania	1,895,000,000	2,843,000	4,832,250,000	7,249,650
Rhode Island	191,000,000	286,000	487,050,000	729,300
South Carolina	60,000,000	90,000	153,000,000	229,500
South Dakota	10,000,000	15,000	25,500,000	38,250
Tennessee	158,000,000	237,000	402,900,000	604,350
Texas	315,000,000	473,000	803,250,000	1,206,150
Utah	76,000,000	114,000	193,800,000	290,700
Vermont	31,000,000	46,000	79,050,000	117,300
Virginia	227,000,000	340,000	578,850,000	867,000
Washington	579,000,000	869,000	1,476,450,000	2,215,950
West Virginia	113,000,000	169,000	288,150,000	430,950
Wisconsin	349,000,000	524,000	889,950,000	1,336,200
Wyoming	18,000,000	27,000	45,900,000	68,850

* Coal consumption for generating electric power is practically nothing.
† Coal consumption for generating electric power is negligible.

Table V shows the length of transmission lines needed in each district.

The arrangement of the central stations is a matter of study for each individual district, but some suggestions can be made. In some districts it might be better to have a number of small stations located at the different mines and supplying power to a main transmission line. In the Indiana district, for example, the coal field is a long, narrow strip on the western border, and there are a number of mines with an output of 500,000 tons of coal a year each. A central station could be located at each of these mines and take its entire output, and each would produce about 330,000,000 kw.-hr. a year.

TABLE III CURRENT GENERATED BY STEAM, AND SHORT TONS OF COAL BURNED, BY DISTRICTS

District	1917		1927	
	Kw.-Hr.	Coal	Kw.-Hr.	Coal
1	6,701,000,000	10,051,500	17,087,550,000	25,631,325
2	1,340,000,000	2,010,000	3,417,000,000	5,125,500
3	632,000,000	948,000	1,611,600,000	2,417,400
4	295,000,000	442,500	752,250,000	1,128,375
5	59,000,000	88,500	150,450,000	225,675
6	812,000,000	1,218,000	2,070,600,000	3,105,900
7	123,000,000	184,500	313,650,000	470,475
8	782,000,000	1,173,000	1,994,100,000	2,991,150
9	479,000,000	718,500	1,221,450,000	1,832,175
10	475,000,000	712,500	1,211,250,000	1,816,875
11	448,000,000	672,000	1,142,400,000	1,713,600
12	2,654,000,000	3,981,000	6,767,700,000	10,151,550
13	17,000,000	25,500	43,350,000	65,025
14	634,000,000	951,000	1,616,700,000	2,425,050
15	721,000,000	1,081,500	1,838,550,000	2,757,825
16	205,000,000	307,500	522,750,000	784,125
17	210,000,000	315,000	535,500,000	803,250
18	18,000,000	27,000	45,900,000	68,850
19	316,000,000	474,000	805,800,000	1,208,700
20	76,000,000	114,000	193,800,000	290,700
21	579,000,000	868,500	1,476,450,000	2,214,675
22	293,000,000	439,500	747,150,000	1,120,725
23	17,000,000	25,500	43,350,000	65,025

Another example may be found in the anthracite field. There might be three large central stations, one in each part of the field. As these plants could burn silt and fine coal, their fuel could be pumped from the various breakers to the central plants, relieving the railroads from handling it.

Still another example is the eastern Kentucky field, containing three main railroad lines on which the coal is produced. It might probably be best in this field to have three main power plants, one on each of the three railroads.

TABLE IV. COAL AND COKE PRODUCTION IN SHORT TONS, IN 1916, BY DISTRICTS

District	Coal	Coke	District	Coal	Coke
1	128,312,000	2,600,000*	14	7,614,000	....
2	149,270,000	28,746,000	15	12,000,000	.....
3	4,930,000	395,000*	16	3,053,543	......
4	33,300,000	2,600,000	17	2,300,000	....
5	44,989,000		18	7,650,000	2,300,000
6	30,500,000	725,000*	19	10,260,948	1,320,000
7	1,056,393		20	3,621,935	224,294
8	18,738,256	3,100,000*	21	3,000,000	140,000
9	11,000,000	980,000*	22	39,230	
10	22,979,915	4,550,000	23	3,893,185	479,153
11	16,106,500				
12	63,500,000	2,750,000*		582,423,212	50,909,447
13	4,308,307				

* Byproduct coke.

In the bituminous field it would probably be better to have a number of smaller plants located at convenient points, so that the slack coal would need to be carried a minimum distance by the railroads. Such a plan would be better than having one or two large plants, as the latter would involve a longer haul.

TABLE V. LENGTH OF TRANSMISSION LINES, BY DISTRICTS

District	Miles	District	Miles
1	14,300	15	8,500
2	5,900	16	4,000
3	1,800	17	4,000
4	6,700	18	600
5	2,100	19	2,000
6	4,800	20	1,000
7	4,000	21	2,000
8	6,300	22	1,000
9	2,500	23	3,000
10	9,500		
11	8,500		123,300
12	15,500	Less 21, 22 and 23	6,000
13	1,000		
14	14,300		117,300

It has been shown that electric companies and users of power would benefit by electric-power generation at the mines. Now it remains to be shown how the railroads would be benefited by the reduction of the burden of transportation. In 1915 there were about 900,000 railroad cars in use in the United States for hauling coal, and 344,119,502 tons were hauled. At 40 tons to a car, there was a total of 8,602,988 carloads, so that each car made 9½ trips a year from the mines to the consumer. As there were 675,000 cars of coal handled in 1917 for electric plants alone, it was necessary to keep about 71,000 cars in this service. In 1927, assuming the same number of trips per car, but 50 tons to a carload, there would be 1,380,000 carloads, requiring 145,000 cars. The locomotives needed to handle these cars, assuming 50 cars to a train in 1917 and 60 in 1927, would be 1400 in 1917 and 2890 in 1927. The reduction in the amount of coal handled, by generating the power at the mines, would be enormous. Of course the revenue from the freight on this coal would be lost to the railroads, but the equipment thus released could be turned to the carrying of other commodities, so that their income would not necessarily be affected adversely.

Precedents for Long-Distance Transmission

At the present time there are a number of precedents for the long-distance transmission of power and for the establishment of central stations at the source of the fuel supply, and it might be well to show what has been done. A number of examples of long-distance transmission of power exist in the West, particularly in California, one of the most noteworthy being that of the Stanislaus system. This is a hydro-electric plant in the Stanislaus Mountains. It has a capacity of 100,000 kw. and transmits power at 110,000 volts to San Francisco, more than 150 miles away. This plant has been in operation since 1907.

There are a number of plants east of the Mississippi River which have their central stations at the mines and distribute power over a considerable extent of territory. The Rochester & Pittsburgh Coal Co., at one of its operations in Indiana Co., Penn., transmits power for a distance of about 30 miles at 22,000 volts. This plant is typical of those which use waste fuel, as it burns bone coal. Such coal is commercially worthless, due to high ash content and lack of luster, but it has to be removed from the mines. This plant has an installation of 12,000 kilowatts.

At Cabin Creek Junction, W. Va., the Virginia Power Co. has installed a plant of 20,000-kw. capacity and arrangements have been made to increase it. Current is transmitted at 44,000 volts to hundreds of coal mines within a radius of 50 miles and the company is now considering extension of the lines.

At Hauto, Penn., a plant of 37,500-kw. capacity, which is to be enlarged to 100,000 kw., has been built by the Lehigh Coal and Navigation Co. The current is transmitted at 110,000 volts for distances up to 50 miles. The plan is to extend the lines eventually to New York and Philadelphia, 98 and 73 miles away, respectively. This current is used to supply a large number of mines and manufacturing plants, and a very small grade of coal is used.

Near Wilkes-Barre, Penn., the D., L. & W. R.R. at its Loomis mine has an installation of 10,000 kw. and transmits the current at 22,000 volts to a number of mining operations. Silt is used for the generation of steam.

At Peoria, Ill., there is a central station with a capacity of 10,500 kw. supplying a population of 140,000 people in five counties having 27 cities and towns. Two mines very near the central station furnish the coal, and the current is transmitted at 33,000 volts.

The Christopher Coal Mining Co., Christopher, Ill., has an installation of 5000 kw., and all the surplus power is stepped up to 33,000 volts and supplied to a public-utilities company.

The Kentucky Utilities Co. has a plant in the Pocket near St. Charles, Va., and another at Varilla, Ky. The Pocket plant is of 10,000 kw. and the Varilla plant of 5000 kw. The Varilla plant is supplied with coal by a company whose tipple is about 500 ft. away, while the Pocket plant is supplied by the coal mines at St. Charles and the washer at the Pocket. These plants are connected by more than 50 miles of transmission lines, and they supply a territory more than 150 miles long, which is being extended monthly· 33,000 volts is used for the transmission of the current.

The Clearfield Bituminous Coal Corporation has a 2000-kw. plant at Clymer, Penn., and a 5000-kw. plant at Rossiter, Penn. The Clymer plant is tied in with the Pennsylvania Public Service Corporation lines, and the one at Rossiter is about to be. The service corporation supplies a number of counties in the central part of Pennsylvania with 22,000-volt current. At present the lines are more than 150 miles long and are being extended.

Packing Water-Pistons of Pumps

Packing the water end of an internally packed pump is considered a comparatively simple job, but the life or service of the packing is greatly influenced by the way it is put in and adjusted. The one big requisite is that the packing be pinched or clamped firmly between the flange and the follower plate. When so clamped, it can withstand the action of the water without being washed away. This is especially noticeable when the pump cylinder has become worn large in the middle so that there is more or less water slip toward midstroke. If the packing is not solidly gripped, it will not stay long, will be washed away; if, however, it is held as in a vise, it will withstand the erosion and "tugging" effect a much longer time.

The packing cannot be expected to expand to suit the worn part and compress to pass into the smaller portion at the ends, as the rings in the steam end do, and still last a reasonable time, because of its fibrous nature.

A split ring should be put in, if necessary, just ahead of the last ring so that the packing will extend slightly beyond the plunger and the follower plate will pinch it hard before coming against the face of the plunger.

By doing without needless luxuries you can save money. And by investing that money in War Savings Stamps, you automatically release to the Government the labor and material that it needs for winning the war. The Government doesn't ask you to give your money, or to do without luxuries forever. Uncle Sam simply wants your game of pleasure and luxury postponed on account of the rain of bullets that the Huns are directing at our fighting lads.

Editorials

"We'll Stand Fast"

Words of Inspiration from "Power's" Paris Correspondent

IN THE world crisis precipitated by the German onslaught in Picardy and Flanders the faith of France in her own armies and those of her allies remains absolutely unshaken. This is the clear-cut impression gained by the observer in Paris today. There is no panic here as Teuton propagandists would have the world believe, nor are there discernible even the symptoms of a general uneasiness.

Long-range shelling by day, bombing raids from the air by night, and the threat of a German advance upon the French Capital, far from demoralizing the spirit of the civil population, have lifted it to new heights of determination and confidence. The daily news from the front is even more encouraging, and there are just beginning to drift back hints of the heroic part which the engineers of the allied forces are playing in the greatest war drama of all time.

When the full story is told of how they have been performing day after day seemingly impossible feats in transporting reserve troops and material and in maintaining lines of communication, it will form the grandest epic in the annals of engineering.

From the picture of public feeling here I will pick out a single detail. At the *pension de famille*, where I stay, lives the aged widow of a French general. Amid the bursting shells of the long-range gun, bombs dropped in the night and early rumors of an overwhelming German attack, her friends attempted to persuade the old lady to leave Paris. I saw her eyes flash, her bent shoulders straighten back, and as she snapped, "*Je reste ici*," she seemed to embody in those three words the spirit of France—"We'll Stand Fast."

Mine-Mouth Generation of Power

THE plan outlined in the article on page 661 of this issue suggests locating large electric power stations in the heart of the coal-mining districts of the country, generating electrical energy there and transmitting it by high-tension lines to the points where power is required. The idea is not a new one, for it has been put forth, in one form or another, in times past. But the exigencies brought about by war conditions lend fresh emphasis to the proposal.

It is at once apparent that the utilization of coal for power generation at the mine does away with the necessity of transporting that coal to distant points and so relieves the railroads of a vast amount of tonnage. So far as the past season is concerned, the congestion of traffic on the railroads was due to lack of motive power to handle the increased quantity of freight. Obviously, any arrangement by which a large percentage of the freight traffic could be eliminated would afford a solution of the transportation problem.

The large power plant is capable of producing energy at a lower cost than the small plant working under like conditions, so that the plan proposed has the additional advantage of economizing in the use of fuel. This, too, has been brought prominently into notice of late.

The author, for the purpose of presenting his argument, divides the country into a number of districts, each of which contains one or more coal fields of sufficient size to furnish the power for that district. The division shown is made arbitrarily, and any definite attempt to put such a plan into operation would probably alter the boundary lines considerably.

The current generated at the district central stations is transmitted to various parts of the district by high-tension transmission lines. The lengths of these lines in some cases would be great, but there are a sufficient number of long-distance transmission lines now in operation to furnish the necessary precedents.

A further step, not mentioned by the author in his discussion, would be the recovery of byproducts from the coal before it is utilized as fuel. This point is now under consideration in Great Britain, in connection with a plan to divide that country into some sixteen districts, each containing electric generating stations as centers of supply of power. The idea is to build the byproduct plant in close proximity to the power plant and to extract from the coal all desirable byproducts before using it to produce heat for power, where such extraction proves justifiable.

All these plans for the utilization of the greatest possible percentage of the value of coal are straws showing that the trend of modern engineering is in the direction of greater efficiency and increased conservation of natural resources.

The Coal Situation

THE problem of supplying every coal consumer in this country with sufficient fuel to meet his needs for the coming winter hinges entirely on transportation, and the Fuel Administration gives assurance that there are enough cars and locomotives to transport the necessary quantity of coal, provided that every car and every locomotive are used to their maximum capacity every day in the year. Also, there are enough mine workers to furnish the required output, if they are kept busy every day in the year and if the cars and locomotives are available.

The full coal-carrying capacity must be utilized all the time, and to attain this end it is necessary that the coal operators be supplied with orders. If orders are delayed, or are small, the output at the mines will be curtailed correspondingly, resulting in idle workmen; but still worse, the number of coal cars delivered to the mine will be reduced to suit the demand, and coal-carrying equipment will be idle.

There is no elasticity in the transportation of coal. The movement must be continuous and always at full capacity, if a fuel famine like that of last year is to be averted. The aggregate demand for coal is so great that a slump in production during a week or a month cannot be made up in a succeeding period.

The Fuel Administration is doing everything in its power to keep all the machinery for the production and distribution of coal working at maximum capacity. The reduction of thirty cents a ton to the domestic consumer is made in the hope that orders for the winter's coal will accumulate to such an extent that both the mines and the railroads will be kept busy continuously throughout the year.

The producer is not able to mine the coal and store it in anticipation of a future demand. Few mines have storage space or equipment; and even if these were available, there would be an unnecessary expense incurred in the double handling of the coal. The most economical and rapid method is to mine the coal, load it directly into cars and ship it to the points where it is to be used, there to be stored until it is needed.

The Fuel Administration will coöperate with any community that desires to provide storage for emergency stocks of coal to be laid in during the summer months; but the greater part of the storage capacity of the country is made up of the bins of the individual consumers, and these are the logical places for the accumulation of stocks of fuel.

The Government has established a schedule of fixed prices for coal at the mines; it has put into effect a zone system of distribution to facilitate transportation; it encourages the production of clean coal by allowing higher prices to producers who take extraordinary pains in preparing their output; and it penalizes in price those coals that contain undue amounts of foreign matter. In view of these measures the prompt and complete coöperation of the consuming public by the placing of orders is needed to insure the successful distribution of the year's coal.

Home Army Must Supply Power

THERE are two fields of battle in the war against German autocracy and militarism, and to win the war we must conquer on both those fields. One is in France and Belgium and extends from the North Sea to the Swiss border. The other is here in America. It extends from the Atlantic to the Pacific and from the Canadian border to the Gulf of Mexico. It covers every city, town and village, every farm, field and woodland in the country.

In France our soldiers, standing shoulder to shoulder with the British, French and Italians, repeat the great French battle cry of Verdun, "You shall not pass!" Their breasts are a wall of steel against the charging masses of the Kaiser. Amid the roar of cannon, the rattle of machine guns and the clash of bayonets, they stand firm.

Over here it is the noisy clang of the riveters in the shipyards, the busy hum of the factory, the whirring wheels of smoothly running engines, the silent efficiency of the great office force, the push of the plow in soft earth and the swift stroke of the woodman's ax.

All are fighting in the great battle that democracy may live—those whose part is played here, as well as those who sail across the sea to offer their lives in France. And it is as essential for final victory that the army here shall stand firm—the army of workingmen and workingwomen—that no part of the long line shall give, that every man shall put forth the last ounce of his strength, that they shall fight with their backs to the wall, as it is that that line in France shall hurl back the German hordes. For our men over the sea cannot win without us at home. They look to us to back them up, to keep a steady stream of men and munitions and supplies of all kinds crossing the Atlantic, to build the ships that will bridge the ocean.

Our duty is as stern as is that of the soldiers in France, and our fate is as unrelenting. Our choice is unremitting labor and unquestioning, willing sacrifice, or defeat and subjugation to the iron despotism of Germany. There are no other alternatives.

The Third Liberty Loan campaign is ended, and the loan well oversubscribed. The response of the people of America has been more than equal to the present demand. They have done well, but this is not all. Let us now concentrate our energies to putting the War Savings Certificates over the top, for they are also a liberty investment that our Government is depending upon to provide the sinews of war. The line on the battlefields of America must not waver, so that the line in France will hold firm, because our men in France put their faith in us in America. Let us not fail them. Let us be equal to any call that is made upon us. Let us now buy War Savings Certificates to the limit of our resources, and then strain our resources to buy more Government securities. In that way lies victory.

Boilers not built in conformity with the Code may be carried into Pennsylvania, but may not be operated, according to an opinion recently rendered by the Attorney-General's Department to the Department of Labor and Industry. The board had ruled that boilers not built in conformity with its boiler code may not be brought into Pennsylvania. The Legal Department is of the opinion that such a ruling cannot be enforced, but that the board can prevent the operation of the boiler until it is made to conform with its code.

Which will you choose? The Government needs all the money, material and labor it can get, and more. This is a war of equipment. No matter how brave our men are, they cannot face the greatest military organization the world has ever known with bare hands. There is not enough labor and material in the country for our usual comforts and luxuries and for our fighters' necessities. We must choose which it shall be.

There's an old saying that it's better to have tried and failed than never to have tried at all; but while it may be right to look at some things in that way, it cannot be applied to all tasks and problems that one meets with in the power-plant field. Overconfidence in one's ability will as surely bring failure as would lack of sufficient courage to tackle the job.

Farley G. Clark, of Niagara Falls, N. Y., proposes to pump coal from mines to centers of consumption through pipe lines. The idea is worthy of study.

Correspondence

Meeting an Emergency

The plant of which I have charge supplies light and heat to a large railway terminal hotel, station buildings, etc. We have two boilers, but use only one at a time, the other being kept clean and ready to fire up at a moment's notice. We burn oil pumped directly to the burners from the underground storage tank, which is about 200 ft. from the boiler room. One 3 x 2 x 4-in. duplex pump is used at a time, supplied from a common 3-in. suction line. This line comes out of the tank above the level of the pumps, drops considerably below their level, then rises through the boiler-room floor to the pumps after making a number of right-angled turns. The pumps run very slowly, controlled by a governor, to supply the oil as fast as it is burned. We have no trouble as long as the oil tank is not less than half full, as the oil is above the level of the pumps; but below this the pump frequently loses the oil, and it is sometimes difficult to get it to pick up again.

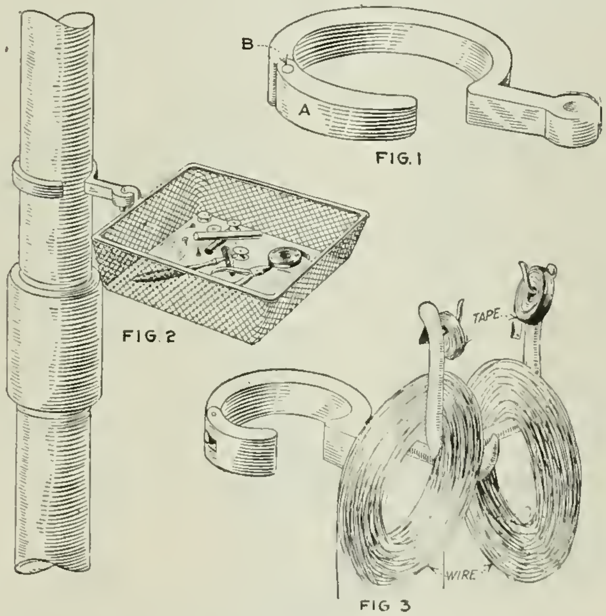
Recently, I had a new man on the midnight to 8 o'clock shift. He had specific instructions what to do and how to manipulate the pumps in case they lost the oil, and was told to call me in case of trouble. One morning about 3 o'clock the pump lost the oil and the man evidently lost his head altogether, for when I got to the plant the fire was out and the steam down to 20 lb. The dampers were wide open, allowing a cold draft through the boiler. The engine was running with full load on, though at such reduced speed that the lights could barely be seen. I shut down the engine, closed the damper and cut out a live-steam heating circuit. By this time the steam was down to 15 lb. I started the spare pump, which was in perfect condition, but the steam was too low to run the pump fast enough to pick up the oil. The case seemed hopeless. There was no means of raising steam except with oil and steam of at least 30 lb. pressure was required to pump the oil. It was very cold and impatient inquiries were coming in thick and fast; so I disconnected the pump suction pipe, put in a tee, then a nipple and valve, and in the valve I screwed a piece of 3-in. pipe about 3 ft. long. I then attached ropes to two pails, and with these we drew oil from the tank, carried it to the boiler room and filled the suction line and pump through my improvised standpipe. By that time there was only 10 lb. of steam pressure, barely enough to move the pump and atomize the oil in the burner. I certainly felt relieved when the gage on the oil line to the burners showed pressure enough to start the fire. We kept carrying oil until we had 40 lb. steam and succeeded in getting the pump to take oil from the tank. In an hour from the time I arrived we had the full load on the engine and steam heat on in all departments.

This incident convinced me that in all oil-burning plants the burner pump should take oil from an overhead tank, so I am installing a small overhead tank to be kept filled by piping the discharge oil from the over-pressure valve, on the oil line between the pumps and burners. From this overhead tank I will run an overflow pipe to the storage tank instead of the present layout where the overflow pipe runs directly back to the storage tank. From the bottom of this auxiliary tank I will run a pipe to the pump suction line so that it will only be necessary to open a valve to prime the pump, since the overhead tank will always be kept full by the discharge from the overpressure valve.

Ash Fork, Ariz. W. G. Camp.

Easily Attached Toolholder

The bracket shown in Fig. 1 is made of machine steel and hardened on the corners for gripping on pipes or poles for holding the tool basket, Fig. 2, or the wire and tape holder, Fig. 3, thus enabling the electrician to have everything within easy reach. The part *A*, Fig. 1, is hinged to give access to the pipe or pole. The rivet *B* is made tight enough to keep the part *A* closed when the bracket is in place. M. P. Bertrande.



FIGS. 1 TO 3 PARTS AND ASSEMBLY OF TOOLHOLDER

Ozone Park, N. Y.

A Suggestion to Advertisers

Although the pages of *Power* are interesting from the front to the back and are full of useful information, there is one thing more your advertisers might do (some do it now but others do not); that is, to mention their representatives in the principal Canadian cities. We have often written to advertisers only to be referred by them to a firm within a hundred miles of here.

Granby, Que., Canada. J. Drummond.

Starting Synchronous Motors

In Mr. Gray's article, "Starting Synchronous Motors," in the Mar. 12 issue of *Power*, it is stated that when an attendant was not at hand to help the operator put the motor in service he tied the starting lever on the compensator in the starting position and then threw in the oil switch at the switchboard.

Some time ago I worked in a plant where there were two large synchronous motors with a similar starting equipment to that described by Mr. Gray. In starting the machines, we first closed the oil switch at the switchboard and then went to the compensator and threw it to the starting position. When the motor had come up to speed, the compensator was closed to the running position, after which the operator went to the switchboard, closed the field switch and made the necessary adjustments.

This may not be any better way of starting the motor than Mr. Gray's, but it seems to be somewhat simpler. D. G. Simmons.

Beaver, Penn.

Snifting Valves on Pumps

By inference from the letter by A. L. Haas, on page 410 in the issue of Mar. 19, it would seem that it is the practice in England to fit snifting valves to pumps of all kinds to admit a small amount of air at each suction stroke. If this is the case, I am wondering what effect is observed in the boilers from this introduction of air. We are in the habit of believing that air (oxygen) in water is a fruitful cause of pitting in pipe systems and boilers, and often considerable trouble and expense are incurred in eliminating it, as against this deliberate introduction. Then again, if the plant is operated condensing, the extra air has to be got rid of from the condenser at the cost of power, not to mention the other mischief it does.

If the entrained air is drawn out at the air chamber or elsewhere before it gets beyond the pump, it would seem to be a useless expenditure of power to compress any small amount of air and then discharge it. Surely, a pump should operate right without snifting valves.

New York City. J. Lewis.

Compressed Air for Cleaning Motors

In the issue of *Power* for Mar. 12 appeared an article by D. R. Shearer, on "Compressed Air for Cleaning Motors." The following on the same subject, but on somewhat broader lines, may be of interest. As it is often necessary to clean equipment carrying potentials of 2300 volts and lower, it is advisable to safeguard the operator as well as the apparatus. The nozzle of the cleaning tool should, therefore, if of metal, be well insulated with cambric and friction tape, otherwise short-circuits may occur between ground and live parts or live parts of opposite polarity. In any case the operator may be subjected to danger of shocks. A nozzle made of one of the insulating compounds now on the market is satisfactory, but should have a metallic lining on account of the erosive effect of high-velocity air.

An air line should be allowed to blow off for several minutes before the nozzle is placed near the insulation. There is usually oil and dirt and often water in the tank or pipe line, and if this is not blown out into the air it may be blown into the insulation of the machine, covering the windings with oil and dirt, both of which are conducive to short-circuits and grounds. The dirt, moreover, at high pressures such as 100 lb. per sq.in. may be forced into the insulation and cause failures.

Mr. Shearer recommends an air pressure of 100 lb. per sq.in. This pressure is too high for most cases, for blowing out rotary converters, generators and motors—a pressure of 60 to 80 lb. is the maximum and should not be exceeded. At 100-lb. pressure, with the nozzle close to the insulation, pieces of grit are easily forced into the insulating materials. On old apparatus or that which has carried heavy loads, the insulation has a tendency to rise up from the conductor, causing air bubbles; high-pressure air blows these open, tends to fray wrappings and may even blow pieces of insulation off entirely, while always tending to crack the insulating varnishes. A pressure above 70 lb. per sq.in., unless the nozzle is held at least 6 in. away from the insulation, is, in my opinion, a dangerous practice.

Every compressed-air tank should be fitted with a pressure gage and a safety valve. The air pressure should preferably be automatically controlled; that is, the air compressor should automatically shut down when the safe working pressure is reached.

Where 500-volt direct current is available, as it is in all rotary-converter railway substations, I have used discarded air compressors from street cars. These outfits occupy about one foot in height and a floor space of about one and one-half by two feet. They are automatically controlled, and the series motor is started direct from the line without the complication of starting resistance.

These sets, although small, answer the purpose for an 8000-kw. station provided a fairly large tank is used. are economical of space and are of low cost.

Chicago, Ill. R. K. Long.

License Internal-Combustion Engine Operators

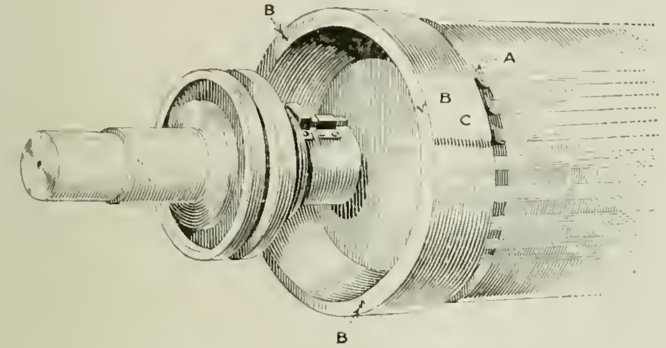
I am a licensed steam engineer and machinist, and also run gas and oil engines and have had several years' experience in testing, erecting, etc., in the gas- and oil-engine business. It has often occurred to me that there should be some way provided for gas engineers to secure a license that would show their proficiency. It seems to me that it would be profitable to all concerned, when understood. The engineers would get their license and possibly more pay, and last, but not least, the employers would know how to get competent men.

The safety departments do not seem to think it necessary to license gas-engine operators, but these men should know as much about lining up engines, setting valves, adjusting bearings, etc., as the steam engineer. I believe that there are a large number of operators that would be glad to avail themselves of such an opportunity. I would like to have an expression of opinion on this matter from the readers of *Power*.

Philadelphia, Penn. T. A. Marshall.

Accident to Turbo-Alternator

We have been hearing considerable about turbine and turbo-alternator failures during the last year or so. The following is a description of a peculiar accident that happened to a 2000-kw. 3600 r.p.m. 2200-volt two-phase alternator, causing a heavy explosion and completely burning out the field and armature windings of the machine. One of the steel end shrouds on the rotor became loose and worked endwise sufficiently to allow the ends of the brass wedges in the slots to bend out by centrifugal force and cut through the winding of the stator. From all appearances the cutting of the armature coils was gradual and no damage was done until one of the wedges was broken off and thrown into the windings, this doing the final damage. There appeared to be two explosions coming very close together, probably caused by one phase winding being short-circuited slightly before the other. The figure shows how the end shroud *C* worked endwise, allowing the brass wedges *A* to bend out by centrifugal force and finally break off and fly into the stator winding. *B* and *B* are small screws that were threaded into the polepieces to help hold the ring in place.



PART OF ROTOR SHOWING HOW END SHROUD WORKED FORWARD

Herkimer, N. Y. H. G. **Burrill.**

Improvement in Boiler Economy

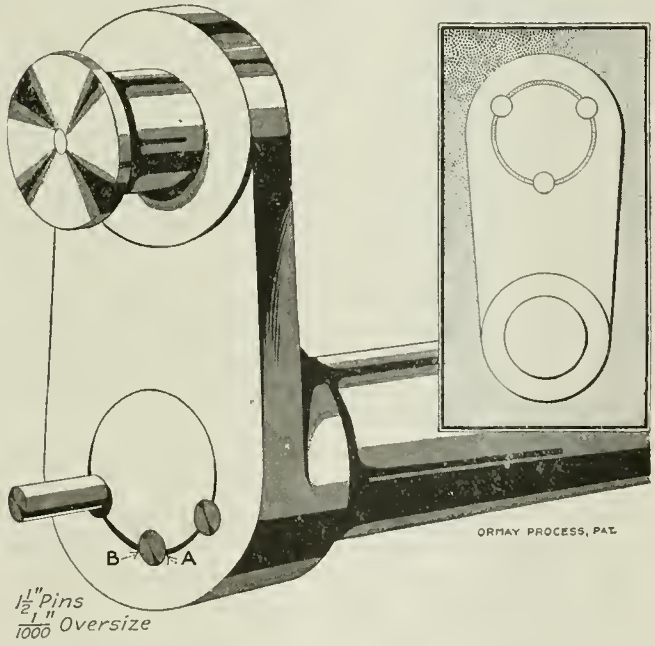
I am not an engineer, only a boiler operator, but the following may be of interest to readers of *Power*. I once had charge of three return-tubular boilers for over four years. When I took charge of them they were burning from eight to nine tons of coal a day on the high-pressure boiler and eight tons on the low-pressure boiler, only two in operation at a time in the winter season. I got busy trying to improve things after looking the situation over. The boiler settings were full of air leaks. In the back end you could throw a dog through, and there was no insulating covering on the boiler tops and no way to clean the tubes. Inside they were coated with scale from ⅛ to ¾ in. thick.

I went to the general manager and told him if he would permit me to make some changes it would make a large saving in coal. He told me that if I could do anything to save coal to "go to it" and that he would get me whatever was needed. I relined the fire wall in the fireboxes, put in new door frames and new grates and patched up the other parts of the boiler settings. We got a new feed pump, and I made a tight wooden top for the water tank and piped the pump exhaust into the tank, and the returns from all steam lines were also piped back to the tank. They had been running into the sewers for years. This was a big saving for we used city water through a meter. I then got busy inside of the boilers with a pick and hammer and got rid of the scale, so I made a saving of eight tons of coal a day, and the whole thing cost only $250, feed pump and all. M. V. B. **Potts.**

Massillon, Ohio.

Fastening a Loose Crank

On page 264 in the issue of Feb. 19 there are illustrations, at the lower part of the page, of what I, and others, consider the wrong method of trying to make a loose crank tight; for it is plain that the looseness of the crank is divided all around the shaft (purposely shown exaggerated in the illustration) and that the taper pins have the load and strains to carry. In other words, the shaft supports the pins and the pins the crank; while, if the job was done as shown in the illustration herewith, the lost motion or looseness would be taken up all in one direction and the crank would fetch up against the shaft for nearly half of its circumference, would have a perfect grip and would retain the original alignment; and the pins would only be called on to hold it in position. I have fixed several in this way and none that I have heard of has worked loose. I have also refitted two that someone had pinned all the way round. I do not make taper holes or pins, but make the pins about one-thousandth of an inch larger than the holes, and drawfile them on two sides at the points *A* and *B*. I pack the pins in ice before driving, but do not always heat the crank. I make the pins about three inches longer than I expect to use, mark the point on them to show when they are "home" and also make some sort of vent to let the air out of hole. I do not grease the pins, but drive them with a battering ram made of a piece of shaft hung by a rope block.



LOOSE CRANK PINNED ON ONE SIDE ONLY

Exeter, N. H. L. **Johnson.**

Watch Your Step!

During the last quarter of a century much has been said and done in the field of industrial management, and the managerial mechanism developed has proved beyond doubt that it is nothing but a mechanism and as such may or may not produce the desired results, depending on how and by whom this mechanism is used. The management of power plants drags in the tail of the procession probably for two reasons: First, belief in the fallacy that good equipment necessarily produces good results; second, because financial interests consider the cost of power an insignificant item of the total expense. When, however, we feel the pinch of the shortage of fuel and when this shortage not only enhances the cost of power, but endangers the very existence of the various industries, even the health and well-being of communities, these fallacies must be disposed of at once.

It is not the equipment and supplies that produce results, but the mode of their use. When this is realized, two problems present themselves to power engineers: First, to secure mechanism for modern management; and, second, to make proper use of it. The success of a managerial mechanism involves certain responsibility by plant owners, since it is obviously their task to provide the plants with the means to study the causes and effects, to standardize and to keep adequate and dependable records. This in turn involves the education and training of the employees to make proper use of the available knowledge. Furthermore, they must have permanent and sufficient incentive for learning and living up to the better way taught them by the expert management. Under such conditions the executive is relieved of all the worries as to routine details, as these are standardized and can be well taken care of by subordinates. The major part of the time of the executive may thus be devoted to solving special problems and inaugurating improvements.

The results accomplished in the plants that have adopted these principles are permanent since they are worked out from the bottom up, and the economy accomplished varies all the way from 15 per cent. to 50 per cent., depending upon the conditions originally found in the plant.

To meet the present contingency both as to men and fuel, the first thing to do is to put the house in order after a thorough study, so that the methods may be based on facts, not on opinions and traditions. When this is done, enough room will be found in which to build up efficiency without resorting to "better equipment" and a lot of patent cures.

New York City. WALTER N. POLAKOV.

The Engineers' Unions

I have read with interest the few letters which have "passed the censor" and have been published in *Power* recently, in regard to engineers' unions, and wish to express, briefly, a few of my sentiments on the subject. I have been a member of one such union for years and must disagree with the statement by Mr. Dye, in the issue of Jan. 1, 1918, that anyone can get into the union and suggesting that candidates be examined.

Before I was accepted, I was required to produce my license to prove that I was an engineer, and in order to get that license I had to undergo a rigid examination. The possession of that paper was good evidence that I was an engineer without the necessity of any further examination on the part of the union, but I was also examined orally by a committee in a thoroughly practical way.

Personally, I have never been directly benefited through being a member of the engineers' union, but indirectly I have, as I am in the Federal service and it is a fact that it was primarily due to the activities of union labor among the Senators and Congressmen that Congress was induced to pass the eight-hour law, which limits the hours of labor of Government employees to eight hours in twenty-four, with one day off in seven and an annual vacation and sick leave on full pay. At present union labor is working very hard for a substantial increase in the wages of Government employees to offset in part the increased cost of living, and from all indications it will be granted. This will affect engineers as well as other employees in the Government service.

The Government as an employer does not recognize unions as an organization except in a few cases such as the navy yards. It is a fact that the lower-paid Government employees, clerks and mechanics who were until a year or two ago unorganized, had not had an increase in wages for many years until Congress in 1917 granted a temporary increase of from 5 to 10 per cent. for one year only, an inadequate increase in the face of the present conditions. But largely owing to the activities of the Federal Employees' Union coöperating with the heads of the various departments, a bill has been introduced in Congress to grant an increase of from 30 per cent. on the salaries less than $1000 to 5 per cent. on salaries up to $2500 per annum, in consideration of the present high cost of living.

Referring again to the engineers' case, if there are no state laws requiring engineers to take an examination and secure a license to operate a plant, or where existing laws are lax, the union naturally can demand further evidence or examination, and to rectify this matter every engineers' organization, union or not, as well as trade organizations should demand more rigid license laws where they are not up to the recognized standard required in Massachusetts, Ohio and some other states.

It must be admitted, however, that there are isolated cases where some individual member has used his influence with the union to hold a position which he otherwise might not be able to hold, but these cases are rare and should be eliminated. On the other hand, the unions certainly have been instrumental in securing uniformity in the scale of wages for engineers in the same localities, doing the same class of work.

Columns could be written setting forth the advantages and disadvantages of unions, but having in mind the editorial in *Power* recently and the editor's reluctance to allow anything of this sort to "pass censor," I can only say that the motto of "Learn more, earn more" should be changed to read, "To earn more, learn more and take the necessary steps to see that you get it." To which end the engineers' union will be found of great assistance. J. C. HAWKINS.

Hyattsville, Md.

Inquiries of General Interest

Compensating Variation from Scale of Planimeter—How is a planimeter used for measuring the mean effective pressure shown by an indicator diagram made with a 16-lb. spring where the planimeter scale is intended to show m.e.p. for a 30-lb. spring? C. L. J.

Operate the planimeter as though a 30-lb. spring had been used and take 16/30 of the result.

Air-Space Walls for Boiler Settings—What is the advantage of air space, or cavity walls, for boiler settings? A. R. W.

An air space acts as a nonconductor for retarding loss of heat from radiation, and when cavity walls are properly designed and constructed, the spreading of the material adds to the strength and stability of the setting. If the outer walls are stayed to the inner walls by good forms of slip and expansion joints, the outer wall will be little affected by expansion and contraction from changes of temperature causing cracks for infiltration of excess air with detriment to furnace economy.

Angle of Advance with Negative Lap—When a D slide valve has negative steam lap, will the eccentric require positive or negative advance to close the steam port before the end of the stroke? T. J. M.

With negative lap the valve has the port uncovered during more than one-half a revolution of the shaft, and if the eccentric should be set at 90 deg. with the crank, the port would be uncovered both at the beginning and at the end of the stroke of the piston. Hence to have the port covered before the end of the stroke the eccentric must have positive advance, that is, must be set ahead of the 90-deg. position, which also would increase the lead or port opening at the beginning of the stroke and hasten all of the valve events

Single Shear and Double Shear—What is meant by a boiler rivet being in single shear or in double shear? F. A. P.

A rivet is said to be in single shear when it is subject to shearing action that tends to produce cleavage at a single cross-section of the rivet, as when used in a riveted lap-joint for holding together two plates that pull in opposite directions. A rivet is said to be in double shear when subject to shearing action that tends to produce cleavage at two cross-sections of its length, as when the rivet is used in a riveted butt-and-double-strap joint for holding together a main plate, sandwiched between an inside and outside cover plate whose direction of pull is opposite to that of the main plate.

Height of Pumping Water—A direct-acting steam pump with steam piston 12 in. diameter and water piston 8 in. diameter is operated with steam at 110 lb. per sq.in. gage pressure. To what height in feet can the pump raise water, assuming 70 per cent. efficiency? G. G. M.

If the total pressure exerted on the steam piston is transmitted to the water piston, 110 lb. per sq.in. gage pressure acting on the steam piston, opposed by back pressure of the atmosphere, would exert a pressure of $(12^2 \div 10^2) \times 110 = 158.4$ lb. per sq.in. on the water piston; one foot head of water exerts a pressure of 0.433 lb. per sq.in., and without friction of water in the pump or pipes the pump could raise the water to a height of $158.4 \div 0.433 = 365.8$ ft. above the level assumed by the suction water under atmospheric pressure. With 70 per cent. efficiency the height would be 0.70 of $365.8 = 256$ feet.

Transmissive Capacity of Steel Shafting—What is the rule for estimating the approximate horsepower-transmitting capacity of the ordinary sizes of steel shafting? S. M.

The approximate number of horsepower capable of being transmitted with safety by ordinary sizes of turned steel lineshafting, when well supported, with pulleys near to the bearings and with the hangers so spaced that the deflection will not exceed 0.01 in. per foot of span, is equal to the cube of the diameter of the shaft in inches for 100 r.p.m. and directly in proportion for other speeds. The safe load for head shafts may be taken as 75 per cent. and for bare transmission shafts as 175 per cent. as much as for ordinary line shafting. Cold-rolled shafting may be taken as one-third stronger than turned steel shafting.

Guarantee Test of Oil Engine—How would a test be made of the guaranteed oil consumption of a 40-hp. oil engine running a 25-kw. 220-volt direct-current generator used for lighting? H. P. K.

To make the test conclusive the economy and regulation should be determined as nearly as possible for the different loads, speeds and other conditions specified in the guarantee. If constant loads of the given magnitude are not obtainable supplying power to the regular load circuit, the desired loads can be obtained by use of a temporary water-rheostat such as illustrated and described on pages 180 and 181 of Aug. 7, 1917, issue of *Power*. If the generator is not to be included in the guarantee, it will be necessary to take into account the efficiency of the generator at the different test loads. These data are generally obtainable of the manufacturer. For reliable results each test should run for a period of at least three hours, noting the weight, kind, source, and analysis of oil used; and readings should be taken at five-minute intervals of the speed of the engine and of the volts and amperes of electrical output. For any test period the average (volts × amperes) ÷ 1000 will be the average kilowatt output, and the number of pounds of oil used per hour divided by the average kilowatts generated will be the oil consumption per kilowatt-hour.

Placing New Piston Rod in Engine—In putting in a new piston rod to replace an old one on a simple engine with V-shaped guides, what is the proper method of centering the rod? J. K.

In providing a new piston rod, the centering of the rod with the stuffing-box is likely to become misplaced. First of all, extend a line through the center of the cylinder past the guides and determine whether the faces of the guides are parallel with the cylinder center line, for that purpose measuring from the cylinder center line to a short round shaft or mandrel, placed in the V of the guide, and of suitable diameter to touch the sides of the V at about the middle of the wearing surfaces. If not parallel, the guides need to be made so by adjustment or as a repair or alteration of the engine. When the guides are parallel to the engine center line, place the new piston rod in the piston and with the piston in the crank end of the cylinder and the end of the rod parallel with the guides, adjust the packing rings so the rod will be in the center of the piston-rod stuffing-box. Then put the crosshead in place with necessary adjustment of the crosshead slippers to make the piston rod parallel with the guides when the rod is connected to the crosshead. If all adjustments have been properly made, the rod will travel centrally through the stuffing-box. If it does not, the vertical and horizontal adjustment of the crosshead should be made so there will be no movement of the stuffing-box gland when the engine is running, otherwise the rod will become scored and it will be difficult to make the packing hold tight.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Power Plants of Modern Ships

By ESKIL BERG

For the power plants of modern ships turbo-generators are built with an efficiency of over 80 per cent., which, with motors of 95 per cent. efficiency and boiler efficiency of 80 per cent., produce a shaft horsepower-hour with 0.825 lb. of coal of 14,000 B.t.u. Six new battleships for the Navy, requiring 33,000 hp. each and five large battle cruisers requiring 180,000 hp. each will be electrically driven. Steam consumption of 11.1 lb. per shaft horsepower-hour is guaranteed for the new battleship "New Mexico," which will be driven electrically.

IN a paper, "Propulsion of Ships," by Eskil Berg, engineer, General Electric Co., Schenectady, N. Y., before a joint meeting of the electrical section of the Franklin Institute and the Philadelphia Section, American Institute of Electrical Engineers, the following interesting figures were given relative to the power plants of modern ships; the abstract is from the March *Journal* of the Franklin Institute.

Speaking of the cautious advance in marine engineering, Mr. Berg said: Some of the Hudson River boats still have side wheels and use boilers with about 30-lb. steam pressure, producing a brake horsepower with about 30 or 40 lb. of steam. Steam engines were built as early as 1765, but it was not until 1807 that one was used to propel a boat. Electricity was used for power transmission as long ago as 1876, but its application as a medium for transmitting power to the propeller of a ship did not take place until 1908. This goes to show that progress in marine propulsion is very slow, the tendency being to follow the old and beaten paths.

The turbine is preferable to the reciprocating engine as a prime mover for ships, because it gives simple rotation and admits the possibility of a large range of expansion. At present the best steam engines are the triple and quadruple-expansion types; but on account of the size of the low-pressure cylinder an expansion ratio of more than 16 to 1 or 20 to 1 is not possible. In the turbine, however, there are practically unlimited possibilities of expansion, depending almost entirely upon the temperature of the condensing water. A vacuum of 29 in. is not at all unusual, and 29.5 in. is being recorded in some of the large central stations during the winter months. What this means may be better understood when we consider the available energy of a pound of steam when expanded from boiler pressure to various degrees of vacuum.

200-lb. pressure to 24 in. vacuum, 220,000 ft.-lb.
200-lb. pressure to 26 in. vacuum, 238,000 ft.-lb.
200-lb. pressure to 28 in. vacuum, 265,000 ft.-lb.
200-lb pressure to 29 in. vacuum, 289,000 ft.-lb.

In other words, a turbine can realize about 25 per cent. more in the energy of steam than the reciprocating engine, which means a saving of about 25 per cent. in fuel, boilers, etc.

Turbines, when used for direct connection to the propeller shaft, must necessarily be designed to operate at a speed that is too low for the economical use of steam, and even then cannot be conveniently designed for a speed low enough to secure efficient propeller action. Sir Charles Parsons realized this and advocated the use of direct-connected turbines only for high-speed ocean liners requiring a large amount of power, and the "Mauretania" is probably one of the best examples of ships using this method of propulsion. The horsepower of the "Mauretania" is 68,000, the speed about 26 knots, and about 23.5 tons of coal per hour is required. The water rate obtained is about 11.5 or 12 lb. and the coal consumption about 1.5 lb. per shaft horsepower-hour.

Three years ago, when the White Star Line decided to build the "Olympic" and the "Titanic," which were slow-speed ships requiring about 25,000 hp., Mr. Parsons advocated a combination of two reciprocating engines exhausting into a low-pressure turbine, which gave an economy about comparable with the "Mauretania."

The steam engine is an efficient prime mover when operating at the higher temperature ranges; that is, an engine may have as high as 80 per cent. thermodynamic efficiency when operating from boiler pressure to atmosphere, whereas if it was operated down to a 28-in. vacuum, the efficiency would not be greater than 40 or 50 per cent. On the other hand, the turbine works efficiently in the low-pressure end of the cycle, so that by using a reciprocating engine in the upper ranges in combination with a turbine to utilize the turbine in the low-pressure ranges, an over-all efficiency is obtained which may be above that obtainable with either the reciprocating engine or the turbine when working alone. In the "Olympic" all reversing and maneuvering is done with the reciprocating engine, making it possible to build a simple and efficient low-pressure turbine.

With electric transmission, high steam pressure and superheat can be used, and the gain in fuel economy by its use has proved to be very appreciable. A steam temperature of 700 deg. F. is now successfully used in Europe, which, with 500-lb. steam pressure, would give 223 deg. F. superheat. The heat available for work would then be about 36.3 per cent., whereas under ordinary steam conditions with 200 lb. pressure and 50 deg. superheat, you would have only 30.75 per cent. available and a gain of 18 per cent. in fuel, which would more than compensate for any additional weight or cost of the electrical equipment.

Shaft Horsepower on 0.825 Lb. Coal

Turbo-generators are now built with an efficiency of over 80 per cent. which, with motors of 95 per cent. efficiency and a boiler efficiency of 80 per cent. would produce a shaft-horsepower-hour with 0.825 lb. of coal, containing 14,000 B.t.u. per lb. or 0.61 lb. of oil of 19,000 B.t.u. per lb., the latter figure comparing favorably with Diesel engines when lubricating oil is taken into consideration.

Owing to the wonderfully fine performance of the collier "Jupiter," which has now been in service for about four years, the Navy Department decided to install electric propelling machinery in the battleship "New Mexico," which is now nearly completed in the New York Navy Yard, and the apparatus for which has recently passed all Government tests at the Schenectady works of the General Electric Co. The Navy Department has also decided to install electric propelling machinery in six other new battleships, requiring about 33,000 hp. each and in five large battle cruisers requiring 180,000 hp. each.

The third instance of electric propulsion is the battleship "New Mexico." This installation provides conditions where the advantages of electric propulsion can be realized. The "New Mexico" is the largest and most powerful battleship that has been laid down by our Navy up to the present. She will have a displacement of 32,000 tons and a designed speed of 21 knots, requiring about 28,000 hp. The propelling machinery is, however, designed to deliver a maximum of 37,000 hp., and it is believed that this will give her a speed of 22 knots.

The equipment will consist of two turbo-generating units, four propelling motors (one for each shaft), switching apparatus, cables, instruments, etc. The contract also calls for two 300-kw. noncondensing direct-current turbo-generators, which will furnish excitation and power to drive the auxiliary machinery. As the General Electric Co. was required to guarantee the steam consumption of the propelling machinery, including that of the auxiliary, the greatest care was taken in their selection, and they are all to be electrically driven. The exhaust steam from the direct-current generating sets, operating noncondensing, will be used for heating the feed water, and steam that may not be required for this purpose will be exhausted into the main turbine. The generators for the "New Mexico" are bipolar alternators, and the motors are arranged to be connected for either 24 or 36 poles. For economic cruising at a speed of 15 knots or less, only one generating unit will be required with the motors on the 36-pole connection. For higher speed the 24 polar motor connection will be used with both generators One generator, however, will be capable of driving the boat up to a speed of about 19 knots.

The steam-consumption guarantees as made to the Government cover the total amount of steam used by both the main generating units and the auxiliaries, and are as follows:

Steam pressure 250 lb. gage at the throttle
10 knots, 14.6 lb. per shaft. horsepower-hour
15 knots, 11.4 lb. per shaft horsepower-hour
19 knots, 11.1 lb. per shaft horsepower-hour
Maximum speed, 11.9 lb. per shaft-horsepower-hour

Very heavy penalties are attached to the guarantees in case they are not met; namely, $25,000 per lb. for the two lower speeds and $20,000 per lb. for the two higher speeds.

To be able to correctly judge the relative economy of different methods of propulsion, it may be interesting to compare the water rate per effective horsepower, taking for example such different methods as the battleships "Florida" and "Utah," which are equipped with Parsons turbines; the "Delaware," which has reciprocating engines; and the "New Mexico" with electric drive:

	Propeller Speed	Water Rate per Effective Horsepower per Hour		
		12 Knots	19 Knots	21 Knots
Florida	328	31.8	24.0	23.0
Utah	323	28.7	20.3	21.0
Delaware	122	22.0	18.7	21.0
New Mexico	175	17.3	15.0	16.4

That electric propulsion can be profitably applied to a small boat is proved by Mr. Ljungstrom, of Sweden, in the case of the small coastwise steamer "Mjolner," which is only 225 ft. long, 56 ft. beam and 15 ft. draft, requiring 900 hp. Two sister ships were built, namely, the "Miner" and the "Mjolner." The former was equipped with triple-expansion engines and Mr. Ljungstrom guaranteed a saving of 30 per. cent. in fuel in his method of electric propulsion in the "Mjolner" over the "Miner," equipped with engines. The boats have now been built and tested and the electrically driven boat showed a saving of 42.3 per cent in fuel consumption. This is indeed a remarkable record, but might be partly explained by the increase in efficiency of the boiler plant. For this electric drive Ljungstrom uses 218 lb. steam pressure and 235 deg. superheat, and this alone would effect a saving in coal over the "Miner" of about 15 per cent.

Emergency War Training

Emergency War Training for Gas-Engine, Motor-Car and Motor-Cycle Repairmen, is the title of Bulletin No. 10, recently issued by the Federal Board for Vocational Education, Washington, D. C. This bulletin contains 78 pages and gives an outline and suggestions for courses designed to train men to repair motor-trucks, motor-cars, motorcycles and airplane motors. As pointed out in the foreword:

> There is a critical and constantly growing need for many thousands of mechanics and technicians for army occupations carried on in and behind the lines of the United States Army. Many of these workers, already experienced in similar occupations of civil life, will be secured through the draft, and possibly through voluntary enlistment. It is recognized by those in a position to know, that the quota thus gained will not be sufficient and that it will be necessary to train many thousands of men in various ways for various occupations. The War Department has taken definite steps to provide for this training systematically through army schools, in some instances at cantonments, but largely at the industrial, trade and engineering schools of the country.
>
> For some months the Federal Board has been making intensive investigations and studies of the demands of these army occupations. A series of bulletins for the guidance of those giving this training has resulted from these studies. The courses and methods suggested in these bulletins have been carefully checked by experienced army officers and represent the consensus of opinion as to what training should be given and how it should be given.

Bulletins thus far published are: No. 1, Statement of Policies; No. 2, Training Conscripted and Enlisted Men for Service as Radio and Buzzer Operators in the United States Army (International Code); No. 3, Emergency Training in Shipbuilding—Evening and Part-Time Classes for Shipyard Workers; No. 4, Mechanical and Technical Training for Conscripted and Enlisted Men (Air Division, United States Signal Corps); No. 5, Vocational Rehabilitation of Disabled Soldiers and Sailors (also printed as S. Doc. No. 166); No. 6, Training of Teachers for Occupational Therapy for the Rehabilitation of Disabled Soldiers and Sailors (also printed as S. Doc. No. 167); No. 7, Emergency War Training for Motor-Truck Drivers and Chauffeurs; No. 8, Emergency War Training for Machine-Shop Occupations, Blacksmithing, Sheet-Metal Working and Pipe Fitting; No. 9, Emergency War Training for Electricians, Telephone Repairmen, Linemen and Cable Splicers; No. 10, Emergency War Training for Gas-Engine, Motor-Car and Motor-Cycle Repairmen; No. 11, Emergency War Training for Oxyacetylene Welders; No. 12, Emergency War Training for Airplane Mechanics—Engine Repairmen, Woodworkers, Riggers and Sheet-Metal Workers; No. 13 (Agr. Ser., No. 1) Agricultural Education—Organization and Administration.

Persons desiring to secure copies of any or all of these bulletins can readily do so by applying to the Federal Board for Vocational Education, Ouray Building, 805 G Street, N. W., Washington, D. C.

Consolidation of Power Companies Proposed

There is on foot a proposition to consolidate the hydroelectric power companies at Niagara Falls. This is at the request of and in coöperation with the War Department as a necessary war measure to provide sufficient electrical energy for war industries in and about the City of Buffalo.

The companies to be consolidated are the Niagara Falls Power Co., the Hydraulic Power Co. and the Cliff Electric Distributing Co. If carried out, this consolidation will call for an expenditure of about $15,000,000 for the construction of an additional plant and equipment, whereby it is hoped to increase the output by 170,000 hp. above the amount now being generated by the independent operation of these companies.

Engineers are also occupied with the proposed power coördination plans of Dr. Garfield, and they, representing the utility interests throughout the United States, are working out rates for transmission line for tying in and estimating of costs.

Fuel and water-power experts are considering linking up the Lehigh Coal and Navigation plants at Lansford and Hauto with the Philadelphia Electric Co. in supplying power to Hog Island, League Island, Eddystone, Westinghouse, Bethlehem, Midvale and all other large industrial establishments.

Moreover, there is a possibility that three or more power plants of 100,000 hp. will be erected at other points in the anthracite region to supply energy to other industrial establishments throughout Pennsylvania so as to link up a chain of such units which would afford a better supply for munition work.

It is also understood that plans are contemplated for linking up power-generating plants from New England to the District of Columbia in units that will be able to supply transmission facilities with a view to affording relief when difficulties may incapacitate the service at any section. This would prevent the crippling of power and lighting circuits which might occur due to one cause or another.

Modifications of Coal Prices

Owing to a reclassification of the coal fields in several districts in West Virginia, in part of Kentucky, and in the coal-mining districts of Missouri, Kansas and Virginia, the selling prices of some coals are slightly changed. The new prices, which are now effective, are as follows:

State	Run-of-Mine	Prepared Sizes	Slack or Screenings
West Virginia:			
No. 10 district: Coal and coke and Gauley districts; Taylor, Barbour, Lewis, Buckhannon, Randolph, Gilmer, Braxton, Webster, and Greenbrier Counties; operations in Nicholas County east of the mouth of the Meadow Branch of the Gauley River and coal and coke district in Kanawha and Clay Counties north of Charleston	$2.30	$2.55	$2.05
Fairmont district: Monongalia, Marion and Harrison Counties	2.15	2.40	1.90
Thacker district: Operations in McDowell County west of Panther on the Norfolk & Western and in Mingo County west along the Tug Fork of the Big Sandy River to Williamson on the Norfolk & Western	2.30	2.55	2.05
New River district: Fayette County south of Hawk's Nest on the Chesapeake & Ohio and Fayette and Raleigh Counties south of Paintsville on the Virginian Railroad and Wyoming County north of Herndon on the Virginian Railroad	2.35	2.60	2.10
Logan district: Logan County and operations in Boone County south of Danville on the Chesapeake & Ohio and Lincoln County south of Gill on the Chesapeake & Ohio	2.15	2.40	1.90
Putnam County	2.50	2.75	2.25
Kenova district: Operations on the watershed of the Tug Fork of the Big Sandy River west of Williamson on the Norfolk & Western, and Wayne County	2.30	2.55	2.05
Kanawha district: Nicholas County west of the mouth of the Meadow Branch of the Gauley River, Fayette County west of Hawk's Nest on the Chesapeake & Ohio, and north of Paintsville on the Virginian Railroad, and operations in Raleigh and Boone Counties on the watershed of the Clear Fork Pranch of Coal River, Boone County, north of Danville on the Chesapeake & Ohio, Kanawha County south of Charleston, and Lincoln County north of Gill on the Chesapeake & Ohio	2.25	2.50	2.00
Kentucky:			
Thacker district: Operations in Pike County on the watershed of the Tug Fork of the Big Sandy River east of Williamson on the Norfolk & Western Railroad	2.30	2.55	2.05
Kenova district: Operations in Pike County and Martin County on the watershed of the Tug Fork of the Big Sandy River west of Williamson on the Norfolk & Western Railroad	2.30	2.55	2.05
Missouri:			
District No. 1: Audrain, Bates, Calloway, Henry, Johnson, Monroe, Randolph, Ralls, St. Clair, Schuyler, Vernon and Montgomery Counties, Adair County, except operations of the Star Coal Co., and Macon County, east of New Cambria and mining operations not covered by other rulings	2.70	2.95	2.45
District No. 2: Boone, Clay, Cooper, Chariton, Carroll, Dade, Harrison, Linn, Lafayette, Putnam, Ray, and Sullivan Counties and Macon County west of New Cambria and the long-wall thin-seam mines in Randolph County	3.15	3.40	2.45
Grundy County: Operations of the Star Coal Co., in Adair County and shaft workings in the Lightning Creek or upper thin vein in Barton, Bates, and Vernon Counties	3.65	3.95	2.45
Platte County	3.40	3.65	2.45
Kansas:			
Cherokee and Crawford Counties, except shaft mines in Lightning Creek or upper thin vein and any mining operations in the State not covered by other rulings	2.70	2.95	2.45
Shaft workings in the Lightning Creek or upper thin vein, in Cherokee and Crawford Counties	3.65	3.95	2.45
Osage, Franklin and Linn Counties	3.50	4.50	2.80
Leavenworth County	3.40	3.65	2.90
Virginia:			
Mines operated near St. Charles, Lee County, by the Darby Coal Mining Co.; Black Mountain Mining Co.; Virginia Lee Co.; Old Virginia Coal Co.; United Collieries Co.; Benedict Coal Corporation; and the Imperial Mine of the Virginia Iron, Coal and Coke Co., Roanoke, Va.	2.65	2.90	2.40

These prices do not include the allowance to operators of 45c. a ton who have complied with the wage increase agreement.

The Fuel Administration has also issued a ruling on the prices of coal from wagon mines, which are mines that are not located on railway lines, so that the coal must be transported from the mine mouth to the railroad in wagons.

Operators of wagon mines will not be allowed to add the cost of hauling to the Government price when the coal is loaded into open-top cars, except when such coal is bought by a railroad for its own use.

This decision of the United States Fuel Administration affirms the rulings promulgated by it Oct. 6, 1917, under which operators of wagon mines are permitted to make a charge of not more than 75c. in addition to the Government price when delivering direct to the consumer or when loading into box cars.

Representatives of the wagon-mine operators sought to induce the Fuel Administration to make a similar allowance for loading into open-top cars. They based their request upon the claim that congestion of the railroads has been relieved sufficiently to justify the use of open-top cars by wagon mines, and that the cost of hauling was the same whether the coal was loaded into box cars or open-top cars.

Investigation of the situation, however, has satisfied officials of the Fuel Administration that the demand for open-top cars by mines that can load only into that kind of cars still exceeds the supply. Under the circumstances, therefore, it was decided that production would be stimulated best by restricting the allowance for hauling to those wagon mines loading into box cars.

Ammonia Oil Separator Explodes

About 10 o'clock Saturday morning, Apr. 27, a high-pressure ammonia oil separator in the Chicago Cold Storage Co.'s plant at Sixteenth and South State Sts. exploded, injuring ten men. The separator was located between the compressor and the condenser on the roof, on a railroad loading platform adjoining the building. The men working in its vicinity at the time of the explosion were injured, most of them being overcome by the escaping ammonia fumes. It is believed that none of the injuries will prove fatal.

In the plant there are three 175-ton vertical compressors, each with two single-acting cylinders. Each compressor is protected by a safety valve set to blow at 250-lb. gage pressure. Depending upon the load and other operating conditions, the condenser pressure varied from 145 to 180 lb. At the time of the explosion the plant log showed it to be 175 lb. gage, and the suction pressure 2 lb. gage. The suction line to the compressor was 5 in. diameter, which is small for pressures as low as 2 lb. gage. It is quite probable that the vapor came back to the machine superheated, and, in being compressed to 175 lb., the temperature would be abnormally high.

The separator was cast of ferro-iron to a diameter of 16 in. and a length of 42 in. The bottom was convex, while the top head was flanged and fastened to the body by sixteen 1⅛-in. bolts. While no blowholes or flaws in the casting could be detected, it was noticed that the cylinder walls were of uneven construction, the thinnest part of the metal being an inch thick. Assuming 30,000-lb. tensile strength for the ferro-iron, the 16-in. cylinder would carry a safe working pressure of 375 lb. per sq.in., based on a factor of safety of ten instead of the eight generally assumed. It is evident that the separator was fully protected by the safety valve and that temperature rather than pressure was the initial cause of the accident.

Thomas Andresen, cooling-plant inspector for the city, investigated the explosion and advances the following theory as to the cause of the accident: The machines were operated with a low suction and a high condenser pressure. Through a leaky stuffing-box sufficient air may have found its way into the cylinder and, in combining with the evaporated hydrocarbon gas from the lubricating oil, formed a dangerous and explosive mixture which was ignited by the unusually high temperature induced by the superheated state of the incoming vapor and the high condenser pressure. No machine or system was ever built to withstand the instantaneous pressure of a hydrocarbon explosion, and as a matter of course the weakest part gave way first. In this case it was the oil separator.

In an explosion of this kind safety valves are of no avail. The cause of the accident must be laid to the unfortunate conditions that build up while the compressor is apparently operating under normal conditions. Similar explosions have occurred frequently when systems that have been in operation are being tested under air pressure. To avoid these possible air explosions, as they are termed, the new rules issued by the City of Chicago prescribe that when testing any existing plant with air, the pressure must not exceed 100 pounds.

Courses for Training Mechanics and Technicians for the Army

Last February the Secretary of War appointed the Committee on Education and Special Training, charging it with the responsibility of training 90,000 men of the National Army for various technical and skilled work. The army is in need, for example, of motor-truck drivers, airplane mechanics, carpenters and blacksmiths. The selective draft methods proving inadequate to supply this demand, the committee was formed to arrange for intensive training.

Educational plants equipped for handling large numbers of students were obviously the machinery that should be adapted to this work. So rapidly has the committee proceeded that 25 schools are now under contract to take the men, 14 schools have begun their work and 7500 National Army men are under instruction. The number of schools will be increased until 30,000 men can be handled at one time. The courses are of eight weeks' duration and the final lot of 30,000 men (for army needs as planned at the minute) will go to the schools Sept. 1.

In arranging for the work institutions were preferred that could accommodate at least 500 men. The institutions include engineering colleges, universities, and mechanics' institutes, while in one city the public-school system is being used. The number of different courses given at an institution depends on various conditions—the number of students, the character of school equipment, location, etc. One school, the University of Virginia, will specialize on the training of motor-truck drivers and will take 600 men at a time. For the truck-driving courses such automobile equipment will be used as is available, and the Government, in addition, will furnish one army truck for each 20 men.

Army officers will be located at each school, and military drill will be carried along simultaneously with the technical instruction. The technical staff will be supplied by the institutions and, with the army officers, will form a board to direct the administration.

The Curricula used are those outlined for intensive training by the Federal Board for Vocational Education, though the staff at each school is given much latitude in the presentation of the essential matter. At some schools coöperation with the local industries is being arranged, as, for example, in the instruction on rubber vulcanizing at Akron, Ohio. At present the following courses are arranged for: Auto driving and repair, bench woodwork, general carpentry, electrical communication (telephone and telegraph work), electrical work, forging and blacksmithing, gas engines, machine shop, sheet metal.

While the men at the schools are National Army men and come through the draft boards, they volunteer for this special training. The Provost-Marshal-General sends out a call to the boards for men with experience fitting them for the lines in which the training is to be given, and are asked to certify volunteers from their rolls. In other words, the men go to the schools directly from their homes and are not drawn from the cantonments. As a result of this volunteer system a very good grade of men has been secured.

The men are required, in addition to their experience, to have had a common school education—though this is not a hard-and-fast rule. Aptitude and ability to learn are the chief requirements.

In the courses themselves the aim will be to push men along as fast as their abilities warrant. Journeymen machinists, for example, will immediately be put on highly specialized work, such as airplane repairs.

All men are ranked as enlisted privates and are paid accordingly, and, of course, are outfitted by the Government. The schools, as a rule, contract for the housing, feeding and instruction in a lump sum per man, per day, but in some cases the housing and feeding will be done by other parties. In arranging for accommodations the Quartermaster's Department has been of invaluable assistance, furnishing cots and other equipment to institutions having the buildings, but lacking the necessary dormitories and dining-room equipment. All sorts of expedients have been used in places where building space was lacking except for the actual instruction. Armories have been converted, and in several cases fair grounds have been used.

To facilitate the work the country has been divided into ten districts, the institutions in each coming, as to the technical instruction, under the direct supervision of a district director. These in turn are under the direction of the general educational director, C. R. Dooley, formerly of Pittsburgh. The committee itself consists of three army officers, Lieut.-Col. J. H. Wigmore, Lieut.-Col. R. I. Rees and Major Grenville Clark. Assisting them is an advisory board consisting of Hugh Frayne, representing labor, and the following representatives of educational interests; J. R. Angell, the colleges; S. P. Capen, Federal bureau of education; J. W. Dietz, corporation schools; C. R. Mann, schools of pure science; Dean Herman Schneider, engineering schools.

Chicago Engineers Hold Joint Meeting

On Apr. 23, C. F. Kittering, president of the Society of Automotive Engineers, gave a most interesting address on "The Automobile Power Plant." The occasion was the first joint meeting of the Chicago Section of the American Society of Mechanical Engineers with the American Institute of Electrical Engineers and the Western Society of Engineers, and the place was the rooms, in the Monadnock Block, of the society last named. The attendance approximated 250. The interest in the subject and the great success of the meeting generally mean that there will be more of them and that active sectional coöperation is in sight.

A. D. Bailey, president of the Chicago Section of the American Society of Mechanical Engineers, presided. In his talk, Mr. Kittering explained very simply the construction and working of the internal-combustion engine, his remarks applying primarily to the four-cycle type. He discussed carburetion, gas feeding, ignition, and gave an elementary conception of fuels and their action in burning. Best of all, he refuted the pessimistic press reports of the airplane situation and reacclaimed the Liberty motor as a wonderful engine, maintaining that in lightness, economy and simplicity it has no superior in Europe. An important outstanding feature was a single design for many services as compared to at least thirty different makes in France or in England. The advantage in supplying repair parts is self-evident. Dimensions of cylinders and parts are standard throughout. To increase the power is merely a question of adding more cylinders. The speaker gave a clear idea of the conditions in service, distinguished between the different types of airplane, and at the end was flooded with a variety of questions pertinent to the subject under discussion.

Ninth Annual Dinner of the Boston Engineers

The Engineers of Boston held their ninth annual dinner at the Boston Club on the evening of Apr. 30 under the auspices of the Boston Society of Civil Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Mayor A. J. Peters was present and made a short address. William H. Blood, Jr., of the American International Shipbuilding Corp., gave a description, illustrated by lantern slides and moving pictures, of the Hog Island shipyards. Arthur D. Flinn, secretary of Engineering Council, told of the organization of the council, its purposes and processes. Maj.-Gen. E. F. Hodges spoke briefly, and A. M. Westendorf showed films of a 22-ft. motor boat which could be maneuvered, reversed and steered both backward and forward by a simple manipulation of the rudder, without altering the direction or speed of the engine. Prof. Charles M. Spofford was chairman of the committee, and James W. Rollins toastmaster.

Interior Surface Defects as Cause of Condenser-Tube Corrosion*

By W. Reuben Webster

It is the belief of some engineers that defects on the interior surfaces of brass condenser tubes act to accelerate corrosion and that accordingly their presence even to a small degree should not be tolerated. Extended observation has failed to furnish a basis for such a belief. Many observations have developed the fact that the variety of corrosion that exhibits itself in local pitting resulting in perforation takes place independently of any interior defects that may exist. No tendency of the pitting to localize on or penetrate the tube at a surface defect has been observed.

It is a common experience to find clauses in specifications that have been adopted by the writer thereof because the requirements which they demand appear to be reasonable but which have, as a matter of fact, no basis either in theory or experience.

Certain users of brass condenser tubes have been impressed with the belief that interior surface defects operate to produce corrosion which exhibits itself in the formation of local pitting, terminating in perforation. The writer at one time held this belief and took occasion to make a careful examination of every case of corrosion of this character which came under his notice, with a view to observing whether there was any evidence in support of it. No case, however, has ever been found by him which would support any such view. It has not been found possible to show that tubes that contained such interior surface defects were any more subject to corrosion than those that were free from them.

It has further been observed that there is no tendency whatever for areas of corrosion to localize in the vicinity of such defects. Moreover, many cases have been found in which severe pitting had occurred in the vicinity of such defects, but no tendency of the corroded areas to follow along the lines of defect has been noticed.

A recent case of severe corrosion was observed which furnishes strong evidence that no such connection exists. The tubes had been in service in the condenser of a large stationary plant for a period of six months, and were removed because of perforations caused by local corrosion on their interior surfaces. Of a lot of eleven tubes, eight were found to be free from surface defects in the vicinity of the corroded areas, while three samples were found to contain such defects. These tubes were sawed longitudinally and opened out flat so as to show the interior surfaces. Three characteristic samples from the unblemished tubes were photographed for comparison with three containing surface defects.

Particular attention is called to the fact that even where a corroded area crosses a defect, no tendency whatever for corrosion to follow the defect is observable. In most of the samples the corroded area was confined to a distance not over four inches from the inlet end of the tube; the remainder of the tube being as free therefrom as when first made. In one or two cases the corroded area was similarly confined to a short distance in the length of the tube, but was some distance from its end.

The effect that temperature has upon corrosion was well shown by the fact that the corroded area in most cases stops quite abruptly on reaching that portion of the tube in contact with the tube sheet. There would be a considerable difference in temperature between the portion of the tube in contact with the tube sheet and that in contact with the steam.

It is not intended that the evidence herewith presented should be considered as arguing in favor of the presence of defects of this character. It is, however, a fact that evidence of their existence can be largely removed by treatment that detracts from the resistance of the tube to corrosion, while on the other hand they are rendered more highly visible by treatment that tends materially to increase this resistance.

As a consequence, tubes treated in a manner tending to decrease their serviceability will frequently be accepted under specifications containing restrictions of the character in question, but would be rejected when made in accordance with methods calculated to give them the maximum endurance.

It, therefore, follows that a rigidly interpreted clause of this nature may operate to weaken rather than strengthen the specifications of which it is a part.

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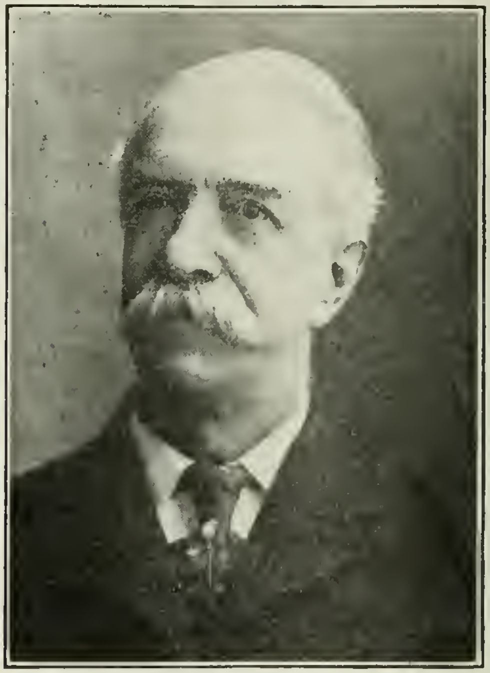
*From a paper before the American Society for Testing Materials.

Charles Jenkins

Charles Jenkins died May 1, 1918, at his summer home at Winthrop Heights, Mass. He was born in Boston in 1852, the son of Nathaniel Jenkins, the inventor of the well-known Jenkins valve. After the death of their father in 1872, the brothers, Alfred and Charles, formed a partnership under the name Jenkins Brothers, to continue the business of their father. Charles remained a member of the firm until 1896, when he sold his interest to his brother and retired to devote his time to his real-estate interests in Boston, residing at 847 Beacon Street.



CHARLES JENKINS

Submarine Engineer Officers Wanted

The Navy is in need of professional engineers for submarine duty, not over 35 years old and physically strong. The qualifications include citizenship in the United States, the degree of mechanical, electrical or mining engineer from a university of recognized technical standing and at least two and one-half years' practical engineering experience. The candidates selected will be commissioned Ensign in the U. S. Naval Reserve Force, and will be sent to the Naval Academy and to the Submarine School in New London for a special technical course.

Engineers subject to the Selective Draft Law and those now in the Army are eligible. Letters from at least three responsible personal acquaintances must accompany each application. Address the American Engineering Service of the Engineering Council, Room 903, 29 West 39th St., New York City. Early responses are requested.

A book will tell you how to open or close a throttle, but that operation is not all there is to starting and stopping an engine. You can get information from books, but never skill.—*Marine Engineering.*

Personals

C. A. Binz, formerly manager of the meter department of Yarnall-Waring Co., is now sales manager of the company.

Albert Tate Smith has returned to The Permutit Co., with which he was formerly connected, to take the position of assistant manager of sales.

Thomas C. Green, of the Garlock Packing Co., Pittsburgh branch, has recently been appointed secretary of the National Exhibitors' Association connected with the N. A. S. E. in place of J. William Peterson, of the Richardson-Phenix Co., resigned.

Laura G. Edwards, who was connected with the advertising department of the National Tube Co. in Pittsburgh and Kewanee for over 12 years, resigned to enter upon a broader opportunity in the publicity department of the A. M. Byers Co. on Apr. 1.

F. W. Fischer has resigned as chief engineer of the Standard Knitting Co., of Knoxville, Tenn., to accept a position with the Air Nitrates Corporation. After a few weeks spent in studying the processes at Niagara and elsewhere, he will assist in the installation of the U. S. Nitrate Plant No. 2 at Muscle Shoals, Ala.

Prof. F. H. Newell, head of the Department of Civil Engineering at the University of Illinois and organizer and director of the United States Reclamation Service, has been awarded the Cullom Geographical Medal by the Geographical Society of New York. Professor Newell is a prominent member of the American Society of Mechanical Engineers and of the American Association of Engineers.

Engineering Affairs

Perth Amboy No. 13, N. A. S. E., will hold its 27th annual state convention, June 1-2. Exhibits will open on May 31.

The Southeastern Section of the National Electric Light Association will hold its annual meeting at Atlanta, Ga., June 19-20.

The American Institute of Chemical Engineers will hold its summer meeting at Berlin, N. H., June 19-22, with headquarters at Mt. Madison House, Gorham.

The New Haven Section of the A. S. M. E. will hold a meeting on May 10. There will be papers and informal talks by engineers of local companies on "Munitions Manufacture."

The Power Section of the Providence Engineering Society will hold a meeting on the evening of May 8, 1918, at which L. B. McMillan, of New York, will give a talk on "Thermal Insulation."

The New Orleans (La.) Section of the A. S. M. E. will hold a joint meeting with the Louisiana Engineering Society on May 13. Dr. Winship will present a paper on "Power Plants of the Oil Tankers Being Built at New Orleans"

The American Order of Steam Engineers will hold its 32nd annual convention at the Parkway Building, Broad and Cherry Sts., Philadelphia, June 10-12. Owing to general existing conditions, there will be no exhibit held in connection with the convention this year.

The National Electric Light Association will hold its regular annual meeting this year in Atlantic City, N. J., with the Hotel Traymore as headquarters, June 13 and 14. The sessions will be devoted entirely to a consideration of vital war problems as related to the industry. In view of the fact that practically all member companies are short-handed and their officers have their time taken up not only with general problems of the industry, but also with local problems and difficulties that come upon them as patriotic citizens, it is believed that the attendance will inevitably be much smaller and more restricted than would occur in normal times and under the usual conditions, all other subjects, however important, being swallowed up for the time being in the fundamentally vital and essential one of winning the war.

The National Gas Engine Association will hold its eleventh annual meeting at the Sherman Hotel, Chicago, June 3-4. The subjects to be discussed on Monday are as follows: "The Iron and Steel Situation"; "Government Requirements on Gas Engines and the Method of Handling Those Matters at Washington"; "The Labor Situation"; "The Fuel Problem," which will be handled by a representative of the Federal Fuel Administration. On Tuesday forenoon the following paper will be read: "What Is the Future of the Farm Gas-Engine Business"; "Sizes of Manufacture from the Manufacturing and Sales Standpoint"; "The Present Condition and Future of the Gas-Engine Export Trade." On Tuesday afternoon there will be a technical session in connection with the Mid-West Section of the Society of Automotive Engineers, at which several papers of a technical nature will be presented and discussed.

The American Institute of Electrical Engineers will hold its 34tn annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 26-28, 1918. Six technical sessions are contemplated. The convention will open at 10:30 a. m. on Wednesday June 26, with President E. W. Rice, Jr.'s, address. This will be followed by the technical committee reports. The following papers will be presented Wednesday, 2:30 p. m.: "Split-Conductor Cables—Balanced Protection," by William H. Cole; "Overhead Transmission Cables," by E. B. Meyer; "The Application of Theory and Practice to the Design of Transmission Line Insulators," by G. I. Gilchrist. Thursday, 10:30 a. m.: "Lightning-Arrester Spark Gaps," by C. T. Allcutt; "The Oxide-Film Lightning Arrester," by C. P. Steinmetz: "Design of Transpositions for Parallel Telephone and Power Circuits," by H. S. Osborne. Thursday, 2:30 p. m.: Members and section delegates conference. Thursday, 8.30 p. m.: "Fixation of Nitrogen," by E. Kilburn Scott; "America's Power Supply," by C. P. Steinmetz. Friday, 10:30 a. m.: "Precharged Condensers," by V. Karapetoff; "Method of Symmetrical Coördinates Applied for the Solution of Polyphase Networks," by C. L. Fortescue: "Flux Distribution in Alternators Under Sustained Short-Circuit Conditions and Different Loads," by N. S. Diamant. Friday. 2:30 p. m.: "Protection from Flashing in D. C. Apparatus," by J. J. Linehaugh and J. L. Burnham; "The Automatic Hydro-Electric Plant," by J. M. Drabelle and L. B. Barnett.

Miscellaneous News

The New Transmission Line from Windsor, Vt., to Claremont, N. H., has been completed and is now in operation. Some economics in operation and better service should be effected through this new line.

Excavation Work for the new 10,000-kw. turbine to be installed at the Dock Street plant, Easton, Penn., has been started. Provided no unusual difficulties are met with, this turbine should be in operation by Aug. 1, next.

A Boiler Exploded at a grist mill on White Oak Creek, in Estill Co., Ky., on Apr. 5, instantly killing two men and injuring half a dozen, one of whom died later from injuries and another lay at the point of death at the time this report was received. The mill was blown some distance from its foundation, and every one in it was more or less seriously injured.

The Eighth Edison Medal has been awarded by the Edison Medal Committee of the American Institute of Electrical Engineers to Col. John Joseph Carty for his work in the science and art of telephone engineering. The medal will be presented to Colonel Carty at the annual meeting of the Institute to be held in the Auditorium of the Engineering Societies Building, Friday, May 17, 1918, at 8:30 p. m. President E. W. Rice, Jr., will preside and the program will be: Address by A. E. Kennelly, outlining the origin and purpose of the Edison Medal; address by Michael I. Pupin, giving history of Colonel Carty's work in regard to telephone engineering; presentation of medal by President Rice; acceptance of the medal by Colonel Carty.

The Output of Bituminous Coal increased 366,000 net tons, or 3.4 per cent. during the week ended Apr. 27, compared with the week previous. We are not, however, getting out the large production that we should, in order to provide for the excessive demand of the coming winter. A part of the falling off is due to lack of cars, many of which have been diverted to meet the demand of the army on account of the drive on the West front. Some of the mines which could get cars are actually idle for lack of orders. It is not known to what extent cars are being added to the railroad equipment. The way that the consumer can help most is to get in orders for all that he is going to need next winter as early as possible, and to take and store all that he can, but not, of course, in excess of his probable requirements.

NEW CONSTRUCTION

Proposed Work

Mass., Newburyport—The Newburyport Gas and Electric Co., 49 Pleasant St., plans to build an addition to its new electric plant on the former Fiberloid wharf. C. Spaulding, Supt.

Mass., Westfield—City plans to appropriate $42,000 to purchase equipment for its light department to enable it to utilize power from the Turners Falls plant.

N. Y., Geddes—The Syracuse Lighting Co., plan to build a brick electric plant. B. H. Shepard, 514 City Bank Bldg., Syracuse, Pres.

N. Y., Groton—The Groton Electric Co., is having plans prepared for the erection of an electric power plant. F. J. McGee, 622 East 113th St., New York City, Pres. Noted Oct. 7.

N. Y., Marshall—The Waterville Gas and Electric Co. plan to build an electric plant B. H. Shepard, 514 City Bank Bldg., Syracuse, Pres.

N. Y., Mohawk—State is having plans prepared by F. M. Williams, Engr., Capitol, Albany, for the erection of a hydraulic power plant on the State Barge Canal here.

N. Y., New York—The Bellevue and Allied Hospitals plan to build a new power plant at the foot of East 26th St.

N. J., Camden—Kind & Lantesmann, 5th St., has had plans prepared for the erection of a new boiler plant.

N. J., Jersey City—Swift & Co., 154 9th St., plan to build a 2-story addition to its engine and power plant on Henderson St. Estimated cost, $23,700.

N. J., Newark—A. Fink and Son, 810 Frelinghousen Ave., has had plans prepared for the erection of an addition to its engine house in connection with its factory.

N. J., Pompton Lakes—City has voted $46,900 bonds for the erection of an electric power plant on Corning Lake.

N. Y., Brooklyn—The State Hospital Commission, Albany, will receive bids until May 22, for installing underground connections and building an addition to its boiler house. E. S. Elwood, Secy.

Penn., Germantown—City plans to build an electric lighting plant on Duval and McCallum St.

Penn., McKeesport—The Atlantic Refining Co., 6th Ave., Pittsburgh, plan to build a service station on Walnut St. and 8th Ave. Estimated cost, $15,000.

Penn., Steelton—The Bethlehem Steel Co. plan to install four 250 hp boilers each, in its new addition now under construction.

Va., Richmond—Hackley Morrison, Moore Bldg., 16 North 9th St., is in the market for a 75 kw., 125 volt, direct current generator directly connected to a generator.

Ga., Commerce—City voted to issue $15,000 for the erection of electric lighting plant. C. A. Goodin, Clerk and Treas. Noted Apr. 16.

Ga., Jefferson—City issued $15,000 bonds for an electric lighting plant and water works system. Noted Feb. 19.

Fla., Oldsmar—The Oldsmar Electric and Ice Co., recently incorporated, plan to install an electric lighting plant and ice factory. J. Bornstein, Pres.

S. C., Branchville—P. Ott is in the market for equipment for an electric lighting plant.

Miss., Purvis—City retained N. A. Kramer, Engr., Magnolia, to prepare plans for the installation of an electric lighting system here.

La., Monroe—The Standard Gin Co., recently organized with $60,000 capital stock, is in the market for power plant, and cotton gin equipment. J. P. Parker, S. Schienker and J. T. Austin, incorporators.

La., Powhattan—The Yarborough Co plans to purchase Scotch boilers and other power plant equipment.

Ohio, Columbus—The Columbus Anvil and Gorging Co. plan to build a new power plant in connection with its factory on West Frankfort St. T. N. Long, Mgr.

Ohio, Lowellville—The Sharon Steel Hoop Co. is in the market for a 15-ton electric crane for its finishing mills here.

Ohio, Mansfield—The City School District will receive bids until May 15, for the construction of a heating and ventilating system in the Brinkerhoof School on Marion Ave. J. H. Bristor, Clerk.

Ohio, St. Paris—City voted $5500 bonds for improvements to its electric lighting plant.

Ind., Indianapolis—The Ross Power Equipment Co., Merchants Bank Bldg., is in the market for a 250 kv.-a., 240/440 volt, 60 cycle, 3 phase engine type generating unit for 125-150 lb. steam, 3-5 lb. back pressure, one 400 kv.-a. generating unit, same as above, one 150 kw., 250 volt compound generating unit directly connected and one 250 and one 500 kw., either simple or tandem, compound engines.

Ill., Pecatonica—City plans to install an electrically operated pump at its pumping station after July 1.

Wis., Eau Claire—The Standard Oil Co. of Indiana, plans to build a complete service and distributing group here. Estimated cost, $30,000. W. W. Holcomb, La Crosse, Dist. Mgr. R. M. Adams, 72 West Adams St., Chicago, Archt.

Wis., Menasha—City is considering the installation of an additional engine in its electric lighting and water works plant.

Wis., Winneconne—The Winnebago Electric Co., recently incorporated, plans to establish an electric lighting plant here. R. W. Button, interested.

Iowa, Eldora—Hardin Co. receives bids about June 11 for brick boiler house, smoke stack, etc. About $15,000. C. Boylan, Co. Aud

Iowa, Red Oak—The Red Oak Electric Co. has applied to the Board of County Supervisors for a franchise to build and operate an electric transmission line on certain roads in Pleasant Township.

Minn., Virginia—City plans to build heating plant.

Kan., Brookville—City voted to issue bonds for the erection of an electric distribution system.

Neb., Lynch—City voted $7800 bonds for the installation of an electric lighting plant.

Ark., Little Rock—The Board of Education will soon award the contract for the installation of a heating and lighting system in the grade and junior high school. L. Thompson and T. Harding, 504 Southern Trust Bldg., Archs.

Tex., Beaumont—The Kansas City Southern R. R. Co., Kansas City, Mo., plans to install electrical equipment to operate the drawbridge over the Neches River here. J. M. Wier, Kansas City, Mo., Ch. Engr.

Okla., Blocker—The Tri State Coal and Coke Co., recently incorporated with $100,000 capital stock, is in the market for mining and power plant equipment.

Okla., Gotebo—City plans to rebuild its electric lighting plant recently destroyed by fire.

Okla., Kiowa—The Kiowa Ice, Light and Water Co., recently incorporated with $50,000 capital stock, plans to install an electric plant and an ice factory. T. L. Sammons and M. T Crane, interested.

Okla., Savannah—The Savannah Lighting and Milling Co., incorporated with $2000, plans to install a lighting plant.

Wash., Ephrata—The Ruff Lighting Co. has petitioned the Commissioners of Grant Co. for authority to build an electric transmission line along the highway in Grant County. S. R. Nelson and C. Reeder, incorporators.

Calif., Los Angeles—F. W. Slinkard, 1437 Wright St., is in the market for 25-30 motors, 440 3 phase vertical centrifugal pump with frame, No. 7.

N. S., Berwick—City plans to build an electric lighting and power plant. Estimated cost, $50,000. H. A. Cornwall, Clerk.

N. S., Halifax—The Nova Scotia Tramways and Power Co. plans to purchase new equipment including electric streets cars, electrical equipment and generating machinery. G. A. Fowler, Lower Water St., Engr.

Que., Makamik—Boisclair Bros. is in the market for sawmill and steam power equipment.

Que., Shawinigan Falls—The Laurentide Power Co. plans to install 3 additional units in its plant. J. E. Aldred, 24 Exchange Pl., New York City, Pres.

Ont., Dunwich Twp.—The Dominion Natural Gas Co., Ltd., Bank of Hamilton Bldg., plans to lay mains and establish a distributing system througnout the township.

Ont., Wallaceburg—The Dominion Glass Co. plans to install a gas producer plant. Estimated cost, $200,000.

Alta., Calgary—City is in the market for a motor generator set.

B. C., North Vancouver—City is considering plans for the erection of a hydro electric plant on the property of the Nairn Falls Power Co.

B. C., Revelstoke—The Lanark Mines Co. plans to build a power plant and dam in connection with its mine and mill here. Estimated cost between $25,000 and $30,000.

CONTRACTS AWARDED

N. H., Plymouth—The Plymouth Electric Light Co. is building a 2-mile electric transmission line from here to Livermore Falls. J. A. Walls, Lexington St. Bldg., Baltimore, Md., Engr.

Mass., Cambridge—The Technology has awarded the contract for the erection of a 1-story, 43 x 190 ft. engine building, to Stone and Webster Engineering Corporation, 147 Milk St., Boston. Estimated cost, $12,000.

N. Y., Binghamton—The Binghamton Light, Heat and Power Co. is building an addition to its electric power plant.

Penn., Philadelphia—The E. F. Benson Co., 926 North Delaware Ave., has awarded the contract for the erection of an engine plant, to W. Steele & Sons Co., 31 South 15th St.

Penn., Pittsburgh—The Heppenstall Forge and Knife Co., 47th and Hatfield St., has awarded the contract for the erection of a new boiler plant to C. Huntsman, Pittsburgh. Estimated cost, $23,000.

Wash., D. C.—The Bureau of Yards and Docks, Navy Dept., Wash., has awarded the contract for the erection of a frequency changer house and a substation, to the Dawson Constr. Co., May Bldg., Pittsburgh, Penn. Estimated cost, $52,520.

Calif., San Pedro—The Seacoast Canning Co., Los Angeles, has awarded the contract for the erection of a cannery and a brick boiler house here, to F. W. Colegrove, 573 7th St. Estimated cost, $23,000.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular May 2, 1918	Individual May 2, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular May 2, 1918	Individual May 2, 1918
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania..	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	May 2, 1918	One Yr. Ago	May 2, 1918	One Year Ago
Pea	$3.45	$2.80	$4.35	$3.70
Barley	2.15	1.50	2.40	1.75
Buckwheat ..	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes...	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes...	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties May 2, 1918	Mt. Olive & Staunton May 2, 1918	Standard May 2, 1918
6-in. lump	$2.65-3.00	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg....	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut.....	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen....	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed..	2.15-2.30	2.15-2.30	2.15-2.30

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba.	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T .fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			⅜-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T .P. S. B.	.81	1.80	....
D. P. D. B.	78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	12	50
Benjamin swivel	.12	100
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$20.00
No. 16 cotton twisted	24.50
No. 18 cotton parallel	21.00
No. 16 cotton parallel	28.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	38.00
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No 18 cotton Canvasite cord	25.00
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$10.50	$12.50	$15.00	$23.50
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	56.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	223.60	....
000	....	....	271.24	....
0000	....	....	332.40	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$13.00	$15.00	$31.09	$13.50	$16.25	$31.25	$13.50	$17.40	$36.30
10	22.15	25.25	50.05	25.00	28.50	56.40	30.30	34.30	67.60
8	31.40	34.85	69.50	34.85	38.85	74.70	42.80	46.85	.....
6	49.40	53.30	.....	59.75	64.25	.....	63.60	74.10	.....
4	71.30	76.15	.....	84.40	84.90	.....	101.75	106.55	.....
2	108.00	113.65	.....	125.50	132.00	.....	151.50	163.00	.....
1	140.40	147.85	.....	163.00	171.15	.....	201.00	209.50	.....
0	176.85	176.85	.....	216.00	225.00	.....	276.00	285.00	.....
00	......	239.45	.....	263.00	273.50	.....	317.00	330.00	.....
000	......	293.15	.....	320.00	331.50	.....	417.00	428.00	.....
0000	......	357.00	.....	388.50	400.50	.....	508.00	516.00	.....

LOOM—Price per 100 ft., in coils:

	Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$66.56	$71.66	$0.1602	$0.1716	$0.059	$0.0632
¾	87.75	94.65	.2108	.2258	.0843	0903
1	129.71	139.91	.3119	.3341	.1096	.1174
1¼	175.49	189.29	.4019	.4289	.1518	.162
1½	209.83	226.33	.5358	.5718	.1875	.2001
2	282.31	304.51	.9823	1.05	.25	.2668
2½	446.36	481.46	1.61	1.71	.3572	.3812
3	583.70	629.60	4.28	4.57	.5358	.5718
3½	729.56	784.76	9.47	10.10	.7144	.7624
4	886.17	951.57	10.93	11.67	.893	.953

From New York Warehouse—Less 5% cash

Standard lengths rigid, 10 ft Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼ in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$65.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

FANS—It is prophesied that there will be a scarcity of electric fans this summer.

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2⅝-in.	75c. per ft.
Common, 2½-in.	33⅓ %

Air

	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.60	$0.35	$0.30

Steam—Discounts from list

First grade.... 25% Second grade.... 30% Third grade.... 40%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	40%	Best grade	15%
Standard	30%		

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	40%
Denver	35%	30%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.60
Duck and rubber for piston packing	1.00
Flax, regular	.90
Flax, waterproofed	1.10
Compressed abestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.90
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	60	2 -in.	.60
3-in.	.45	2½-in.	75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure		5% off
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5¼	6.9	7½	10½
Fiber or sponge	8	6	7.4	7½	15
Transmission	7	6	7.4	7½	13
Axle	4½	4	3.6	3	5
Gear	4½	4½	7.0	7½	6
Car journal	22 (gal.)	3½	4.5	3	6

COTTON WASTE—The following prices are in cents per pound:

	Chicago	New York		Cleveland
		Current	One Year Ago	
Colored mixed	12.00 to 12.50	8.50 to 12.00	10.00 to 12.00	12.50
White	10.00 to 11.00	11.00 to 13.00	13.00 to 15.00	16.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13½	$45.00	13¼ x 20½	$52.00

In Chicago they sell at $30@33 per 1000.

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw per barrel	$1.55*	$1.13	$1.65	$1.13	$1.65	$1.05
5-gal. cans	1.65*	2.23	1.80	1.23	1.75	1.15

* Nominal.

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50	10.50
12½-lb. keg	11.75	11.25	10.75	11.25	10.75	10.75
100-lb. keg	11.25	11.50	11.00	11.50	11.00	11.00
1- to 5-lb. cans	13.25	13.00	12.50	12.50	13.00	12.50

Note—Price change imminent

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	30%	35%	40%*
Tinned	30%	35%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York ..... $6.09½ Cleveland ..... $5.85 Chicago $5.50

Coneheads, same sizes:

New York ..... $6.19½ Cleveland ..... $5.95 Chicago $5.60

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$50.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	....
Magnesite brick, per net ton	135.00 to 145.00	....
Chrome brick, per net ton	....	....
Deadburned magnesite brick, per net ton	85.00 to 90.00	....
Special furnace chrome brick, per net ton	......	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $55.
Birmingham—Fire clay, $35.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	5c.	None
Mexican heavy, 12-14 Baumé	7c.	7 1/10c.

Note—There is practically no fuel oil in Chicago at present time.

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$15.00	$9.50
Cleveland	15.00	7.00
Chicago	15.00	8.25

In coils an advance of 50c. usually is charged
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft	7.40	6.60	6.60	5.80
7 in. by 35 ft	10.70	9.60	9.60	8.55
8 in. by 35 ft	12.20	10.90	10.90	9.65
7 in. by 40 ft	12.35	11.00	11.00	9.75
8 in. by 40 ft	13.75	12.15	12.15	10.65
8 in. by 45 ft	18.20	16.20	16.20	14.30
8 in. by 50 ft	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$ 9.00
12-in. butts, 6-in. tops, length 30-40 ft	11.50
12-in. butts, 6-in. tops, length 41-50 ft	12.50
14-in. butts, 6-in. tops, length 51-60 ft	21.00
14-in. butts, 6-in. tops, length 61-71 ft	23.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
¾ to 3	49%	35½%	¾ to 1½	33%	17%

LAP WELD

Inches	Black	Galvanized	Inches	Black	Galvanized
2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			

BUTT WELD, EXTRA STRONG PLAIN ENDS

Inches	Black	Galvanized	Inches	Black	Galvanized
¾ to 1½	47%	34½%	¾ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

Inches	Black	Galvanized	Inches	Black	Galvanized
2	40%	28½%	2	27%	14%
2¼ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts bold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

	Per Net Ton		Per Net Ton
1 in.	$340	1¾ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

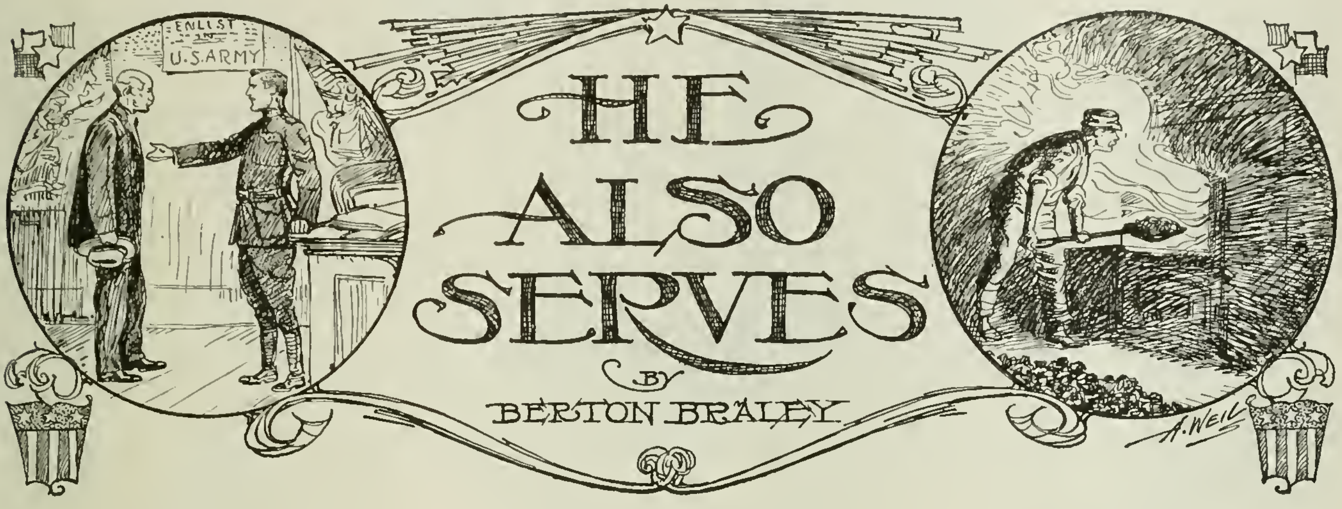
These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

POWER

Vol. 47 NEW YORK, MAY 14, 1918 No. 20

HE ALSO SERVES

BY BERTON BRALEY



Seemed sort of hard, at first, I couldn't go
To fight beside the boys acrost the sea.
I tried, all right, but sergeant he says, "No.
You're over age for soldierin'," says he.
"Look here," says I, "I may be over age,
But see this chest, these muscles, an' these hands—
I ain't too old to earn a fireman's wage,
Why won't I do to fight in furrin' lands?

"The kids is growed," I says, "an' Jim an' John
Is over there; I got a bit laid by,
The wife she wouldn't starve while I was gone,
I'd like to fight with my two boys, an' I
Could do my bit, I know." The sergeant smiles,
"I know you could," he says, "but man alive,
I'd get called down in fifteen diff'runt styles
If I took you—you're over forty-five."

So I goes back to work—not feelin' gay,
An' thinkin', "Hell, it's fierce to be so old!"
But then it sort of comes to me next day
That after all, the guys that are enrolled
As soldiers ain't the only ones that serve,
An' us at home can do our bit, all right.
I guess a man can use his strength an' nerve
To *work* for Uncle Sam, as well as fight.

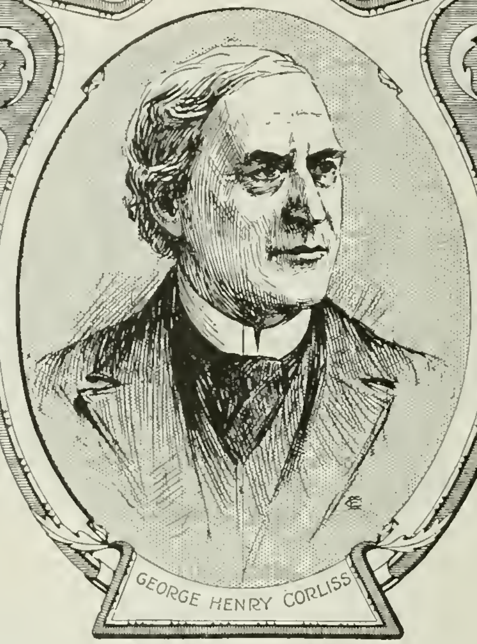
So now I watch my fires an' save my coal
(That's helpin', when you think what fuel means),
An' do my job with all my heart an' soul
Makin' the steam that's drivin' our machines;
For it's machines that's gonta win this war
Cuttin' an' shapin' guns an' other things
That's used to aid our boys who're fightin' for
The old U. S. against them Prussian Kings.

Here in the basement where the boilers hum
I have enlisted till the war is won,
There ain't no music of a fife an' drum
To cheer my spirits while my work is done,
But with my shovel an' my slice-bar, too,
I toil an' sweat an' never make a yelp,
I'm in the service till the game is through,
Too old to fight, but not too old to help!

The "One Hundredth Anniversary" of George Henry Corliss

By H. F. Mueller

CHIEF ENGINEER of WASHBURN-CROSBY MILLS, MINNEAPOLIS, MINN.



GEORGE HENRY CORLISS

GEORGE HENRY CORLISS was born in Easton, N. Y., June 2, 1817. He was the son of a doctor, and although he did not follow the footsteps of his father, trying to make people healthy, he became nevertheless a doctor indeed, a doctor of the engineering profession. He was a man of strong and determined character, who could not only make decisions but carry them out in spite of difficulties and resistance. He was a religious man and always polite and kind and anticipatory in his manners. He lived in a plain cottage near his factory and devoted his spare time to his family. There alone he sought and found recreation and enjoyment. He was very fond of the lawn around his house and took great care of it. "Such a lawn as mine," he would declare boastfully, "cannot be found in the whole United States." Corliss received many honors and appreciations. At every exposition he received the highest awards even if he had no exhibit at all; for instance, at the World's Fair in Vienna, he received the Gold Medal for the reason that most of the engines exhibited were built after the Corliss patents. In 1870 The American Academy of Arts and Sciences awarded Corliss the Rumford Medal.

Since James Watt's time no name has been so often or so intimately connected with the steam engine as the name of Corliss. The work of this great American marked a new step in the development of the steam engine. His improvements revolutionized the steam-engine business and gave his name an everlasting fame.

He died in February, 1888, after a short illness, thirty years ago, but his engine has held its place at the head for nearly three-quarters of a century. Many and various and some fearful and wonderful attempts have been made at various times to produce an engine to supersede it, but so far with little success, and through all these years, the Corliss engine has maintained its proud position as the standard mill and factory engine. We first find young Corliss working as a clerk in a store. Next it is reported that he erected a general merchandise outfit of his own in a small country town, but, at about 22 years of age, realizing that the monotony of the village threatened to dull his senses, he shut down that plant, dismantled it, went to a larger city and found employment in a shoe factory. The noise of the factory, the humming sound of the moving machinery was classic music in the ears of young Corliss. He remained in the shoe factory about four years, and his remarkable ability for technic and construction soon became known. He made here his first invention, a sewing machine, and it was to get it built that Corliss left the shoe factory and went to Providence, R. I., the only place at that time where such work could be done. He arranged with the firm of Fairbanks & Bancroft, then doing a machine and engine business, and started at once with the perfection of his sewing machine. Fairbanks & Bancroft, however, soon discovered that Corliss was a man they could use to great advantage in their own employ, and as they did not care to manufacture sewing machines they closed the dampers on that work and persuaded Corliss to disconnect himself from the sewing machine and devote his time and attention to projects which they had on hand. Corliss changed over and started in a new direction. He made good, so splendidly good that inside of a year Fairbanks & Bancroft riveted young Corliss solidly to their shops by making him one of their partners. It was at this time that Corliss conceived the improvements which revolutionized the steam-engine business and made his name a household word to every engineer in the country. He made a radical departure from the customary engine design of those days by constructing a cylinder with two valve chests, one for the steam inlet and one for the exhaust outlet. He used four valves in his cylinder, one at each corner. He designed a wristplate oscillated by an eccentric, to which the four valves were connected. He designed a valve-releasing gear with dashpots to close the steam valves quickly. He attached the governor to the valve mechanism and designed an entirely new engine frame.

The first engine of Corliss design, started in February, 1848 (Corliss was then 31 years old), was a 260-hp. walking-beam engine; the cylinder, shown in Fig. 1, measured 22 in. diameter by 72-in. stroke. The inlet valves are at the left and the exhaust valves at the right. The inlet valves on the first few Corliss engines were flat and were opened and closed by small shafts with racks and pinions operated from the central wristplate. The motion rod effecting the opening had a hook on one end, held by a spring against the valve shaft, which connected to the lever and so opened the valve. After the motion rod had traveled a certain distance, it struck a wedge-shaped arrangement which disengaged the hook, and the valve was closed by a weight attached to the valve-shaft or hook lever. The cutoff was not under the influence of the governor, but set by hand. The first engine having the cutoff controlled by the governor and having cylindrical oscillating valves, Fig. 2, was built in 1850.

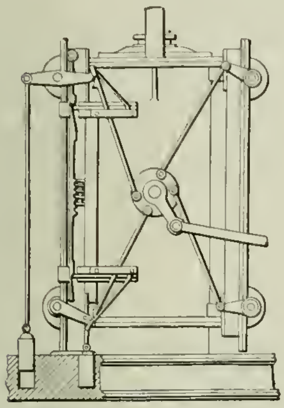


FIG. 1

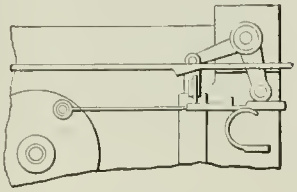


FIG. 2

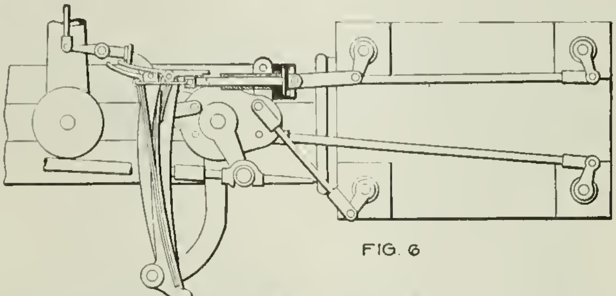


FIG. 6

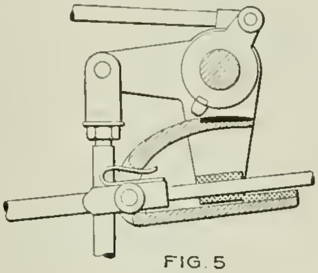


FIG. 5

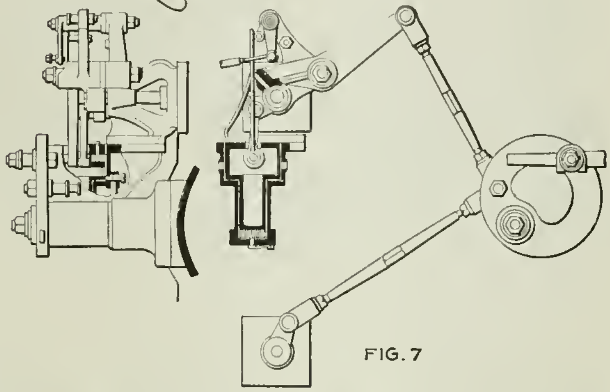


FIG. 7

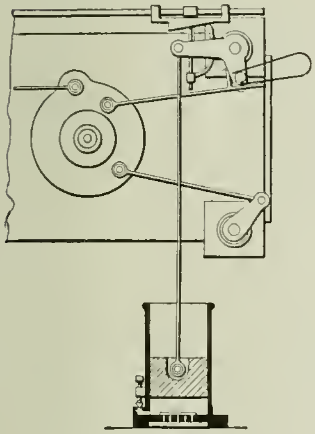


FIG. 3

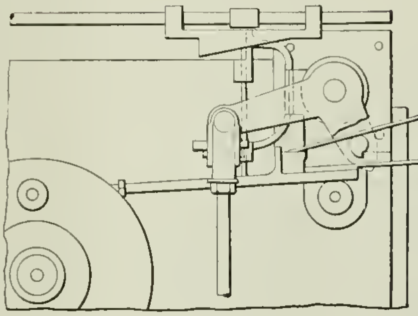


FIG. 4

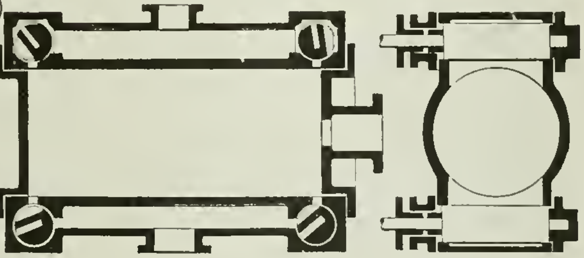


FIG. 8

FIGS. 1 TO 8. EARLY TYPES OF CORLISS VALVE GEARS

Fig. 1—The first Corliss cylinder and valve gear, 1848. Fig. 2—Valve gear of 1850. Fig. 3—Valve gear of 1851, dashpot taking shape. Fig. 4—The inclined gear of 1852. Fig. 5—"Crab-claw" gear of 1858. Fig. 6—Known as the spring-lever gear, put out in 1859. Fig. 7—Corliss' latest design, 1875. Fig. 8—Familiar Corliss cylinder and valve shown in section.

In Fig. 3 the springs holding the inlet motion rods in their respective places are fastened directly to the rods. The valves are closed by weights in smooth cylinders, but cushioned by air entrapped at the bottom of the little cylinders.

For a long time the gear shown in Fig. 4 was considered the best Corliss valve gear, and many engines were built of that design. Fig. 5 is the so-called crab-claw gear. Corliss very seldom used this gear, but some other engine builders did, especially William Harris, of Providence, R. I. It was frequently called the Harris-Corliss gear. Weights were used to close the valves on this gear.

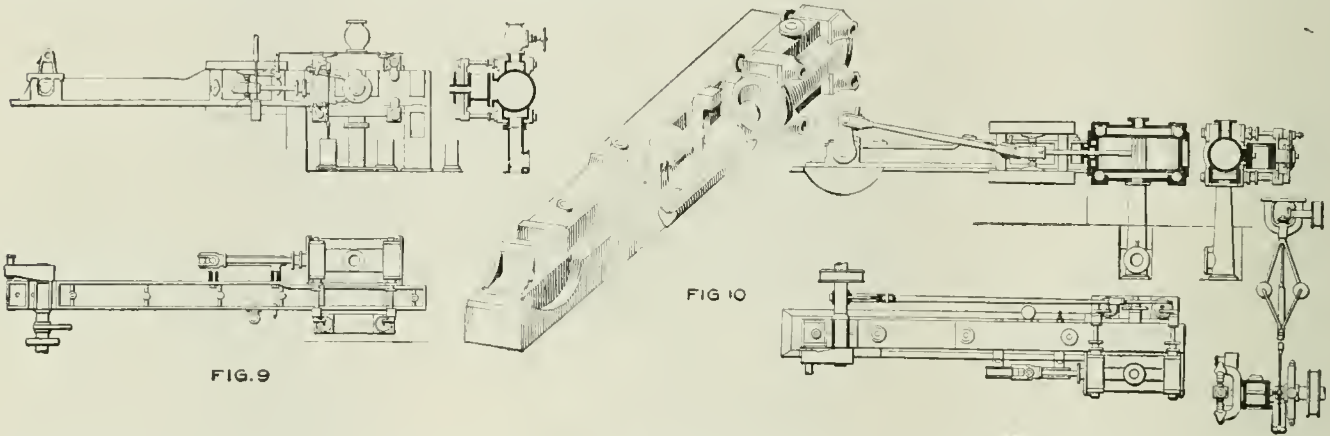
Fig. 6 is the so-called spring-lever gear, intended to do away with weights. This gear did not prove satisfactory. The springs broke frequently and were sometimes replaced by weights. A few engines were built with coil springs to close the valves, but the springs all gave trouble and Corliss fell back to the old crab-claw gear. Fig. 7 shows Corliss' latest design. Here the valves are closed neither by weights nor by springs, but by the pressure of the atmosphere on a dashpot that has a differential piston. The lower, or smaller, end, packed with a cup leather, acts as a vacuum pump; the upper or larger piston serves as an air cushion. A small check is located at the lower end of the vacuum cylinder for the escape of air leakage. To prevent the cast-iron piston striking hard metal against metal in case the vacuum is too strong and not enough air is admitted for cushioning, a leather washer is placed underneath the dash piston. This was the first valve gear designed permitting adjustment of the valves while the engine is in operation. The motion rods are threaded right and left. Fig. 8 is a sectional view of the Corliss cylinder showing the position of the valves.

Engineers laughed at the new machine and ridiculed Corliss and his inventions. They had a couplet in circulation running this way:

Levers, links and motions various,
Endless jimcracks all precarious.

But by-and-by the Corliss inventions were appreciated and Corliss was praised to the skies.

Within the year 1848 or early in 1849 Corliss had completed and had in operation two more engines like the first. Those three engines were so successful that tracts of land were purchased and extensive shops erected for the manufacture of engines. The engines installed gave excellent satisfaction, and the prospects for more and greater business were splendid, everything worked so nicely; then something serious happened which almost shut down the whole plant. Corliss took out a patent in 1849, after he had built three engines, but with this first patent troubles of large dimensions arose. Seven years prior to this a man by the name of Sickles had taken out patents on steam-engine improvements and when he heard of the Corliss patent and the wonderful success of his engine, he started to investigate and seemed to discover that the Corliss patent was very much like that of his own. Legal proceedings were the consequence, and before young Corliss realized the situation he was confronted with a high-pressure lawsuit.



FIGS. 9 TO 11. SOME EARLY TYPES OF CORLISS ENGINE FRAMES, SHOWING THE GRADUAL EVOLUTION FROM BEDPLATE TOWARD THE GIRDER FRAME

Sickles, in his legal proceedings, not only tried to prevent Corliss from manufacturing these engines, but also directed his threats against those using the engines, so Corliss had to defend himself and his customers at the same time. He had both hands full. Lawyers of the highest ability were employed on both sides, and the litigation was carried on with much bitterness. The case was tried before various juries and judges, and the fight extended over a term of 15 years. Finally, the Corliss patents were fully sustained in all points, and thenceforth, until their expiration in 1870, Corliss had the field to himself. The legal fight cost Corliss $100,000.

Many feel a certain sympathy for Sickles, who came so near achieving a great success yet missed it. The inventions of Sickles and Corliss were as different as the two men. Sickles invented an improved method of lifting, tripping and cushioning poppet valves. It seems that he had no other valve in mind; in fact, his claims are so drawn as to exclude all others. In the Corliss invention the valve does not leave its seat, it slides back and forth. As a poppet valve is dropped to its seat, it is necessary to bring the valve to rest in an extremely short distance in order to prevent slamming and destruction. Sickles used for that purpose a water dashpot. With the Corliss valve it matters little when the motion of the valve is arrested; it can pass over the ports and close them at full speed, and whether it stops a little sooner or a little later is of no consequence. Corliss brought his valves to rest by means of weights and cushioned the weight simply by an air cushion. Theoretically, the Sickles invention was all right, but the Corliss invention was the most practical one. A prominent engine designer, a man of the theory, connected with the Allis-Chalmers Co., once relieved his mind as follows: "Damn practice, it always interferes with theory." The theory that Corliss possessed never interfered with practice. Corliss' head was not filled with theory, he was a practical fellow, without college or technical training. He did not know anything about algebra, but he knew how to build useful engines right and left and put them on the market. Frederick E. Sickles was a marine engineer who fought for his theory, but a theory that interfered with practice. As stated before, Corliss got his first patent in 1849 for a term of 14 years. In 1851 and again 1859 the patent was renewed and at that time divided into six patents, each one covering a certain part of the Corliss engine. One patent was for the wristplate, one for the liberation of the valves, one for the air cushion, one for the positive closing of the valves, one for the claws and one for the combination of the governor with the cutoff.

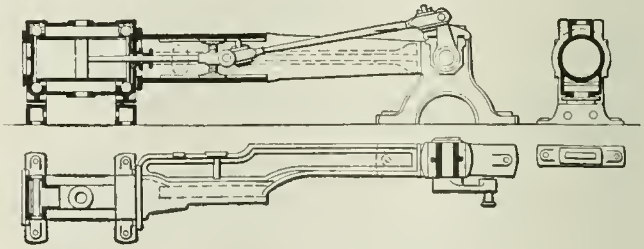


FIG. 12. THE CORLISS GIRDER-FRAME ENGINE

There was no patent on the four-valve cylinder, and the credit of originating it has been claimed by others. William Wright, at one time foreman of the Corliss shops, was one who claimed it.

ENGINE FRAMES DESIGNED BY CORLISS

Corliss not only developed the valve gear to a high degree of perfection, but all other parts of his engine also. Under the hands of this genius the whole engine soon had a different appearance in every detail. The old-style engine bed, which looked like a coffin with two low sides and a crosspiece at each end, he discarded altogether. Figs. 9, 10, 11 and 12 show the gradual development of the final standard, the familiar girder frame. First came the box-type frame, which had the shape of the letter U. The front end served as a bearing for the crankshaft, and the rear end carried the cylinder on one side and the valve gear on the other. The guides were bolted to the side of the frame. The open top of the frame was closed with a polished mahogany cover. It is said that engineers found it convenient to lay tools and things inside of the U frame, and when more than full they had some bother to make the lid fit nicely. Corliss later changed the design, turned it upside down, and the worry of the engineer in fitting the lid properly was done away with. Then came the girder, a frame extending between the main bearing and the cylinder, and carrying also the crosshead guide; the whole engine standing on the foundation instead of lying down, showing good proportions and graceful lines. Fig. 13 shows a 32 x 84-in. engine installed in 1853, in a cotton mill, to replace a Sickles poppet-valve engine that had been in operation only 2½ years, and guaranteed to effect a saving of 50 per cent. at the coal pile. Fig. 14 shows indicator diagrams from the competing engines and why Corliss effected the big saving. If Sickles had studied the poppet engines abroad and improved on his design, he could have made the road for Corliss far more difficult. Fig. 15 shows a highly developed horizontal engine.

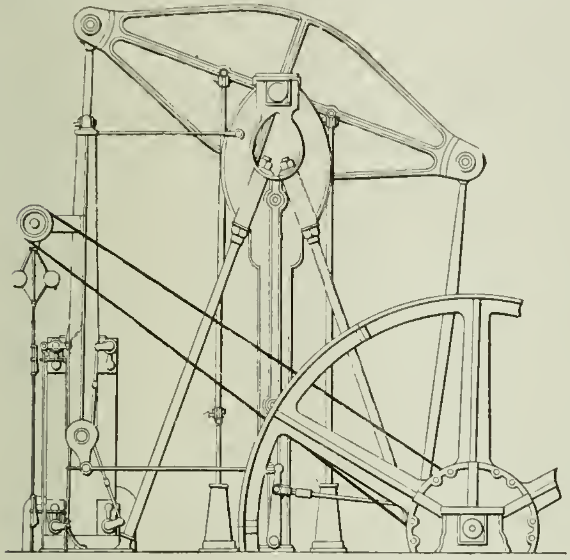


FIG. 13

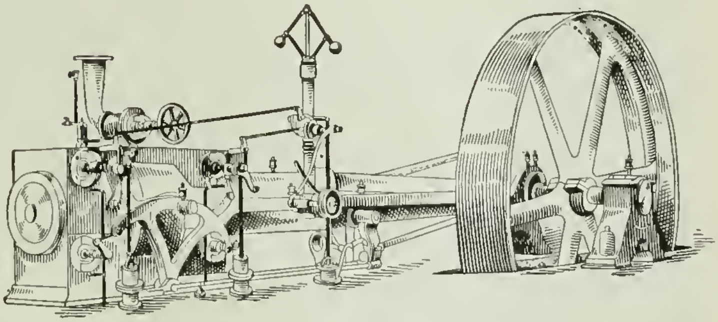


FIG. 15

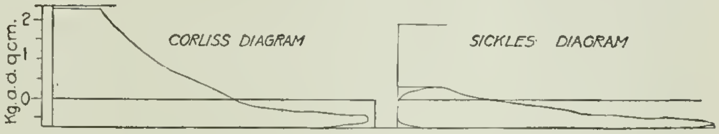


FIG. 14

FIGS 13 TO 15. EARLY AND LATER DESIGNS CONTRASTED

Fig. 13—One Corliss engine that supplanted a Sickles. Fig. 14—Shows an indicator diagram from each. Fig. 15—A typical Corliss of late design

Corliss met with considerable difficulty in finding customers for his first engines; people were prejudiced against the new machine. The valve gear was considered too complicated, and fear was expressed that it would not stand up under the working strain. Nobody believed in the advantages claimed by Corliss. To overcome this terrible resistance and secure orders for his shop, Corliss introduced his engines by giving them away and receiving as payment therefor only the savings effected over and above the old-time machines. This plan of introducing his engine proved to be all right. One of the first, a 180-hp. unit, was installed in a flour mill and the mill people agreed to give Corliss the savings over the old engines for a period of five years. Corliss realized from this outfit the sum of $19,734.22. A few more such contracts put him in shape to pay for his $100,000 lawsuits.

After the first success in economy, Corliss made the most daring guarantees for his engines the world had ever heard of. In 1852 he got a contract for an engine to drive a rail mill that he guaranteed would develop one-third more power than the old engine and at the same time reduce the daily coal bill from five tons to two tons, and in case of failure he would pay a penalty of not less than $1 for each pound of coal used in excess of his guarantee. A still bolder guarantee was made in another case. He furnished a 200-hp. engine for a certain concern for the modest price of $7100 (almost seven times as much as what an engine of that size could have been purchased for a few years ago) to replace an old one of the same size which was using over nine tons of coal per day. Corliss guaranteed that his engine would not use more than four tons, and he would pay $5000 for every ton of coal used in excess of his guarantee. Those daring guarantees soon established such a reputation for the engine that almost any price that Corliss asked would be paid. These fabulous guarantees would look suspicious to engineers of today, but notice that Corliss never guaranteed that his engine would save a certain amount in steam consumption per indicated horsepower-hour. He guaranteed the saving at the coal pile only. He was wise in doing so, for if based on the steam consumption his guarantee would never have been so big and blustering. Corliss was not only a remarkably great engineer, but also a remarkably shrewd business man. The way he introduced his engine and the manner he advertised are proof of that. He had a keen eye for the things going on in the boiler room. He knew then, as we know now, that when a boiler is forced by unskilled hands, much fuel is wasted, that when a boiler is fired moderately the chances for obtaining drier and consequently less costly steam are far better; therefore he knew that when his engine would be hitched to a battery of overworked boilers those boilers would be greatly relieved and a great saving effected right there in the boiler room.

It is a recorded fact that Corliss believed in ample boiler capacity, believed in "lots of boiler capacity." Boilers furnishing steam to his engines generally had a snap. In those plants installed and guaranteed by Corliss only from one-half to one-third as much steam per square foot of heating surface was generated as in boilers of other plants. He also believed in superheated steam, and all boilers furnished by him were arranged for that purpose. Another condition that existed in those days when Corliss made his bewildering guarantees was that the old engines were too small to handle the load economically, a condition naturally in favor of the new Corliss engine replacing such overloaded units. From this consideration we see that the enormous saving guaranteed and fulfilled by Corliss was not altogether due to the Corliss engine alone, but that a good portion of it must be credited to the changes in the boiler room and to the old engines being overloaded.

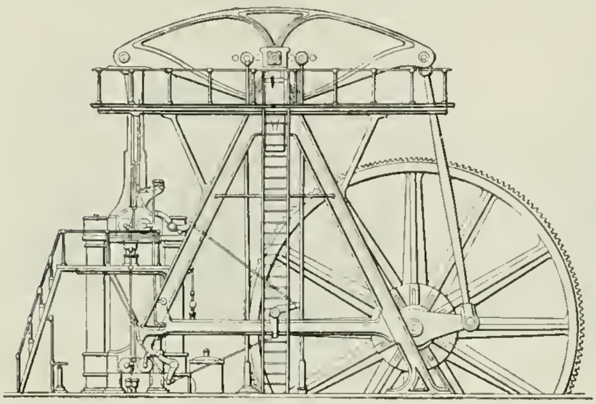


FIG. 16

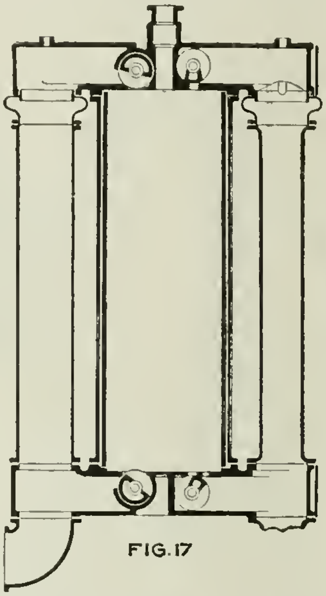


FIG. 17

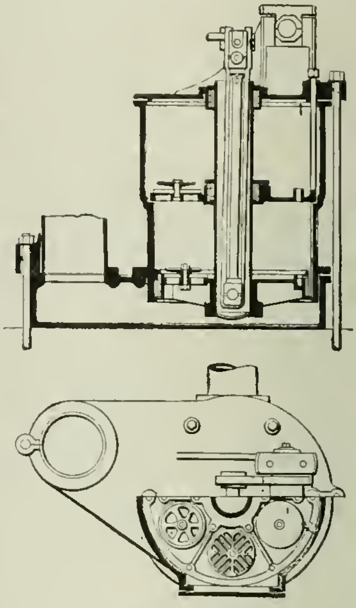


FIG. 19

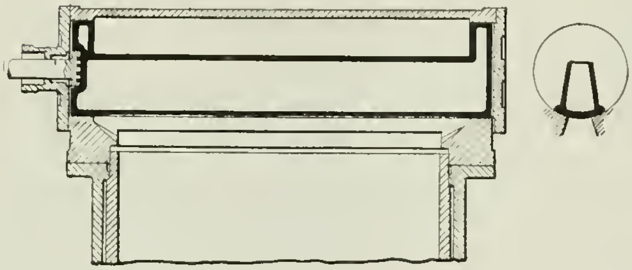


FIG. 18

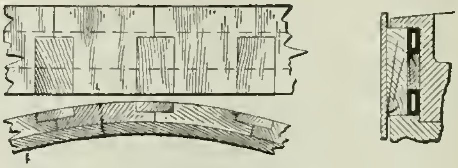


FIG. 20

FIGS. 16 TO 20. SECTIONAL VIEWS OF THE CENTENNIAL ENGINE, CYLINDER, VALVES AND AIR PUMPS
Fig. 16—General outline. Fig. 17—Cylinder, showing position of valves. Fig. 18—Design of valves. Fig. 19—Two views of condenser and air pump. Fig. 20—Wooden packing for air-pump plungers.

Corliss not only made unusual guarantees as to economy but also as to perfect regulation of speed, which merit was of almost as much value to a cotton mill as the saving of fuel. The spindles of a spinning machine revolve with great rapidity, and a variation of speed at the engine will be many times multiplied by the time the motion reaches the fast-running spindle. If the spindle is driven faster than intended, bad work is the result, if it is driven too slow, diminished production is the consequence. The old-fashioned engines were not very satisfactory in governing. The Corliss engine was superior, and Corliss was not slow in guaranteeing it, and he saw to it that his engine rapidly became the standard mill engine. The first engines built by Corliss were of the walking-beam type, but he soon devoted himself to the development of the horizontal type and achieved a wonderful success. He also built a number of pumping engines; the first one was for the City of Providence, R. I. This machine had five horizontal steam cylinders and five horizontal double-acting pumps, evenly spaced around one central vertical shaft. There was no dead-center, no flywheel and no limit to the slow speed which the pump could run. It could run as slow as one revolution in five minutes. In 1857 Corliss built his first cross-compound engine with steam-jacketed cylinders.

In 1870 the Corliss patents became public property, and a number of firms throughout the land began to build Corliss engines. A few shops had been licensed by Corliss, but comparatively few engines were built outside of his works. He charged a license fee not only to outside builders, but also to the firm in which he was a partner. The fee was a dollar and a half per square inch piston area of cylinders over 24 in. diameter, and two dollars per square inch area for cylinders under 24 in. To save the 50c. on each square inch, the first cylinders had large diameters and short strokes, but after the expiration of the patents a marked increase in the length of the stroke with a corresponding decrease in bore is noted.

Fig. 16 is a line drawing of the Centennial Engine of 1876, and Figs. 17, 18, 19 and 20 are sectional details. This is no doubt the most famous engine ever built and was considered when new the most magnificent piece of work in the art of steam engineering. It was enthusiastically praised by all who saw it, and the European engineers credited it an unsurpassed masterpiece of human possibility and the most excellent representative of American steam engineering. The engineering press has referred to this engine times innumerable. I shall, therefore, make mention of only such parts as will be of general interest.

The "Centennial" was a vertical twin engine of the walking-beam type. Each side could develop about 700 hp., at 36 r.p.m., but in Philadelphia it was not called upon to do more than 400 hp. altogether, and it was operated with a steam pressure of from 15 to 22 lb. per sq. in., although it was intended to use 45 lb. The whole engine weighed 607 tons, and it required a train of 35 cars to ship it. The walking beams, of elegant design, had the form of wings, were 27 ft. long and 9 ft. high in the center, and weighed 11 tons each. The flywheel was a gear-wheel, the largest ever made, almost 30 ft. in diameter. It had 216 teeth and weighed 56 tons. The connecting-rods were 25 ft. long, 10 in. thick in the center, and were forged out of 9500 old horseshoes. The cranks were made of solid bronze highly polished and weighed 5 tons each. The cylinders were 40 in. diameter and 10 ft. stroke, steam jacketed. The valves were in the heads and clearance space was reduced to a minimum. The valves were 12 in. diameter and 52 in. long, cored hollow and operated by T-head valve stems. The ends of the valves were cylindrical for a short distance to serve as guides. Port area was $\frac{1}{11}$ of the piston area for the steam valves and twice that amount for the exhaust valves. Each half of the engine had its own condenser and air pump, of the vertical type, 36 in. diameter and 24 in. stroke, operated from the walking beams. The packing was made of wood, as shown in Fig. 20, pieces being joined together in a peculiar manner to break the joints.

I had the good fortune to see this engine in operation one whole day in the Pullman works. It stood in a room 84 ft. square by 66 ft. high kept like a palace. The engine generally delivered 1400 or 1500 hp., but one time it was called upon to deliver 2500 hp. One man's time was continually occupied in keeping the engine oiled. To refill the oil cups on the four extreme pins of the walking beams, it was necessary to shut the engine down every six hours. The engineer stopped the engine at a certain position and the oiler refilled two cups, then he turned the engine half a turn, and the other two cups were filled. In the fall of 1910 this famous engine, after a continuous service of over 30 years, was shut down for the last time and forever.

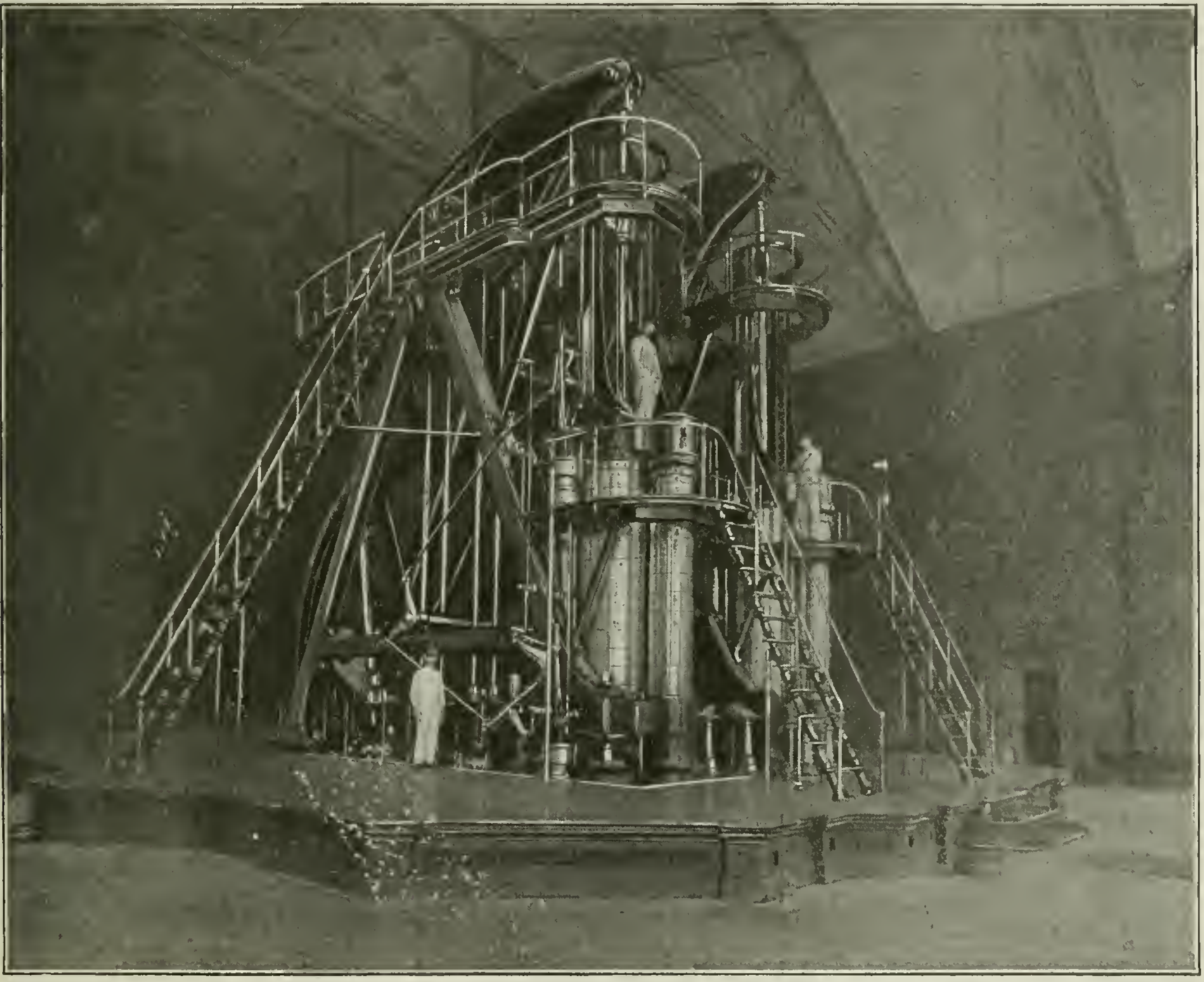


FIG. 21 THE CENTENNIAL ENGINE AT THE PULLMAN WORKS

Zone System for the Distribution of Bituminous Coal

By order of the Fuel Administration, the distribution of bituminous coal for the year beginning April 1, 1918, will be controlled by a zone system, which is intended to reduce the burden on the railroads, facilitate shipment of coal, and keep all the mines working at full capacity.

THE factor that loomed largest in the fuel crisis of last winter was the lack of adequate transportation facilities. Under the plan of distribution then followed, a consumer in any part of the country was free to order his coal supply from any producing district, regardless of the length of haul involved. As a consequence, it often happened that cars and locomotives were engaged in delivering coal to distant regions that could have been served far more quickly from fields near by.

Obviously, this complete freedom of choice as to the source of coal used led to cross-hauling in addition to the utilization of railroad equipment in unnecessarily long hauls, the result being a great waste of transportation power. To prevent this needless waste and make possible an increased production to meet the war demands, the United States Fuel Administration, in conjunction with the Director General of Railroads, has announced a zone system for the control of bituminous-coal distribution for the year beginning Apr. 1, 1918.

The zone system was adopted only after prolonged conferences with coal producers, jobbers and consumers, as well as with the traffic and operating officials of the railroads. Briefly explained, it divides the country into a number of zones, each of which must obtain its coal supply from mines that are relatively near, thus preventing abnormal and wasteful transportation movements, insuring more nearly equal distribution of cars to the mines and more steady employment of mine labor.

Of course, so radical a change in the methods of conducting the coal business will cause some inconvenience to producers and consumers, and will involve additional expense in some cases. For example, the producers of Pocahontas coal may no longer ship their output to Chicago and Western points by rail; as a result, they must find new markets in the East. Those plants in and around Chicago that have been burning West Virginia coal will be compelled to substitute Illinois coal, which can be obtained with less than half as long a haul. As the two fuels are of very different characters, changes in the boiler settings and methods of firing will have to be made, which will entail expense.

It is the hope of the Fuel Administration, however, that the consumer and the producer will bear these unavoidable inconveniences in the realization that the readjustment of the distribution of coal is for the welfare of the nation. In other words, they are appealed to on the grounds of patriotism.

There are exceptions to the conditions imposed by the zone system. Certain industries require coals of particular quality or characteristics, as, for example, by-product, gas, blacksmith and metallurgical coals. If a consumer needs coal of one of these kinds and is unable to obtain it from the producing districts that are permitted to ship into the zone in which he is located, permits will be issued to allow the special-purpose fuel to be brought in from other districts.

The zone system does not affect the following bituminous coal:

1. Coal for railroad fuel, for which special arrangements will be made by the Fuel Administrator and the Director General of Railroads.
2. Coal for movement on inland waterways, which is in no way restricted by the system.
3. Coal delivered to Canada, which is subject to regulations of the Fuel Administrator.

To enable the consumer of bituminous coal to determine the districts from which he may obtain his fuel and to show the producer the zones in which he may sell his output, the map has been prepared.

It will be seen that the entire territory of the United States has been divided into a large number of irregular zones or sections, colored differently so that they may readily be distinguished one from another, and each marked with a key number. Each of these separately numbered zones has certain definite boundary lines and is restricted to the use of coals from certain districts. The Key to Consuming Zones gives a complete list of all the zones shown on the map, states the districts from which they may obtain coal, and defines the boundaries of each zone.

If a consumer wishes to find out what coals are available for his use, he locates on the map the zone in which he lives and notes its number. Then, in the Key to Consuming Zones, under that zone number, he will find the list of producing districts from which he can obtain coal. In case there is any doubt as to the number of the zone in which he lives, reference to the boundaries given in the key will at once decide the point. Following this key is a list of the meanings of the abbreviations and terms used in the key.

The Key to Producing Districts is intended to show the producer the several zones in which he may market his product. He knows the district in which his mine is located, and on referring to this key he finds the numbers of the zones, as shown on the map, into which the output from his mine may be sent.

A wall map of large size, showing the same zoning in fuller detail, may be obtained from the Coal Zone Map Co., Glen Echo, Md.

KEY TO CONSUMING ZONES

ZONE NO. 1

RESTRICTED TO FOLLOWING COALS—North Dakota, South Dakota, docks.

BOUNDARIES—Northern and Western: Lake Superior and Canada; North Dakota state line and South Dakota state line to Ortonville, Minn. **Southern and Eastern:** From Ortonville via C. M. & St. P. Ry. through Granite Falls and Benton Junction to Minneapolis, thence via M. St. P. & S. S. M. Ry. through Chippewa Falls and Abbotsford to Amherst Junction, thence via G. B & W. R. R. to Kewaunee, Wis.; western banks of Lakes Michigan and Huron.

ZONE NO. 2

RESTRICTED TO FOLLOWING COALS—Illinois (summer only), docks, North Dakota, South Dakota, Iowa (to points in Iowa only).

BOUNDARIES—Northern: From Kewaunee, Wis., via G. B. & W. R. R. to Amherst Junction, thence via M. St. P. & S. S. M. Ry. through Abbotsford and Chippewa Falls, Wis., to Minneapolis, Minn., thence via C. M. & St. P. Ry. through Benton Junction and Ortonville, Minn., to the Minnesota-South Dakota state line. **Western:** Minnesota-South Dakota state line. **Southern:** Commencing at South Dakota-Minnesota-Iowa state line east to the C. R. I. & P. Ry. line running through Gordonsville, Minn., and Northwood, Iowa, thence south via that line to Mason City, Iowa, thence east via C. M. & St. P. Ry. through McGregor, Iowa, Madison and Watertown to Milwaukee, Wis. **Eastern:** Lake Michigan from Kewaunee to Milwaukee, Wis.

ZONE NO. 3

RESTRICTED TO FOLLOWING COALS—Illinois, Kentucky (Western), Indiana. docks.

BOUNDARIES—Northern and Western: From Milwaukee, Wis., via C. M. & St. P. Ry. to Waukesha, thence via M. St. P. & S. S. M. Ry. to Illinois-Wisconsin state line. **Eastern and Southern:** From Milwaukee, Wis., via Lake Michigan (west bank) to Illinois-Wisconsin state line, thence via that line to M. St. P. & S. S. M. Ry.

ZONE NO. 4

RESTRICTED TO FOLLOWING COALS—Illinois, Kentucky (Western), docks.

BOUNDARIES—Northern: Via C. M. & St. P. Ry. from Milwaukee, Wis., through Watertown to Madison, Wis. **Southern:** Via C. M. & St. P. Ry. from Milwaukee, Wis., through Milton Junction to Madison, Wis.

ZONE NO. 4A

RESTRICTED TO FOLLOWING COALS—Illinois, docks.

BOUNDARIES—Northern and Western: From Milwaukee, Wis., via C. M. & St. P. Ry. through Milton Junction to Madison, Wis., thence via I. C. R. R. to Dixon, Ill. **Eastern and Southern:** From Milwaukee, Wis., via C. M. & St. P. Ry. through Elkhorn to Beloit, Wis., thence via C. & N. W. Ry. through Belvidere and Sycamore to Dixon, Ill.

ZONE NO. 5

RESTRICTED TO FOLLOWING COALS—Iowa, Kansas, Illinois, Missouri, Oklahoma, Arkansas.

BOUNDARIES—Northern and Eastern: From Sioux City, Iowa, via C. M. & St. P. Ry. through Rock Valley and Spencer to Nora Junction, thence via C. R. I. & P. Ry. to Cedar Rapids, thence via C. M. & St. P. Ry. through Sigourney to Ottumwa, thence via C. R. I. & P. Ry. to Keokuk, Iowa, thence via Missisippi River to Missouri-Arkansas state line. **Western and Southern:** From Sioux City, Iowa, via C. M. & St. P. Ry. through Manilla and Adel to Des Moines, Iowa, thence via C. B. & Q. R. R. to Albia, thence via W. Ry. to Moravia, Iowa, thence via C. M. & St. P. Ry. to Chillicothe, Mo., thence via W. Ry. to Moberly, thence via M. K. & T. Ry. through New Franklin to North Jefferson City, thence via western boundary of Cole, Miller and Pulaski Counties to St. L. S. F. Ry., thence via St. L S. F. Ry. through Springfield and Neosho to Missouri-Oklahoma state line, thence south to Arkansas-Missouri-Oklahoma state line, thence east via Arkansas-Missouri state line to the Mississippi River.

ZONE NO. 6

RESTRICTED TO FOLLOWING COALS—Illinois, Kentucky (Western).

BOUNDARIES—Northern and Western: —From Arthur, Ill., via P. C. C. & St. L. R. R. to Decatur, Ill., thence via I. C. R. R. through Centralia to Cairo, Ill., thence via Mississippi River to Memphis, Tenn. **Eastern and Southern:** From Arthur, Ill., via C. & E. I. R. R. through Marion to Joppa, Ill., thence via Ohio River to Cairo, Ill., and thence via I. C. R. R through Clinton and Fulton, Ky., and Dyersburg, Tenn., to Memphis, Tenn.

ZONE NO. 6A

RESTRICTED TO FOLLOWING COALS—Illinois, Kentucky (Western), docks.

BOUNDARIES—Northern: From Madison, Wis., to Woodman, Wis., via C. M. & St. P. Ry. **Southern:** From Madison, Wis., to Woodman, Wis., via C. & N. W. Ry.

ZONE NO. 7

RESTRICTED TO FOLLOWING COALS—Illinois, Iowa (to points in Iowa only).

BOUNDARIES—Northern and Eastern: From Nora Junction, Iowa, via C. M. & St. P. Ry. to Woodman, Wis., thence via C. & N. W. Ry. to Madison, Wis., thence via I. C. R. R. to Freeport, Ill., thence via I. C. R. R. to Dixon, Ill., thence via C. & N. W. Ry. through Nelson to Peoria, thence via P. C. C. & St. L. R. R. to Decatur, thence via I. C. R. R. through Centralia to Cairo, Ill. **Southwestern:** From Nora Junction, Iowa, via C. R. I. & P. Ry. to Cedar Rapids, thence via C. M. & St. P. Ry. to Ottumwa, thence via C. R. I. & P. Ry. to Keokuk, Iowa, thence east of the Mississippi River to Cairo, Ill.

ZONE NO. 8

RESTRICTED TO FOLLOWING COALS—Illinois, Indiana.

BOUNDARIES—Northern and Eastern: From Dixon, Ill., via I. C. R. R. to Decatur, Ill. **Western and Southern:** From Dixon, Ill., via C. & N. W. Ry. through Nelson to Peoria, Ill., thence via P. C. C. & St. L. R. R. to Decatur, Ill.

ZONE NO. 9

RESTRICTED TO FOLLOWING COALS—Illinois, Indiana, Kentucky (Western).

BOUNDARIES—Northern and Western: From Waukesha, Wis., via C. M. & St. P. Ry. to Beloit, Wis., thence via C. & N. W. Ry. through Belvidere, Sycamore, DeKalb, to Dixon, Ill., thence via I. C. R. R. to Decatur, Ill., thence via P. C. C. & St. L. R. R. to Arthur, thence via C. & E. I. R. R. through Mt. Vernon to Joppa, Ill. **Eastern and Southern:** From Waukesha, Wis., via M. St. P. & S. S. M. Ry. to Wisconsin-Illinois state line, thence via this line to Lake Michigan, thence via Lake Michigan to Michigan City, Ind., thence via C. I. & L. Ry. to San Pierre, thence via N. Y. C. R.R. to Wheatfield, thence via C. & E. I. R. R through Brazil and Otter Creek Junction through Vincennes to Evansville. Ind., thence both sides of the Ohio River, Evansville, Ind., to Joppa, Ill.

ZONE NO. 10

RESTRICTED TO FOLLOWING COALS—Indiana, Illinois (Danville district on Wabash Ry. only). Kentucky (Western, to Jeffersonville and New Albany only).

BOUNDARIES—Northern and Western: From San Pierre, Ind., via N. Y. C. R.R. to Wheatfield, thence via C. & E I. R.R. through Brazil, Otter Creek Junction and Vincennes to Evansville, Ind. **Eastern and Southern:** From San Pierre, Ind., via C. I. & L. Ry. to New Albany, Ind., thence along northern bank of Ohio River to Evansville, Ind.

ZONE NO. 11

RESTRICTED TO FOLLOWING COALS—Virginia (L. & N. R.R.), Tennessee (M. R.R.), West Virginia (Southern), Illinois, Indiana, Kentucky (Eastern and Western).

BOUNDARIES—Southeastern: From San Pierre, Ind., via N. Y. C. R.R north to South Bend, Ind., thence via M. C. R.R. to Michigan-Indiana state line. **Western and Northern:** From San Pierre, Ind., north to Michigan City, thence along Lake Michigan and Indiana-Michigan state line to M. C. R. R. from South Bend, Ind., to Niles, Mich.

ZONE NO. 12

RESTRICTED TO FOLLOWING COALS—Indiana, Illinois (Danville district on Wabash Ry. only).

BOUNDARIES — Northeastern — From Monon, Ind., via C. I. & L. Ry. to Indianapolis, Ind., thence via C. C. C. & St. L. Ry. through Greensburg to North Vernon, Ind., thence via P. C. C. & St. L. R.R. to Madison, Ind. **Southwestern:** From Monon, Ind., via C. I. & L Ry. to Louisville, Ky., thence via Ohio River to Madison, Ind.

ZONE NO. 13

RESTRICTED TO FOLLOWING COALS—Kentucky (Western).

BOUNDARIES—Northern and Eastern: From Cairo, Ill., along Ohio River (north bank) to Louisville, Ky., thence south via L. & N. R.R. from Louisville through Bowling Green, Ky., including Glasgow and Scottsville branches, to Kentucky-Tennessee state line. **Western and Southern:** From Cairo, Ill., via I. C. R.R. through Fulton, Ky., to Kentucky-Tennessee state line, thence east via state line to L. & N. R.R. running from Franklin, Ky., to Mitchellville, Tenn.

ZONE NO. 14

RESTRICTED TO FOLLOWING COALS—Indiana, Kentucky (Eastern), West Virginia (Northern and Southern), Virginia (L. & N.), Tennessee (M. R.R.), Michigan, Ohio (on G. R. & I. Ry. only).

BOUNDARIES—Northern and Western: From Mackinaw City, east bank of Lake Michigan, to Benton Harbor, Mich., thence via C. C. C. & St. L. Ry. to Niles, thence via M. C. R.R. to Michigan-Indiana state line. **Eastern and Southern:** From Mackinaw City via G. R. & I. Ry. and branches to Michigan-Indiana state line, thence west via state line to M. C. R.R. running from Niles to South Bend, Ind

ZONE NO. 15

RESTRICTED TO FOLLOWING COALS—Illinois, Indiana, Kentucky (Eastern and Western), West Virginia (Northern and Southern), Virginia (L. & N.), Tennessee (M. R.R.), Michigan.

BOUNDARIES—Northern and Western: From Benton Harbor, Mich., via Lake Michigan to Indiana-Michigan state line. **Eastern and Southern:** From Benton Harbor, Mich, via C. C. C. & St. L. Ry. to Niles, thence via M. C. R.R. to Indiana-Michigan state line, thence west via state line to Lake Michigan.

ZONE NO. 16

RESTRICTED TO FOLLOWING COALS—Indiana, Illinois (Danville district on Wabash Ry. only), Kentucky (Eastern), West Virginia (Southern).

BOUNDARIES—Northern: Michigan-Indiana state line from G. R. & I. Ry. west to M. C. R. R. running from Niles, Mich. to South Bend, Ind. **Western:** Via N. Y. C. R. R. South Bend to San Pierre, thence via C. I. & L. Ry. through Monon to Indianapolis, thence via C. C. C. & St. L. Ry., Indianapolis to Greensburg, Ind. **Eastern:** G. R. & I. Ry. from Michigan state line south to Richmond, Ind., thence via P. C. C. & St. L. R. R. to Greensburg, Ind.

ZONE NO. 17

RESTRICTED TO FOLLOWING COALS—Virginia (L. & N. R.R.). Kentucky (Eastern), Tennessee (M. R.R.), West Virginia (Southern).

BOUNDARIES—From Cincinnati north via P. C. C. & St. L. Ry. to Richmond, Ind., thence west to Rushville, Ind., thence south via C. C. C. & St. L. R.R. through Greensburg, thence east to Cincinnati, O.

ZONE NO. 18

RESTRICTED TO FOLLOWING COALS—Virginia (L. & N. R.R.), Kentucky (Southern), Tennessee (M. R.R.).

BOUNDARIES—Northern and Western: Cincinnati, Ohio, via C. C. C. & St. L. Ry. through Greensburg, to North Vernon, Ind., thence via P. C. C. & St. L. R.R. to Madison, Ind. **Eastern and Southern:** North bank Ohio River, Cincinnati, Ohio, to Madison, Ind

ZONE NO. 19

RESTRICTED TO FOLLOWING COALS

—Kentucky (Eastern). Tennessee (M. R.R.), West Virginia (Southern, also Eastern, to points on C. & O. Ry. from Catlettsburg, Ky., to Cincinnati, Ohio).

BOUNDARIES—Northern and Eastern. From Louisville, Ky., via Ohio River and Big Sandy River to Kentucky-Virginia-West Virginia state line **Western and Southern:** From Louisville, Ky., to Lebanon Junction to Bowling Green, Ky., to Mitchellville, Tenn., including Glasgow and Scottsville (Kentucky) branches, thence via Kentucky-Tennessee state line and Kentucky-Virginia state line via Tug River to Big Sandy River.

ZONE NO. 20

RESTRICTED TO FOLLOWING COALS—Virginia (L. & N. R. R.). Kentucky, (Eastern), Tennessee (M. R.R.), West Virginia (Northern and Southern). Indiana. Illinois (Danville district on Wabash Ry. to points in Indiana only), Ohio, Michigan.

BOUNDARIES—Southern and Eastern: From Richmond, Ind, east via P. C. C. & St. L. R. R. to Ohio state line, thence north via state line to Michigan state line. thence via N. Y. C. R. R. to Jackson, Mich., thence via M. C. R.R. to Lansing, thence via P. M. Ry. through Ionia to Howard City, Mich. **Western:** From Howard City, Mich., via G. R. & I. Ry. through Fort Wayne to Richmond, Ind.

ZONE NO. 21

RESTRICTED TO FOLLOWING COALS—Virginia (L. & N. R.R.), Kentucky (Eastern), Tennessee (M. R.R.), West Virginia (Northern and Southern), Ohio, Michigan

BOUNDARIES—Northern and Eastern: From Mackinaw City, Mich., along the eastern boundary of Michigan (lower peninsula) and Ohio to Toledo, Ohio, thence via C. C. C. & St. L. Ry. through Bellefontaine to Dayton, Ohio **Western and Southern:** From Mackinaw City, Mich., via G. R. & I. Ry to Howard City, thence via P. M. Ry. through Ionia to Lansing, Mich., thence via M. C. R.R. to Jackson, thence via N. Y. C. R.R. to Indiana-Michigan-Ohio state line, thence south along state line and P. C. C. & St. L. R. R running from Richmond Ind., to Dayton, Ohio.

ZONE NO. 22

RESTRICTED TO FOLLOWING COALS—Virginia (L. & N. R.R.), Kentucky, (Eastern), Tennessee (M. R.R.), West Virginia (Southern), Ohio.

BOUNDARIES—From Cincinnati, Ohio, north via C. C. C. & St. L. Ry. to Dayton. Ohio, thence via P. C. C. & St. L. R.R. west to Richmond, Ind., thence southeast via P. C. C. & St. L. R.R. to Cincinnati, Ohio.

ZONE NO. 23

RESTRICTED TO FOLLOWING COALS—Kentucky (Northeastern). West Virginia (Northern and Southern, also Eastern, along main lines of C. & O. Ry. and N. & W. Ry. to Columbus and Cincinnati, Ohio) Ohio.

BOUNDARIES—Northern and Eastern: From Toledo, Ohio, via south bank of Lake Erie to Sandusky, Ohio, thence via P. C. C. & St. L. R.R. through Columbus, thence via N. & W. Ry. through Circleville to Chillicothe. **Western and Southern:** From Toledo, Ohio, via C. C. C. & St. L. Ry. through Springfield to Dayton, Ohio, thence via B. & O. R. R. through Washington C. H. to Chillicothe, Ohio.

ZONE NO. 24

RESTRICTED TO FOLLOWING COALS—Kentucky (Northeastern), West Virginia (Southern, also Eastern, along main lines of C. & O. Ry. and N. & W. Ry. to Columbus and Cincinnati, Ohio), Ohio.

BOUNDARIES—Northern and Eastern: From Dayton, Ohio, via B. & O. R.R. through Washington C. H. to Chillicothe, thence via N. & W. Ry. to Waverly, thence via C. & O. Northern Ry. to Portsmouth. **Western and Southern:** From Dayton, Ohio, via C. C. C. & St. L. Ry. to Cincinnati, Ohio, thence via north bank of Ohio River to Porstmouth, Ohio.

ZONE NO. 25

RESTRICTED TO FOLLOWING COALS—West Virginia (Northern, also Eastern, along main lines of C. & O. Ry. and N. & W. Ry. to Columbus and Cincinnati, Ohio), Ohio.

BOUNDARIES—Northern and Eastern: From Bucyrus, Ohio, via T. & O. C. Ry. to Thurston, Ohio, thence via Z. & W. Ry. through Fultonham to Zanesville, thence via Z. & W. Ry., K. & M. Ry. to Athens. **Western and Southern:** From Bucyrus, Ohio, via P. C. C. & St. L. R.R. to Marion, Ohio, thence via H. V. Ry. to Columbus, thence via N. & W. Ry. to Chillicothe, thence via B. & O. Ry. to Athens, Ohio.

ZONE NO. 26

RESTRICTED TO FOLLOWING COALS—Ohio.

BOUNDARIES—Northern and Eastern: From Sandusky, Ohio, via south bank of Lake Erie to Lorain, thence via W. & L. E. Ry. through Wellington to Pittsburgh Junction, thence via P. & W. V. Ry. through Mingo Junction to Ohio River. **Southern and Western:** From Sandusky, Ohio, via P. C. C. & St. L. R.R. to Bucyrus, Ohio, thence via T. & O. C. Ry. to Thurston, thence through Zanesville to Athens, thence via K. & M. Ry. through Athens to Middleport, thence via Ohio River (north bank) to P. & W. V. Ry. opposite Mingo Junction.

ZONE NO. 27

RESTRICTED TO FOLLOWING COALS—Pennsylvania, Ohio.

BOUNDARIES—Northern and Western: Along south bank Lake Erie from Conneaut, Ohio, to Lorain, Ohio, thence via W. & L. E. Ry. through Wellington to Pittsburgh Junction, thence via P. & W. V. Ry. through Mingo Junction to Ohio River. **Eastern and Southern:** From Conneaut, Ohio, via Pennsylvania-Ohio state line to East Liverpool, Ohio, thence via Ohio River to P. & W. V. Ry. at a point opposite Mingo Junction.

ZONE NO. 28

RESTRICTED TO FOLLOWING COALS—No change contemplated in this plan, except that low-volatile coal in the Pocahontas, Tug River and New River districts on the N. & W. R. R. and the C. & O. Ry. and the Virginian Ry., and Clinch Valley districts in Tazewell and eastern Russell Counties along the N. & W. R. R., also high-volatile east of Charleston, W. Va., on C. & O. Ry. and east of Iaeger, W. Va., on N. & W. R. R. will be restricted to the District of Columbia, (except C. & O. Ry.) Virginia, (including tidewater terminals) also points in West Virginia on the direct line of the C. & O. Ry. and N. & W. R. R. east and west bound and Virginia Ry. east bound.

BOUNDARIES—All territory east and northeast of Ohio, Kentucky and Virginia. including New England.

ZONE NO. 29

RESTRICTED TO FOLLOWING COALS—Ohio, West Virginia (Northern, also Eastern, to points on the direct lines of the C. & O. Ry. and N. & W. Ry.).

BOUNDARIES—Northern and Eastern: From Chillicothe, Ohio, via B. & O. R.R. to Athens, thence via K. & M. Ry. to Middleport, thence via Ohio River (north bank) to Ironton, Ohio. **Western and Southern:** From Chillicothe, Ohio, via N. & W. Ry. to Waverly, thence via C. & O. N. Ry. to Portsmouth, thence via Ohio River (north bank) to Ironton, Ohio.

ZONE NO. 30

RESTRICTED TO FOLLOWING COALS—No change.

BOUNDARIES—All territory west of the following state lines: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma and Texas.

ZONE NO. 31

RESTRICTED TO FOLLOWING COALS—North Dakota, Wyoming, Montana and other fields east of the Rocky Mountains, docks.

BOUNDARIES—All territory in North Dakota west of the Missouri River.

ZONE NO. 32

RESTRICTED TO FOLLOWING COALS—North Dakota, South Dakota, Wyoming, Montana, docks.

BOUNDARIES—Northern, Western and Southern: North boundary of North Dakota to Montana, thence south to and via Missouri River to Mobridge, S. D., thence via C. M. & St. P. Ry. through Aberdeen to Bigstone City, S. D. **Eastern:** East boundary of North Dakota, thence via Minnesota-South Dakota state line to Bigstone City, S. D

ZONE NO. 33

RESTRICTED TO FOLLOWING COALS—South Dakota, Wyoming, Montana and other fields east of the Rocky Mountains, North Dakota, docks.

BOUNDARIES—Northern and Eastern: From Montana-North Dakota-South Dakota state line to the Missouri River, thence via Missouri River to South Dakota-Nebraska state line. **Western and Southern:** Western and southern state boundary of South Dakota.

ZONE NO. 34

RESTRICTED TO FOLLOWING COALS—North Dakota, South Dakota, Wyoming, Montana, Illinois (summer), docks.

BOUNDARIES — Southwestern: From Mobridge, S. D., via Missouri River to Sioux City, Ia. **Northern and Eastern:** From Mobridge, S. D., via C. M. & St. P. Ry. through Aberdeen, S. D., to Bigstone City, S. D., thence via Minnesota-South Dakota state line and Iowa-South Dakota state line to Sioux City, Ia.

ZONE NO. 35

RESTRICTED TO FOLLOWING COALS—Iowa, Kansas, Missouri, Arkansas, Oklahoma, Colorado and other fields east of the Rocky Mountains, Wyoming.

BOUNDARIES—Entire state of Nebraska.

ZONE NO. 36

RESTRICTED TO FOLLOWING COALS—Kansas, Missouri, Iowa, Arkansas, Oklahoma, Colorado (Southern).

BOUNDARIES—Entire state of Kansas.

ZONE NO. 37

RESTRICTED TO FOLLOWING COALS—Oklahoma, Missouri, Arkansas, Kansas, Colorado, New Mexico, Texas.

BOUNDARIES—Entire state of Oklahoma.

ZONE NO. 38

RESTRICTED TO FOLLOWING COALS-New Mexico, Colorado, Texas.

BOUNDARIES—All Texas territory west of Pecos River.

ZONE NO. 39

RESTRICTED TO FOLLOWING COALS—Colorado, New Mexico, Arkansas, Oklahoma, Texas.

BOUNDARIES—Northern and Eastern: From New Mexico-Oklahoma-Texas state line east along northern border of Texas to Arkansas-Louisiana-Texas state line, thence south to Logansport, La., thence via H. E. & W T. Ry. to Houston, via G. H. & H. R R. to Galveston, thence Gulf of Mexico to Rio Grande River. **Southwestern:** From New Mexico-Oklahoma-Texas state line to Pecos River, thence via Pecos River to Rio Grande River thence via Rio Grande River to the Gulf of Mexico.

ZONE NO. 40

RESTRICTED TO FOLLOWING COALS—Kentucky (Western), Alabama, Texas.

BOUNDARIES—Northwestern: From Logansport, La, via H E. & W. T. Ry. to Houston, Texas, thence via G. H. & H R. R. to Galveston. **Eastern and Southern:** From Logansport, La., along Louisiana-Texas state line to the Gulf of Mexico.

ZONE NO. 41

RESTRICTED TO FOLLOWING COALS—Arkansas, Illinois (summer), Iowa, Kansas, Missouri, Oklahoma, docks.

BOUNDARIES—Northern and Western: From Minnesota-Iowa state line directly south of Gordonsville, Minn., to Iowa-Minnesota-South Dakota state line, thence directly south along Iowa-South Dakota state line to Rock Valley, Ia. **Eastern and Southern:** From Iowa-Minnesota state line directly south of Gordonsville, Minn., via C. R. I. & P. Ry. to Mason City, Ia., thence via C. M. & St. P. Ry. to Rock Valley, Ia.

ZONE NO. 42

RESTRICTED TO FOLLOWING COALS—Arkansas, Iowa, Kansas, Missouri, Oklahoma.

BOUNDARIES—Northeast: From Sioux City, Ia., via C. M. & St. P. Ry. through Manilla and Adel to Des Moines, thence via C. B. & Q. R. R. through Chariton to Albia, thence via W. Ry. to Moravia, Ia., thence via C. M. & St. P. Ry. through Seymour to Missouri-Iowa state line. **Western and Southern:** From Sioux City, Ia., via Missouri River (east bank) to Iowa-Missouri state line, thence via Missouri state line, north boundary, to C. M. & St. P. Ry. line running south from Seymour, Ia.

ZONE NO. 43

RESTRICTED TO FOLLOWING COALS—Iowa, Arkansas, Kansas, Missouri, Oklahoma.

BOUNDARIES—Northeastern and Southern: Iowa-Missouri state line from Missouri River to C. M. & St. P. Ry. running south from Moravia, Ia., through Chillicothe, Mo., thence via W. Ry. through Huntsville to Moberly, thence via M. K. & T. Ry. through New Franklin to North Jefferson City, thence via western boundary of Cole, Miller and Pulaski Counties, Mo., to St. L. S. F. Ry. thence via St. L. S. F. Ry. through Lebanon, Springfield, to Missouri-Oklahoma state line. **Western:** Western boundary of Missouri.

ZONE NO. 44

RESTRICTED TO FOLLOWING COALS—Arkansas, Illinois, Kansas, Missouri, Oklahoma, Texas.

BOUNDARIES—Northern and Eastern: From Arkansas-Missouri-Oklahoma state line east to Mississippi River, thence via Mississippi River (west bank) to Memphis, Tenn. **Western and Southern:** From Arkansas-Missouri-Oklahoma state line south to C. R. I. & P. Ry. running from Howe, Okla., through Mansfield, Danville and Little Rock, Ark., to Memphis, Tenn.

ZONE NO. 45

RESTRICTED TO FOLLOWING COALS—Alabama, Arkansas, Illinois •(only on lines of St. L. S. W. Ry. and St. L. I. M. & S. Ry), Kansas, Missouri, Oklahoma, Kentucky (Western), Texas.

BOUNDARIES—Northern and Eastern: From Arkansas-Oklahoma state line via C. R. I. & P. Ry. running from Howe, Okla., through Mansfield, Danville and Little Rock, Ark., to Memphis, Tenn., thence via Mississippi River (west bank) to Arkansas-Louisiana state line. **Western and Southern:** South along Arkansas-Oklahoma state line from C. R. I. & P. Ry. Howe, Okla., to Mansfield, Ark., to Arkansas-Louisiana-Texas state line, thence east along Arkansas-Louisiana state line to the Mississippi River.

ZONE NO. 46

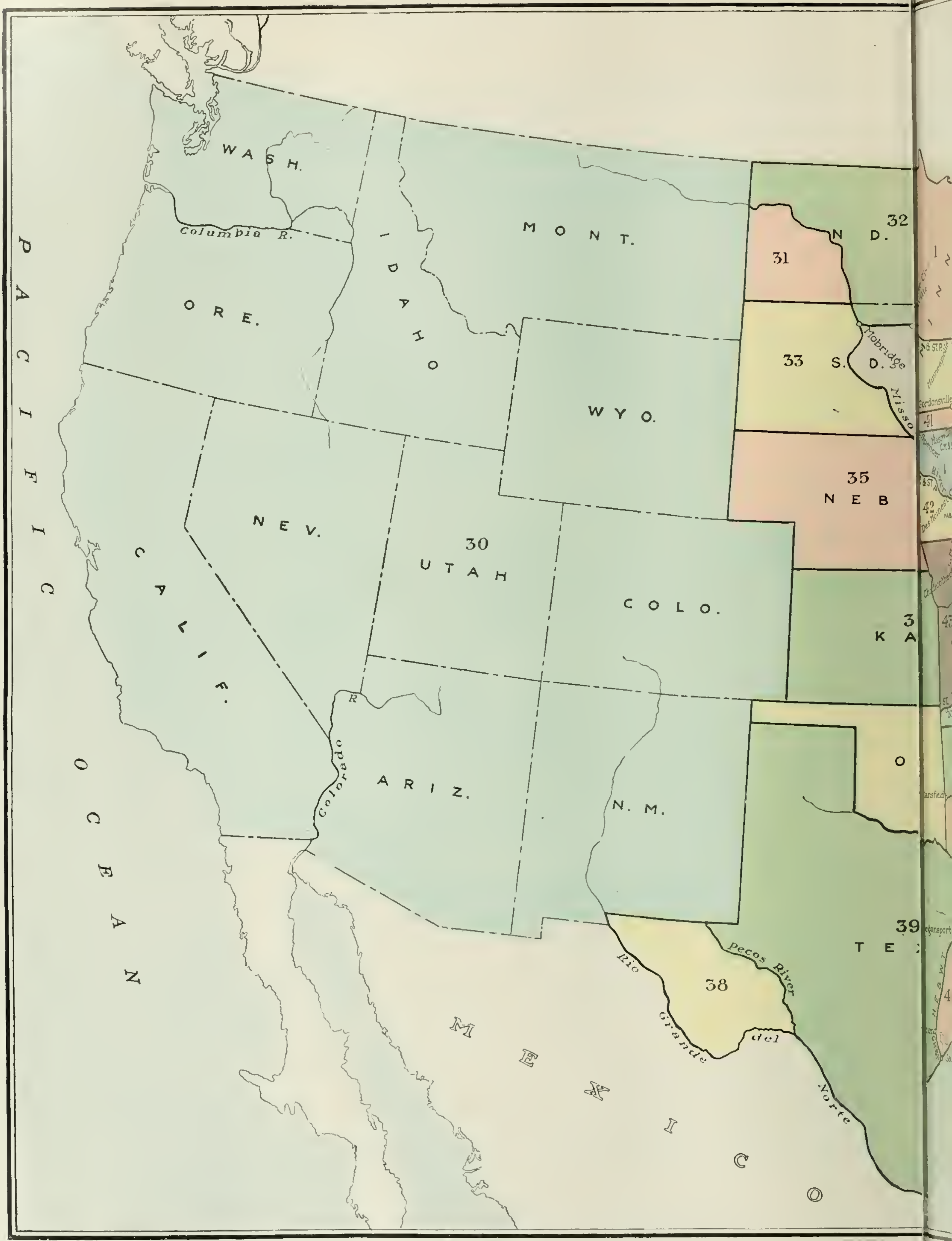
RESTRICTED TO FOLLOWING COALS—Alabama, Arkansas, Illinois (only on lines of St. L. S. W. Ry. and St. L. I. M. & S. Ry.), Kentucky (Western), Texas.

BOUNDARIES—Northern and Eastern: From Arkansas-Louisiana-Texas state line east to the Mississippi River, thence along Mississippi River (west bank) to the Gulf of Mexico. **Western and Southern:** Louisiana-Texas state line to the Gulf of Mexico, thence to Mississippi River.

ZONE NO. 47

RESTRICTED TO FOLLOWING COALS—Kentucky (Western).

BOUNDARIES—Northern and Eastern: From Kentucky-Tennessee state line south of Fulton, Ky., east to L. & N. R. R. passing south through Mitchellville, Tenn., through Nashville and Columbia to Iron City, Tenn., including Scottsville and Hartsville, Ky., branches. **Western and Southern:** From Kentucky-Tennessee state line south of Fulton, Ky., via I. C. R. R. to Memphis, thence east via N. C. & St. L Ry. to Perry-



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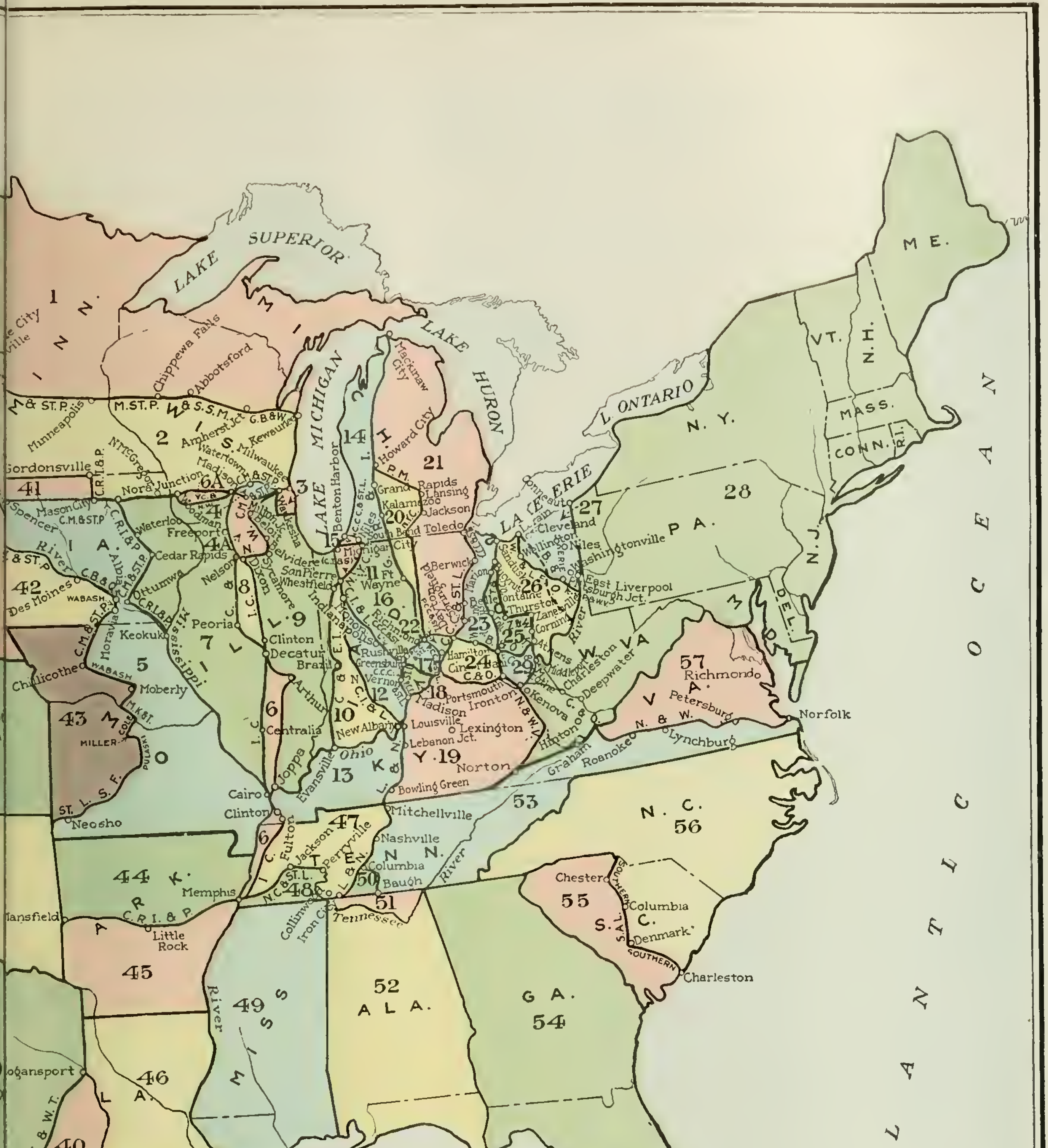
Map Showing Districts in Which Com



rom Various Sources Is Available

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ville, thence along Tennessee River (east bank) to Alabama-Mississippi-Tennessee state line, thence via Alabama-Tennessee state line to Iron City, Tenn.

ZONE NO. 48

RESTRICTED TO FOLLOWING COALS—Alabama.

BOUNDARIES—Northern and Eastern: From Memphis, Tenn., via N. C. & St. L. Ry. to Perryville, thence via Tennessee River (west bank) to Alabama-Mississippi-Tennessee state line. **Western and Southern:** From Memphis to Arkansas-Mississippi-Tennessee state line, thence east along Mississippi-Tennessee state line to the Tennessee River.

ZONE NO. 49

RESTRICTED TO FOLLOWING COALS—Alabama, Kentucky (Western).

BOUNDARIES—Northern and Eastern: Tennessee-Mississippi state line and Alabama-Mississippi state line. **Western and Southern:** East bank Mississippi River to the Gulf of Mexico.

ZONE NO. 50

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern), Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia), Kentucky (Western), Tennessee, Georgia.

BOUNDARIES—Northeastern: From Columbia, Tenn., via L. & N. R. R. to Baugh, Tenn. **Western and Southern:** From Columbia, Tenn., via L. & N. R. R. through Lawrenceburg to Iron City, thence east via Alabama-Tennessee state line to Baugh, Tenn.

ZONE NO. 51

RESTRICTED TO FOLLOWING COALS—Alabama, Kentucky (Southern), Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia), Tennessee, Georgia.

BOUNDARIES — Northern: Tennessee-Alabama state line. **Southwestern and Eastern:** Tennessee River.

ZONE NO. 52

RESTRICTED TO FOLLOWING COALS—Alabama.

BOUNDARIES—Northern and Eastern: Tennessee River to Alabama-Georgia state line, thence south along state line to Apalachicola River, thence via said river to the Gulf of Mexico. **Western and Southern:** Alabama-Mississippi state line to the Gulf of Mexico.

ZONE NO. 53

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern, also Western, to points on N. C. & St. L. and T. C. R. R. Nashville to Old Hickory and Hermitage, Tenn. inclusive), Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia, also Clinch Valley district in eastern Russell and Tazewell Counties), West Virginia (Eastern, also Southern, on C. & O. Ry. east of Charleston and N. & W. Ry. east of Iaeger, W. Va.), Georgia, Tennessee.

BOUNDARIES—Northern and Eastern: From Mitchellville, Tenn., east along Tennssee-Kentucky state line to Virginia state line, thence via L. & N. R. R. to Norton, thence via N. & W. R. R. through Roanoke. Petersburg (and branches of N. & W. R. R. at Petersburg) to Norfolk, thence south to Virginia-Carolina state line. **Western and Southern:** From Mitchellville, Tenn., via L. & N. R. R. through Nashville and Columbia to Baugh, Tenn., including Scottsville, Ky., branch, thence along Alabama-Tennessee-Georgia state line, thence via North Carolina-Tennessee state line, thence via North Carolina-Virginia state line to the Atlantic Ocean.

ZONE NO. 54

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern), Tennessee, Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia), Alabama, Georgia.

BOUNDARIES—State of Georgia and all of Florida east of Apalachicola River.

ZONE NO. 55

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern), Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia), Tennessee, Georgia, West Virginia (Eastern).

BOUNDARIES—Northern and Eastern: From Georgia-North Carolina-South Carolina state line to the line of the Sou. Ry. running south from Charlotte, N. C., through Chester to Columbia, S. C., thence via S. A. L. Ry. to Denmark, thence via Sou. Ry. to Charleston, S. C. **Western and Southern:** South Carolina-Georgia state line to the Atlantic Ocean.

ZONE NO. 56

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern), Tennessee, Virginia (all Black Mountain and Stonega Districts in Lee Dickenson, Wise and western Russell Counties of Virginia, and Clinch Valley districts in Tazewell and eastern Russell Counties along the N. & W .Ry), West Virginia (Eastern, on C. & O. Ry. and N. & W. Ry. and Virginian Ry.).

BOUNDARIES—All of North Carolina, and that portion of South Carolina on and east of the line of the Sou. Ry. Charlotte, N. C., through Chester to Columbia, thence via S. A. L. Ry. to Denmark, thence via Sou. Ry. to Charleston, S. C.

ZONE NO. 57

RESTRICTED TO FOLLOWING COALS—No change contemplated. Coal to be supplied generally from low-volatile fields.

BOUNDARIES—That portion of Virginia on and north of the N. & W. R.R. Graham, Va., to Norfolk, Va., including branches at Petersburg.

EXPLANATION OF ABBREVIATIONS AND TERMS USED

B. & O.	Baltimore & Ohio R. R.
C. & C.	Coal & Coke Ry.
C. & E. I.	Chicago & Eastern Illinois R. R.
C. & N. W.	Chicago & Northwestern Ry.
C. & O.	Chesapeake & Ohio Ry.
C. & O. N.	Chesapeake & Ohio Northern Ry.
C. B. & Q.	Chicago, Burlington & Quincy R. R.
C. C. & O.	Carolina, Clinchfield & Ohio Ry.
C. C. C. & St. L.	Cleveland, Cincinnati, Chicago & St. Louis Ry.
C. I. & L.	Chicago, Indianapolis & Louisville Ry.
C. M. & St. P.	Chicago. Milwaukee & St. Paul Ry.
C. R. I. & P.	Chicago, Rock Island & Pacific Ry.
E. R. R.	Erie R. R.
G. B. & W.	Green Bay & Western R. R.
G. H. & H.	Galveston, Houston & Henderson R. R.
G. R. & I	Grand Rapids & Indiana Ry.
H. E. & W. T.	Houston East & West Texas Ry.
H. V.	Hocking Valley Ry.
I. C.	Illinois Central R. R.
K. & M.	Kanawha & Michigan Ry
K. & W. V.	Kanawha & West Virginia R. R.
L. & N.	Louisville & Nashville R. R.
L. F.	Long Fork R. R.
M. C.	Michigan Central R. R.
M. K. & T.	Missouri Kansas & Texas R. R.
M. R. R.	Middlesborough R. R.
M. St. P. & S. S. M.	Minneapolis, St. Paul & Sault Ste. Marie Ry.
N. & W.	Norfolk & Western Ry.
N. C. & St. L.	Nashville, Chattanooga & St. Louis Ry.
N. Y. C.	New York Central R. R.
P. & W. V.	Pittsburgh & West Virginia Ry.
P. C. C. & St. L.	Pittsburgh, Cincinnati, Chicago & St. Louis Ry.
P. Co.	Pennsylvania Co.
P. M.	Pere Marquette Ry.
Q. & C.	Queen & Crescent Route.
S. A. L.	Seaboard Air Line Ry.
Sou. Ry.	Southern Ry.
St. L. I. M. & S.	St. Louis, Iron Mountain & Southern Ry.
St. L. S. F.	St. Louis-San Francisco Ry.
St. L. S. W.	St. Louis-Southwestern Ry.
T. & O. C.	Toledo & Ohio Central Ry.
T. C.	Tennessee Central R. R.
V. Ry.	Virginian Ry.
W. & L. E.	Wheeling & Lake Erie Ry.
W. M.	Western Maryland Ry.
W. Ry.	Wabash Ry.
Y. & O. R.	Youngstown & Ohio River R. R.
Z. & W.	Zanesville & Western Ry
Summer	From Apr. 1 to and including Sept. 30.
Winter	From Oct. 1 to and including Mar. 31.

KENTUCKY

Eastern	All mines in eastern Kentucky on Sou. Ry. (Q &C.), L & N., C. & O., N. & W. and L. F.
Northeastern	Sandy Valley & Elkhorn Ry., L. F., C. & O., and N. & W. in Thacker, Big Sandy and Elkhorn districts.
Northern	L. & N. in Hazard and Elkhorn districts.
Southern	Sou. Ry. (Q.&C.) and L. & N. in Harlan, Jellico and Southern Appalachian districts.
Western	L. & N. and I. C. west of Louisville, Ky.

WEST VIRGINIA

Eastern	C. & O. and N. & W. in low-volatile fields of Pocahontas, Tug River and New River districts.
Northern	K. & M., K. & W. V. and C. & C. west of Dundon.
Southern	C. & O. and N. & W. in Kanawha, Kenova and Thacker districts.

KEY TO PRODUCING DISTRICTS

Location of Producing Districts	Numbers of Consuming Zones to which restricted
Alabama	40, 45, 46, 48, 49, 51, 52 54
Arkansas	5, 35, 36, 37, 39, 41, 42, 43, 44, 45, 46.
California	30.
Colorado	30, 31, 33, 35, 36, 37, 38, 39.
Docks[1]	1, 2, 3, 4, 4A, 6A, 31. 32, 33, 34, 41.
Georgia	50, 51, 53, 54, 55.
Illinois (summer)	2, 34, 41.
Illinois	3, 4, 4A. 5, 6, 6A, 7, 8, 9, 10[2], 11, 12[2], 15, 16[2], 20[2], 44, 45[3], 46[3].
Indiana	3, 8, 9, 10, 11, 12, 14, 15, 16, 20.
Iowa	2[4], 5, 7[4], 35, 36, 41, 42, 43.
Kansas	5, 35, 36, 37, 41, 42, 43, 44, 45.
Kentucky:	
Eastern	11, 14, 15, 16, 17, 19, 20, 21, 22.
Northeastern	23, 24.
Southern	18, 50, 51, 53, 54, 55, 56.
Western	3, 4, 6, 6A, 9, 10, 11, 13, 15, 40, 45, 46, 47, 49, 50, 53[5].
Maryland	57.
Michigan	14, 15, 20, 21.
Missouri	5, 35, 36, 37, 41, 42, 43, 44, 45.
Montana	30, 31. 32, 33, 34, 35.
New Mexico	30, 35, 37, 38, 39.
North Dakota	1, 2, 31, 32, 33, 34
Ohio	14[6], 20, 21, 22, 23, 24, 25, 26, 27, 28[7], 29.
Oklahoma	5, 35, 36, 37, 39, 41, 42, 43, 44, 45.
Oregon	30.
Pennsylvania	27, 28, 57.
South Dakota	1, 2, 32, 33, 34.
Tennessee (M. R. R.)	11, 14, 15, 17, 18, 19, 20, 21, 22.
Tennessee	50, 51, 53, 54, 55, 56.
Texas	37, 38, 39, 40, 41, 45, 46.
Utah	30, 31, 33, 35, 36.
Virginia (L. & N.)	11, 14, 15, 17, 18, 20, 21, 22.
Virginia[8]	50, 51, 53. 54, 55, 56.
Virginia[9]	53, 56.
West Virginia:	
Eastern	19, 23[10], 24[10], 25[10], 29[10], 53, 55, 56.
Northern	14, 15, 20, 21, 23, 25, 29.
Southern	11, 14. 15. 16. 17. 19, 20, 21, 22, 23, 24, 53.
Wyoming	30, 31, 32, 33, 34, 35

[1] South bank Lake Superior and west bank Lake Michigan.

[2] From Danville district on Wabash Ry. only.

[3] Only on lines of St. L. I. M. & S. and St. L. S. W. Rys.

[4] To points in Iowa only.

[5] To points on N. C. & St. L. and T. C. Nashville to Hermitage and Old Hickory, Tenn., inclusive.

[6] On G. R. & I. only.

[7] From mines in Columbiana County, O., only.

[8] All Black Mountain and Stonega districts in Lee, Wise, Dickenson and western Russell Counties.

[9] Clinch Valley districts in Tazewell and eastern Russell Counties.

[10] Along lines of C. & O. and N. & W. to Cincinnati and Columbus, O.

The Government and The Water Powers

An Interview with

Hon. Franklin K. Lane

SECRETARY OF THE INTERIOR

IN THE hearings before the Special House Committee on the Administration's Water-Power Bill, Chairman Sims asked a number of questions which involved the right or the probable disposition of the Federal Government to take over and operate the properties upon the expiration of the license. At that time, under the measure before the committee, the Government would have its choice of three courses:

To take the property;

To transfer the privilege to another licensee;

To renew the license to the original holder.

Suppose, as likely to be the case, that there is no other applicant for the privilege; then the Government must either renew the license or take the project over and operate it. If the Government has no use for the power for purely governmental purposes such as making nitrates or munitions or operating possibly government-owned railways, could it make current for sale? Has it the right under the Constitution to go into the business of supplying electricity for light, heat and power, and water for irrigation commercially? If so, is it entitled to do so at a profit or would it have to furnish the current at cost? Would it be possible against powerful opposing influences to get Congress to vote a huge appropriation for the purpose of going into business in competition with an industry the recent growth of which is significant of what it will come to be in fifty years?

Would License Be in Effect a Grant in Perpetuity?

If the Government were found to be unauthorized to take over such a project and operate it commercially or if the objections to doing so were insuperable, would it not be reduced to the necessity of renewing the license to the original holder and that upon his own terms? Would not the license under such circumstances be in effect a grant in perpetuity?

This phase of the question evoked so much interest and discussion among those present at the hearings and others that we sought an expression from Secretary Lane, whose experience in former connections as well as in his present administrative position gives especial weight to any utterance of his upon the subject.

The Secretary expressed the opinion that the license would not, in effect, be a grant in perpetuity, for the reason that the bill provides that a renewal in such case shall be upon such terms and conditions as may be prescribed by the then existing laws, affording Congress ample opportunity to impose such new terms or conditions as the public interest shall then be deemed to require. The Government will not be required to renew the license upon the original holder's "own terms," because if the United States does not take over the properties itself or find another applicant who will take them, the original licensee must accept any condition offered or abandon his property and lose his whole investment.

As to the right of the Government to acquire and operate such a project, Mr. Lane thought there could be no doubt. The Salt River reclamation project, he said, "which I have turned over to the water users for operation," is practically paying its own way out of the power developed under the Roosevelt dam. The Shoshone reclamation project in Wyoming, built by the Department, is furnishing water for irrigation and electricity to towns and industries within a wide radius, as is also the project at Minidoka, Idaho.

Government Right to Sell Water and Electricity

"Has the right of the Government to sell water and electricity ever been questioned?" we asked.

"Never," replied the Secretary. "If it were, how would you justify it? There is probably no inhibition, but it is urged by the opponents of Government activities of this sort that among the powers conferred upon the Federal Government by the constituent states there are none which can be construed to warrant such undertakings.

"I know of no inhibition in the Constitution or elsewhere upon the right of the Federal Government to develop water power and dispose of the product to the public," said the Secretary. "Under the Constitution, the Federal Government has jurisdiction and authority over the navigable waters of the United States, under which authority dams and other works for the improvement of navigation are constantly being constructed. Many of these structures involve the incidental development of water power, and there can be no question, I think, of the right of the Government to utilize this incidental value for the benefit of the public and to secure a return to the Federal Treasury of a part of the expenditures made for such improvements.

Right of Congress to Dispose of Public Lands

"As to the public lands, the Constitution vests in Congress full authority to 'dispose of' the same. The Supreme Court has stated that Congress may deal with these lands precisely as an ordinary individual may deal with his property, and that as the lands are held in trust for the people of the whole country, it is for Congress to determine how they shall be handled. For instance, Congress has a right to establish forest and other reservations for public purposes, or to devote lands to some other national or public purpose. These are rights incident to proprietorship, to say nothing of the power of the United States as a sovereign over the property belonging to it. Furthermore, the so-called general welfare clause of the Constitution has been given a very liberal construction and indicates the intention of the framers of the Constitution to confer very broad powers upon the Federal Government for the public good. The Government was created by the people and is operated for their benefit. If the public interest warrants or requires the development of electrical power and its sale by the Federal Government, the Constitution seems to fully warrant the undertaking.

"But," continued the Secretary, "would not the probable outcome be that the municipality, which would naturally grow up about one of these developments, would acquire it on the expiration of the license? A project too large for a municipality or a drainage or other district could be acquired by the state. There is no doubt of the competency of any state to enter upon such an undertaking, and the competency of a municipality or district is a matter of state legislation. In view of the present tendency of public opinion one can well imagine a general disposition on the part of communities to own their own public utilities by the time these licenses begin to expire."

Public Ownership of Public Utilities

We acknowledged our sympathy with the tendency and the probability of the suggested outcome so far as public utilities were concerned. "But what," we asked, "would happen in the case of a project which served only special industries; big metallurgical works, for example? If a license were granted to a syndicate of paper manufacturers to develop a power for the manufacture of paper, what could the Government do with that on the expiration of the license, and would it have any control of the project in the meantime? Not being a public utility, would it come within the jurisdiction of a public-utility commission or similar body? Could the Federal commission control it? If the commission undertook to recover exorbitant profits by the imposition of a high rental, they would simply pass the charge on to the consumer."

Secretary Lane thought that this would be a very exceptional case. "A community would undoubtedly grow up about such an industry and the water power would supply the needs of that community and so become to an extent a public utility, sufficiently so perhaps to warrant the community in taking it over. Most public utilities furnish power as well as light, and their status as public utilities is not determined by the proportion of their output sold for power or the number of their power customers. As to rate control during the term of the license, the syndicate would have to sell in competition with other manufacturers and the growing sentiment in favor of restricting prices to cost plus a fair profit and legislation against control of production and distribution could be depended upon to prevent an abuse of the privilege or its use for speculative purposes. The time is long past, and wise men see that it is past, when there is a speculative value in these things. The right of the community, of the nation, of the collective body of citizens that we call the people of the United States, their right is superior to any right that you or I may have to speculate upon those things that are primary resources."

"What is your attitude, Mr. Secretary," we asked, "toward the initial development of the powers by the Federal Government?"

"If we had money enough," said Mr. Lane; "if this were not a time of war; if we could think in the terms of money that we are now thinking of; or if four or five years ago Congress had been willing to expend hundreds of millions of dollars in the development of water power as it is forced now to spend billions of dollars for war—then it would be a wise thing to put a large part of the public revenues into such projects where they are found to be needed. I have no doubt in my own mind that such schemes as water-power developments are perfectly practicable from a governmental standpoint, no matter what your sympathies may be respecting Government ownership, as a rule, of large utilities. A thing that is as well standardized as a water-power scheme can be operated successfully by the Government. But I do not think that this is practicable at this time nor probably will it be for many years to come, and it is necessary that there should be real development, and that soon.

"The water powers should be given into the hands of the men capable of developing them under such conditions as will warrant large investment. We cannot save things for men who have no capital, or men who go about things with a spade where a steam shovel is needed. The conditions under which these privileges are granted should guard against extortion during their use and insure the return of the resource to the people at the termination of the license if the people want to take it back by refunding the net investment. The term of the grant should be long enough to afford the promoter or *entrepreneur* an opportunity to make a profit commensurate with his risk and enterprise, and to attract the necessary interest, talent and capital to get some good out of these powers for the present generation and stop our extravagant incursions upon the supply of fuel that is of increasing value for other than power purposes. The bill before Judge Sims' committee is designed to do this and seems to promise to do it better than any measure previously offered."

Our Government wants to spend 19 billion dollars this year, a sum so vast that it cannot be comprehended. From 1791 to Jan. 1, 1917, a period of 126 years, the Government spent only 26 billion, 300 million for all purposes—for wars and in times of peace, for pensions, for the Panama Canal, and for every other expense of the Government. This is only about five billion dollars more than has been appropriated by Congress to be spent in one year to provide for the tremendous demands of the war. This sum cannot be borrowed except from the people. It cannot be raised except by taxation or loans from the current income of the people. We must save and lend our savings to the Government.

What is the Capacity of a Turbine?

In "Power" for Mar. 19 appeared an editorial on the question which forms the title above. There is renewed interest in the subject. In the editorial those interested were invited to express their opinions. Some are given in this article.

THE Power Test Code of the American Society of Mechanical Engineers, page 30, paragraph 23, reads as follows: "The commercial rating of capacity determined on for power-plant apparatus, whether for the purpose of contracts for sale, or otherwise, should be such that a sufficient reserve capacity beyond the rating is available to meet the contingencies of practical operation; such contingencies, for example, as the loss of steam pressure and capacity due to cleaning fires, inferior coal, oversight of the attendants, sudden demand for an unusual output of steam or power, etc."

Needless to say, this paragraph is controversial, and is the subject of serious consideration by the Power Test Committee of the society, which committee is now revising the code.

The Prime Movers Committee of the National Electric Light Association has not expressed itself on this question of turbine capacity. The Association of Edison Companies has not declared what it accepts or agrees is the capacity of a turbine, neither has the American Institute of Electrical Engineers so far as the writer can learn. This much may be said: Most engineers responsible for the selection and operation of large turbines, particularly, agree that if a turbine guaranteed to give a specified capacity at specified conditions of steam pressure, superheat and vacuum gives the specified capacity, the builder has fulfilled his obligations though not one kilowatt more than that capacity can be got, the steam pressure, superheat and vacuum being the same.

The expressions which follow are by men prominent in turbine and power-station development; all are anonymous.

From a user: The writer has closely followed turbine development practically from its start, and was not aware that there was any active question about turbine rating at this time. If, however, this question is active, the American Society of Mechanical Engineers should investigate and report upon the subject.

Another procedure which I would suggest is to submit this matter to the consideration of the Prime Movers Committee of the National Electric Light Association and the Steam Plant Committee of the Association of Edison Illuminating Companies. Both of these bodies are composed of the leading men in the electrical industry, all of whom have given much thought to turbine matters.

In the earlier days of turbine development it was customary to apply two ratings to a machine; namely, normal capacity and maximum capacity. This double rating was objectionable and has been abandoned. Today, turbines are rated on maximum capacity based on steam pressure at the throttle, or in the bowl, superheat and vacuum. These conditions are applied to a steam engine, and there is no uncertainty in the mind of anyone about the performance of the engine. They apply just as well to the turbine. When these conditions are complied with by the purchaser and the guaranteed kilowatt load is developed by the turbine, the purchaser is getting what he purchased, and he has no more grounds for asking that he should get a greater output than he would have to expect a grocer to sell him a pound and a quarter of sugar when he ordered a pound.

The character of the station load has nothing to do with the capacity of the turbine. Load fluctuations vary with different stations, and they vary from hour to hour in any station. The turbine manufacturer does not know and is not concerned about this; that is a matter of engineering on the part of the purchaser. If the latter does not properly do his engineering the turbine manufacturer should not be blamed.

As a matter of fact, I think the thought that inspired the editorial was not the determining of the capacity of a given turbine when steam conditions are fixed, but determining what capacity turbine should be installed to meet load conditions in a given station. This is a matter that cannot be governed by any set of rules, but must be determined for each specific case.

From a designer: It is not surprising that there should be revived the question, "what is the Capacity of a Turbine," notwithstanding all that has been written on the subject. The bald statement of so many kilowatts capacity means nothing without more explanation, and if one desires to state the capacity, more explanation is necessary. This is rightly so, for in accordance with the required service some turbines are designed to have very large and others very small capacities above the point at which their steam consumption is best, all depending upon the load factor. This perhaps has been rendered more aggravating by a tendency on the part of salesman and purchaser alike to say their turbine is as big as they can stretch it. It is not uncommon for a turbine and generator to be called upon to sustain a load 100 per cent. in excess of the average load for a limited time; which gives opportunity for a wide disparity of rating.

The old Corliss engine practice of giving an engine an arbitrary overload capacity of 50 per cent. would seem to have no place today because of the varying load factors that obtain; for example, in large lighting systems on the one hand, where a turbine, if operating at all, is operating close to its point of best steam consumption, a very small percentage capacity above this is needed. On the other hand there are other plants, railroads, for example, where the turbine is called upon to sustain heavy peak loads and swings, sometimes requiring a capacity 100 per cent. in excess of the point of best steam consumption.

It is certainly convenient to specify the rating of the generator at its maximum continuous capacity, and so far as the generator itself is concerned, there need never be confusion. With the turbine the matter is more difficult, and this is made doubly so by its extreme flexibility. A turbine designed to pass a given number of pounds of steam, if designed with proper regard to the volumes of steam, will give the best performance with a flow of this quantity. It requires no particular ingenuity on the part of the designer to find means of passing a much larger quantity of steam through the turbine, permitting much greater loads, with some impaired efficiency.

If your question is prompted by considerations of the safety of the turbine under overload, as seems to be implied, then it may be said that with full specified pressure behind all the nozzles with which the turbine is equipped, or, if bypassing is resorted to with full pressure at these secondary points of admission, no dangerous pressure should obtain in any of the lower stages. In other words, the turbine is defective if it cannot be caused to slow down by an excessive overload without injury to the turbine. This also with allowance for a reasonable increase of pressure beyond that specified and also with a simultaneous loss of vacuum which in itself will cause increase of pressure in certain of the low-pressure stages.

It may be thought desirable by some people to state in a word the capacity of a machine which rather more expresses its monetary value, or its physical dimension for the same reason that many years ago prompted the use of the term "nominal horsepower."

Is not the matter entirely covered and made clear by merely stating the kilowatts capacity at the point of best steam consumption, and in addition the maximum continuous kilowatts capacity; the latter being the extreme load the turbine is warranted to sustain when operating under the specified operating conditions? The former in a measure expresses the size of the machine. To describe the complete unit one should further amplify this by quoting the maximum continuous rating of the generator, which is not necessarily the maximum capacity of the turbine.

From a user: Before the days of large steam turbines the commercial rating of reciprocating engines was established by common practice at about 85 per cent. of their maximum capacity, which gave considerable overload capacity to meet the swings which might demand capacities above the commercial rating.

When turbines entered the field it quite naturally followed that their rating should be calculated on the same basis, and in addition, the turbine designers, lacking in experience and data combined with a desire to produce the required horsepower in their machines, very much underestimated their capacity, and in comparison with the generators turbines were much overpowered and furnished almost unlimited overload capacity. Sometimes the capacities were as high as 100 per cent. above builder's rating. It is not difficult to see that this condition would eventually adjust itself to a more accurate basis for calculating capacities when the experience in operation had demonstrated that turbines were, in comparison with reciprocating engines, much underestimated, with the result that today machines are rated at 7500 kw. which in former years were sold for 5000-kw. machines. The former has led to confusion when referring to turbine capacities, producing a new term, "maximum capacity," to denote the physical limit of output as compared with the old commercial rating.

At present contracts for turbines are drawn with the understanding that with a given steam pressure, superheat and vacuum they will develop their maximum rating. As it is difficult to design a turbine so that it will develop its rated capacity and no more, there is generally a slight reserve capacity above the rated capacity. Should a turbine purchased as a 10,000-kw. machine on test develop 11,000 kw., the purchaser has a 10,000-kw. rated machine with capacity of 11,000-kw.; but it does not follow that all 10,000-kw. machines will carry 11,000 kw. Under the same contract conditions should the turbine develop 10,000 kw. only as its maximum load, the contractor has met his obligations. Should the turbine fail to carry the rated load when the conditions of pressure, temperature and vacuum are not met with, the machine does not in any sense become one of lower capacity.

As all turbine installations should include recording instruments to measure the load, vacuum, pressure and temperature, the question of conditions under which a machine might fail to maintain its speed is easily determined.

The load to be reported to the public service commission from the operating station should be maximum hour, maximum of 15 min. and the maximum swing.

The writer of the first communication mentions that the question of what capacity turbine should be installed to meet load conditions in a given plant may have been the thought which prompted the editorial. While the questions of capacity of a particular turbine and of what capacity turbine or turbines should be installed for given load conditions are separable, they are, of course, closely related, one greatly influencing the other.

This latter question has always been a controversial one; but since the introduction of turbines of large capacity—units of 30,000 and 35,000 kw. are becoming numerous and some of 60,000 kw. are being built—it has become more unsettled. This question, which is that of what reserve capacity to allow, also is one demanding consideration by individuals and the engineering societies.

How Is This for Red Tape?

Considerable has been said about the water-power developments of this country being tied up with governmental red tape, but how about Italy? E. Strachan Morgan, writing in the London *Electrical Review* on, "Electrical Developments in Italy," says:

> There were a short time ago lying in the Ministero delle Finanze 2600 demands for water-power concessions, some of which had been on file for more than 20 years. Even by the provisions of the Villa Bill, drafted with a view to simplifying procedure, every demand goes through twelve stages. It goes to the Prefetto, to the Genio Civile, to the Magistrato Supremo delle Acque in Rome, then back to the Prefetto, to the Deputazione Provinciale, then back to the Genio Civile, which at last orders a survey of the local conditions, then back to the Magistrato Supremo in Rome, then to the Ministero dei Lavori Pubblici, then back to the Magistrato Supremo, then to the Ministero delle Finanze, at whose recommendation the concession may be granted by a Decreto Reale. It does not take much knowledge of bureaucratic procedure to realize what considerable possibilities of delay there are even in this "express" treatment of a demand.

Show your patriotism by contributing to the American Red Cross Fund.

Determining of Load Centers of Circuits*

By TERRELL CROFT

The object of this article is to explain the location of load centers of electric circuits in a way that it can be readily understood. The results given by the methods indicated, are not absolutely accurate, but they are sufficiently so for all practical purposes.

THE location of the load center of a circuit with a distributed load must be determined before any wiring formula can be correctly used for it. The load center of a circuit is that point at which the total load on the circuit can be assumed to be concentrated when making wiring calculations. An electrical-load center is somewhat analogous to a center of gravity of a body. To illustrate, in Fig. 1 all of the eight lamps are of the same size and equal distances apart. The load center for the branch circuit lying between switch S and the last lamp B is at AA; that is, it is at the middle of the group of lamps. The distance from the starting point S of the circuit to the load center, denoted by D, would be used for the distance D in the direct-current formula, cir.mils. $= \frac{22ID}{E_d}$. The voltage drop E_d in the formula would be the drop in the circuit from the switch S to the last lamp B. The current I of the formula would be the total current taken by all of the eight lamps, or for any condition the sum of the amperes taken by all the elements on the circuits. If the conductors were calculated for a drop of 5 volts, the drop between S and B would be 5 volts. Then if the electromotive force impressed at S is 110 volts, the pressure at lamp B, with all lamps burning, will be 110 — 5 = 105 volts. The other seven lamps in the group would be subjected to somewhat greater voltages. The pressure would increase slightly at each successive lamp in the direction of the switch; lamp C would receive the highest pressure of the group.

In practice the location of the load center is seldom determined by calculation. An approximate location is assumed, the position of which is determined by inspection of the loads on the circuit and their positions. Considerable experience is necessary before the center can be thus located by inspection with a fair degree of accuracy. The beginner should compute several cases until he is familiar with the principles involved. A high degree of accuracy in the location of the load center is not essential, because there are other factors entering into wiring calculations that usually cannot be accurately determined.

The load center of a group of receivers symmetrically arranged and all of the same capacity will be in the middle of the group, as indicated in Figs. 1 and 2. The distance denoted by D in the wiring calculation formula is the distance from the beginning of the circuit under consideration to the load center, measured along the circuit.

The load center of a group of receivers unsymmetrically located or of unequal capacities is found by first multiplying the normal-ampere capacity of each receiver by its distance from the beginning of the circuit under consideration, second, adding all these products together, and third, dividing this sum by the total current of the circuit. The quotient thus obtained will be the distance in feet of the load center from the starting point of the circuit. In Fig. 3 there are three loads of 100, 40 and 20 amperes located 80, 100 and 130 ft. respectively from the switch S at the source of supply. To find the location of the load center as explained in the foregoing, first multiply the distance in feet each load is from the beginning of the circuit, by the normal amperes of the load corresponding to each distance. Thus:

80 ft. × 100 amp. = 8,000 amp.-ft.
100 ft. × 40 amp. = 4,000 amp.-ft.
130 ft. × 20 amp. = 2,600 amp.-ft.
Total, 160 amp. 14,600 amp.-ft.

Then the total ampere-feet divided by the total current is 14,600 ÷ 160 = 91.25 ft., equals the distance the load center is from the beginning of the circuit as shown in the figure.

Instead of measuring all the distances from the beginning of the circuit, they can be measured from the first receiver of the group; then the resulting distance to the load center will be measured from the first receiver of the group. The example Fig. 4, illustrates this method. Multiplying the distance in feet of each receiver from the first load by each load in amperes, the result is:

0 ft. × 100 amp. = 0 amp.-ft.
20 ft. × 40 amp. = 800 amp.-ft.
50 ft. × 20 amp. = 1,000 amp.-ft.
Total, 160 amp. 1,800 amp.-ft.

Then dividing the total ampere-feet by the total amperes, 1800 ÷ 160 = 11.25 ft., equals the distance in feet from the first load to the load center. This value plus the distance from the beginning of the circuit to the first load is the distance that the load center is from the supply end of the circuit, in this case equals 80 + 11.25 = 91.25 ft., as indicated in Fig. 4. This result is the same as that obtained with the method given in Fig. 3. However, it should be noted that these methods are not absolutely correct, because they assume that each receiver takes its normal current. This assumption is not a true one, because the voltage at the farther end of a circuit is lower than that at the near end. Consequently, the same lamps or other receivers will pass more current if located at the near end of the circuit than at the far end. Nevertheless, these values are accurate enough for use in wiring calculations.

Where no energy is taken from a circuit except at its end, the distance D used in the formula for circular mils, is the entire length of the circuit. This is illustrated by the example in Fig. 5. Here the only load on the circuit is one of 100 amperes at the end of the line, 250 ft. from the supply main. Then the load center is at the point AA in the circuit, or where the load is located. With a 100-ampere load and a 5-volt drop in the line, the size of conductors required is

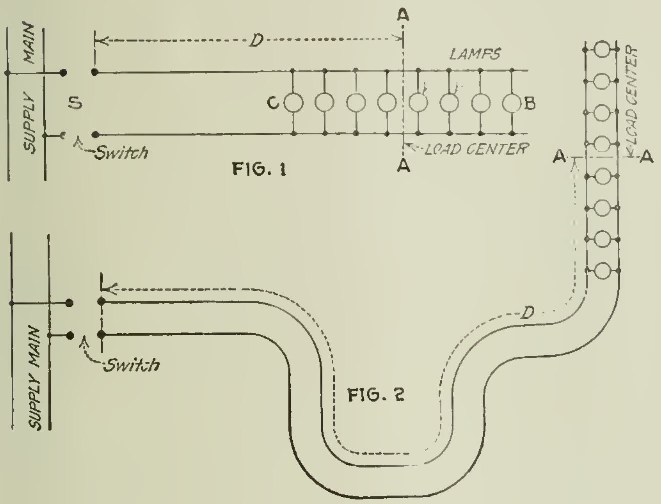
$$cir.mils = \frac{22DI}{E_d} = \frac{22 \times 250 \times 100}{5} = 110{,}000$$

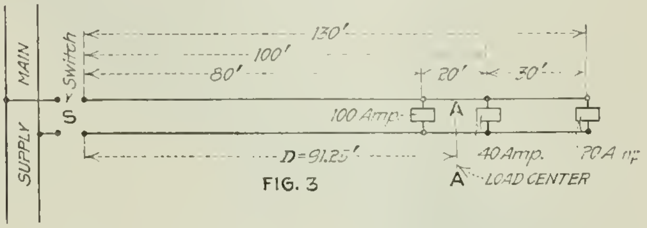
The problem, Fig. 6, will further illustrate how a load-center value is used and is typical of those which are often encountered in practice:

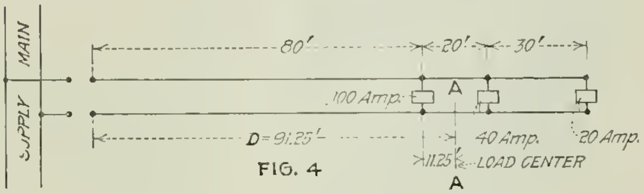
A direct-current circuit is to supply a total load of 155 amperes. This is subdivided into minor loads of 35, 15, 60 and 45 amperes, located respectively 180, 200, 280 and 325 ft. from the source of energy, as indicated in the figure. The permissible drop in the circuit is 5 volts. Where is the load center located? What size conductors should be used to insure that the drop to the last load on the circuit (the 45-ampere load) will not exceed the permissible drop $Ed = 5$ volts?

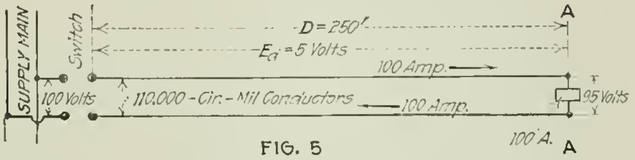
To find the location of the load center the procedure indicated in Fig. 3 may be followed, thus:

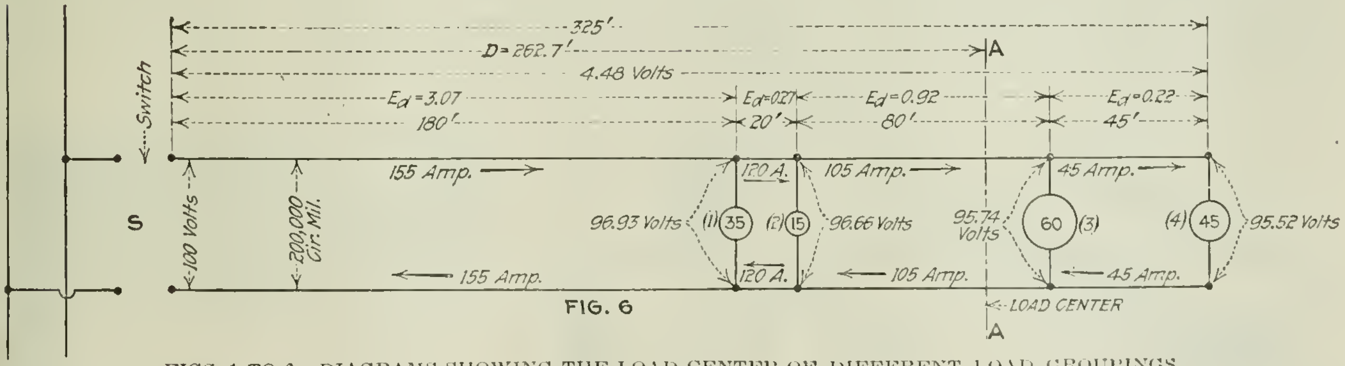
180 ft. × 35 amp. = 6,300 amp.-ft.
200 ft. × 15 amp. = 3,000 amp.-ft.
280 ft. × 60 amp. = 16,800 amp.-ft.
325 ft. × 45 amp. = 14,625 amp.-ft.
155 amp. 40,725 amp.-ft.











FIGS. 1 TO 6. DIAGRAMS SHOWING THE LOAD CENTER OF DIFFERENT LOAD GROUPINGS

The total ampere-feet divided by the total amperes is 40,725 ÷ 155 = 262.7 ft. approximately. Therefore, the load center is the distance $D = 262.7$ ft., as shown in the figure, from the source of energy. The current I is 155 amperes, then the size of the conductors required to not exceed the 5 volts drop in the line is

$$cir.mils = \frac{22DI}{E_d} = \frac{22 \times 262.7 \times 155}{5} = 179{,}161$$

The next size larger standard conductor is 200,000 cir.mils. and is the size that will have to be used. This size conductor will give a slightly less volts drop in the line than the size calculated on account of having less resistance.

The volts drop and current in the different sections of the circuit, the distances and the voltage at each receiver, are shown on the figure. The total drop to the last load is 4.48 volts. The drop in each section was computed by the formula:

$$E_d = \frac{22DI}{cir.mils}$$

where D is the length in feet of each section. Hence the volts drop in the first section is $E_d = \frac{22 \times 180 \times 155}{200{,}000} = 3.07$ volts,

in the second section, $E_d = \frac{22 \times 20 \times 120}{200{,}000} = 0.27$ volt,

in the third section, $E_d = \frac{22 \times 80 \times 105}{200{,}000} = 0.92$ volt,

and in the fourth section, $E_d = \frac{22 \times 45 \times 45}{200{,}000} = 0.22$ volt.

The difference between the voltage at the switch and the volts drop in the first section will give the volts at load No. 1, or 100 — 3.07 = 96.93; the difference between the voltage at the first load and the volts drop in the second section will give the volts impress at the third second load, or 96.93 — 0.27 = 96.66 volts; at the third load the volts equal 96.66 — 0.92 = 95.74 volts; and at the last load the volts equal 94.74 — 0.22 = 95.52 volts. This makes the volts drop in the line 4.48 instead of 5, as assumed at the beginning on account of the conductors being slightly larger than the theoretical size calculated.

"John Crane" Flexible Metallic Packing

Flexibility and compressibility are necessary features in a packing which must also possess the ability to prevent pressure from leaking past it. In order to meet these requirements, the "John Crane" flexible metallic packing is made by taking long thin continuous strips of metal foil and wrapping them spirally around and around and back and forth and coating each sheet with a layer of lubricant, Fig. 1, the purpose of which is to permit the metal strips to slide on each other and to allow bending about the smallest diameter rod and at the same time giving it compressibility sufficient to compensate for wear and to control any leakage at ordinary pressures.

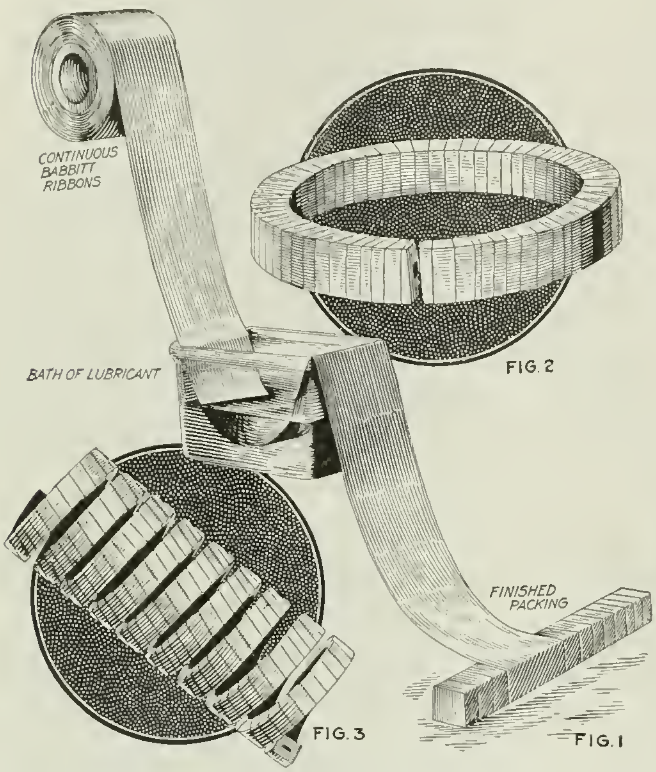
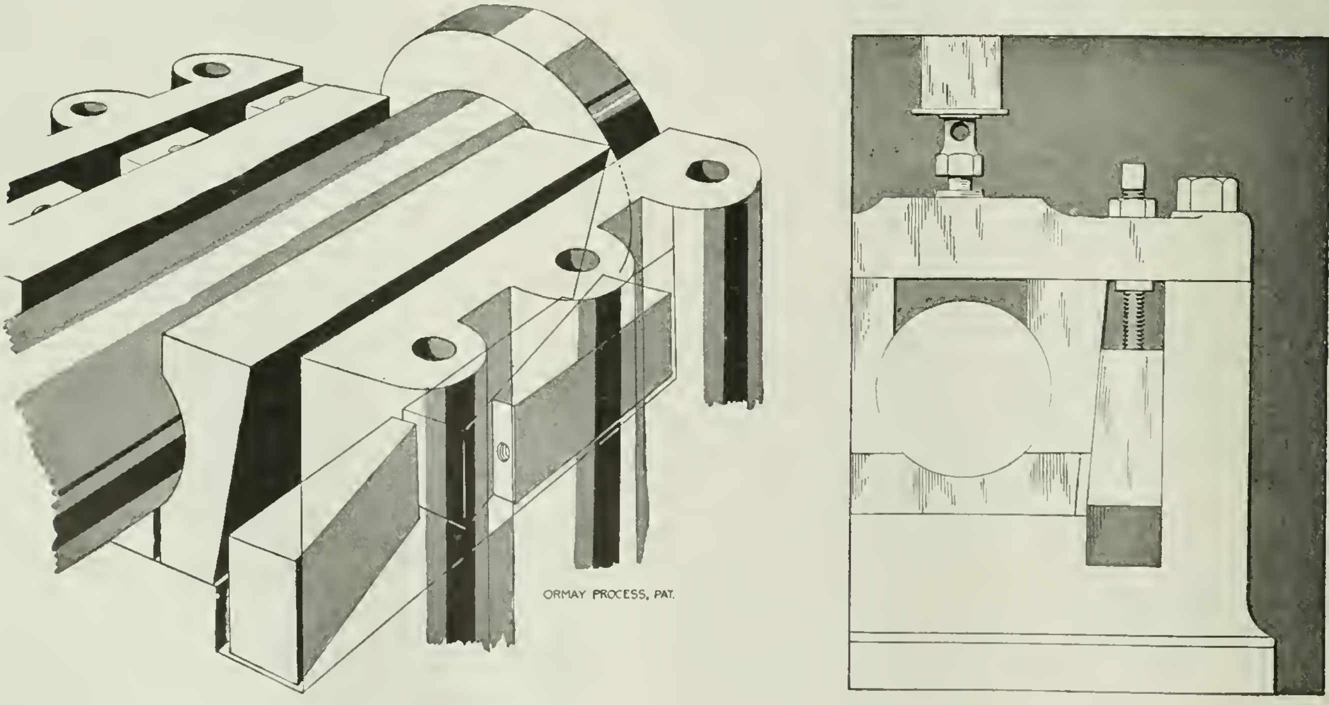


FIG. 1. LUBRICATING THE METAL STRIPS. FIG. 2. RING PACKING. FIG. 3. SPIRAL PACKING

The antifriction metal of which the packing is made is so soft that it can be easily cut with a knife and it will take any shape. This packing, made by the Crane Packing Co., 29 South Clinton St., Chicago, Ill., is in a large number of forms, such as straight lengths, rings, and spirals, from $\frac{1}{32}$ in. to 2 in. in size. It is suitable for steam, ammonia, hot and cold water, both high- and low-pressure; hydraulic, oil and acid service. The ring and the spiral forms of packing are shown in Figs. 2 and 3, respectively. The rings are generally preferred for large plungers, and the spiral coils are used on small work, such as valves and small steam rods.

Removing Main-Bearing Quarter Blocks

Lacking the right "twist of the wrist," a simple job sometimes becomes an ordeal. For example, it became necessary to remove the quarter blocks from the main bearing of a Buckeye engine. After taking off the cap and dropping the three adjusting wedges as far as they would go, the bearing would not lift out. The wedges were "big end down" and would not come out, of course; the governor was over too close to allow them to come out sidewise, and to shift the governor over on the shaft was "some job"—this was done once, but was not bragged about later when the right way was found. The fact that this (shifting the governor) was done by the engineering staff of a steel company seems to justify writing this. All there is to getting the wedges out of the way is to move two of them over to one side enough to allow the other to be laid over on its side (small end toward the others) then the middle one can be laid over alongside of it (small end toward the large end of the first one) and pushed over enough to allow the third one to be laid over on its side. This leaves "all kinds of room" to handle the quarter block.



ADJUSTING WEDGES LAID OVER ON SIDES OUT OF THE WAY

Favorable Performance of High Setting

By H. L. Strong

Though modern practice has proven the desirability of setting boilers well up from the fire and leaving ample room for the complete burning of the gases, it seems difficult for many to grasp the idea and apply it in practice, especially when applied to horizontal tubular boilers.

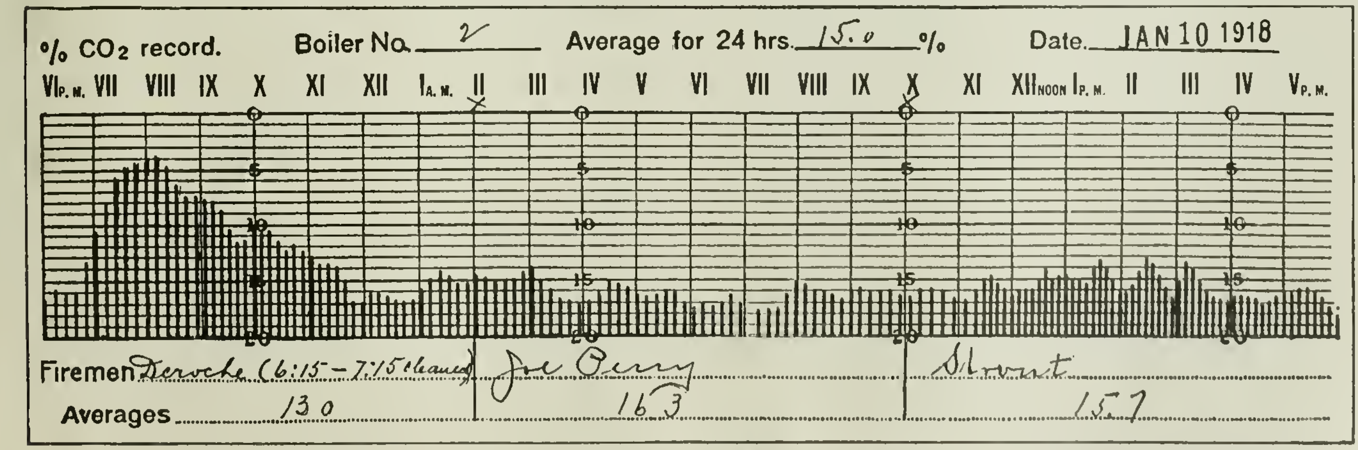
I have found that low settings, especially for boilers that are forced, give the following troubles: Reduced capacity, less efficiency, smoke, severe conditions for the fire sheets, rear tube sheets and tube ends, also severe service for the firebrick linings, and excessive deposits of ash in the combustion chamber, which become fused and difficult to remove. New River coal is used. We have in our plant four 90-in. return-tubular boilers set 38 in. above the grate, and it requires careful firing to obtain 12 per cent. CO_2. The flow meters will register 800 hp. on heavy driving. The outside lap of the first girth seam on all four boilers became burned and cracked and it was necessary to electrically weld the seams and rivets.

The combustion chambers fill rapidly, and we have to loosen the deposit with a pick and clean it out at least every fourth week. The firebrick linings deteriorate rapidly, and ash deposits fuse onto the walls back to and including the rear wall and have to be broken off with picks and bars. These are hand-fired boilers having shaking grates, set level. With the exception of the height of setting and level grates, these boilers are identical with the setting of the fifth one of this type, which we installed during the summer of 1917 and which is described here. The new boiler is set 5 ft. 4 in. above the dead plate. The grate is of the shaking type, built in four sections, and half of each section shakes separately. The grate is 7 ft. deep and 12 ft wide, the furnace design being such that the grate projects 2 ft. 3 in. beyond the boiler on each side. The grate pitches to the rear one inch to the foot, or seven inches in all. The height from the rear end of the grate to the shell is 5 ft. 11 in.; height of bridge-wall, 2 ft. 3 in. A considerably higher bridge-wall was tried in connection with a hand stoker grate having 1 ft. 8 in. pitch in 7 ft., but the heat was so intense that it melted out this bridge about as fast as we could repair it. The distance from the bridge-wall to the shell is 3 ft. 8 in.; extreme height of furnace, 8 ft. 9 in.; distance from combustion-chamber floor to shell, 6 ft. 6 in.; from rear head to rear wall, 2 ft. 8 in.; width of combustion chamber, or setting beyond grate, practically the same as the diameter of boiler, or 90 in.

Unfortunately, we made no test of this boiler, and some valuable information is therefore not available. This boiler raises steam from cold water quicker than the lower-set boilers. The capacity is greater when driving on peak loads; for under conditions where the others do 800 hp., the new one frequently shows 1000 hp. on the flow meter. Any reasonably good firing will maintain 15 per cent. CO_2 on the recorder, and I have never yet found more than a trace of CO. The extreme variation of load and consequent draft irregularity (0.25 in. to 0.5 in. over the fire) is favorable to CO production, too. The accompanying CO_2 chart was made on an ordinary run. Between 6:15 and 7:15 p.m. the fire was cleaned, which accounts for the condition shown. We allow one hour from the time cleaning is started until the fire is again in working order. When it is understood that this fire, burning New River run-of-mine coal and carrying 0.5 in. draft over the fire, is about twelve inches thick, it will be appreciated that cleaning 84 sq.ft. of grate and trimming off the clinker is not an easy job.

When in doubt about the accuracy of our recorders, we check them with the Orsat, and at the time this chart was made the recorder agreed exactly with the Orsat. Some years' experience with gas analysis has convinced me that a high percentage of CO_2 is not so dangerous to economy as many think, especially when there is careful and efficient supervision. I have found the worst cases of CO in samples having 12 to 13 per cent. CO_2 If a recorder shows 15 to 17 per cent. CO_2, it is fairly safe to say that there is not much, if any, CO present. I do not recall that I ever found over 1 per cent. CO in a sample of 15 to 17 per cent. CO_2 and more frequently none; I have, however, found 4 per cent. CO in samples containing 12 or 13 per cent. CO_2. During the 24-hour period of this CO_2 chart, the lowest uptake temperature (aside from the cleaning period) was 400 deg. F., the highest 525 deg. F. and the average 474.2 deg. F.; the average temperature of the fireroom, 75.7 deg. F.

[The performance between 3 a.m. and 12.30 p.m. that is, 15 per cent. CO_2 or better without a break, is indeed commendable for a hand-fired plant; in fact, it is a remarkable performance.—Editor.]



% CO_2 record. Boiler No. 2 Average for 24 hrs. 15.0 % Date JAN 10 1918

Firemen Deroche (6:15 – 7:15 cleaned) | Joe Perry | Strout

Averages 13 0 | 16 3 | 15.7

CO_2 CHART, 90 IN. HORIZONTAL RETURN-TUBULAR BOILER BURNING NEW RIVER COAL

What Your Red Cross Dollars Do*

LESS than a year ago the Red Cross called upon the American people for a fund of $100,000,000 with which to finance the tremendous work of relief and reconstruction that was vital to our Allies and ourselves, if the German terror was to be beaten back.

And so the call came for the First War Fund, and in one week America's answer went echoing back to Europe—more than a hundred million was freely given to make the world fit for democracy. At that time the membership of the Red Cross was less than two million. In six months it had increased to five million and with the Christmas membership drive the enrollment sprang in one mighty bound to 22,000,000 loyal supporters of this perfect embodiment of the nation's purpose in this war.

Today the American Red Cross is the largest organization of any kind in the world and the greatest force for good. In the black welter of warring nations it is the one bright spot of Hope—Humanity's Light.

With such a vast working force behind it there will never be any doubt that the tremendous work, which in the last twelve months has been barely started, will be upheld and continued throughout the war until its ravages have been restored. For this purpose the American people are going to be asked to contribute $100,000,000 more during what is known as the Second Red Cross War Fund Week, May 20-27.

But with each call for funds the question naturally arises as to where these millions go, and since twenty-two million members have a right to know how their money is being spent, the following gives in brief what the first War Fund has been appropriated for up until Mar. 1, 1918.

FRANCE, $30,936,103.04

Established infirmaries and rest stations along all routes followed by the American troops in France.

Built canteens for use of French and American soldiers at the front, also at railroad junctions and in Paris.

Supplied American troops with comfort kits and sent them Christmas gifts.

Established a hospital distributing service that supplies 3423 French military hospitals and a surgical dressing service that supplies 2000.

Provided an artificial-limb factory and special plants for the manufacture of splints and nitrous oxide gas.

Established a casualty service for gathering information in regard to wounded and missing.

Opened a children's refuge hospital in the war zone and established a medical center and traveling dispensary to accommodate 1200 children in the reconquered sections of France. Fifty thousand children throughout France are being cared for in some measure by the Red Cross.

Planned extensive reclamation work in the invaded sections of France from which the enemy has been driven; this work now being carried out with the coöperation of the Society of Friends and an alumni unit from Smith College.

Established a large central warehouse in Paris and numerous distribution warehouses at important points from the sea to the Swiss border for storing hospital supplies, food, soldiers' comforts, tobacco, blankets, clothing, beds and other articles of relief.

Secured and operate 400 motor vehicles for the distribution of supplies.

Opened a hospital and convalescent home for the repatrie children at Evian; also established an ambulance service for the adult repatries who are now returning from points within the German lines at the rate of 1000 a day.

Organized a nurses' service for American Army use.

Established twenty dispensaries in the American Army zone to improve health conditions in that section before the coming of American troops.

BELGIUM, $2,086,131

Erected warehouses and stores to serve as centers of relief distribution.

Started reconstruction work in reconquered territory, supplying repatriates with temporary dwellings, tools, furniture, farm animals and supplies essential to giving them a fresh start in life.

Appropriated $600,000 for the relief of Belgian children, covering their removal from territories under bombardment and the establishment and maintenance of them in colonies.

Provided funds for the operation of a hospital for wounded Belgian soldiers and for part of the equipment of a typhoid hospital.

ITALY, $3,588,826

Provided the Italian Army with three complete motor-ambulance sections comprising sixty ambulances, forty trucks and 100 American drivers.

Contracted for 10 field hospitals complete for use by the Sanita Militaire and the Italian Red Cross.

Supplied 1,000,000 surgical dressings. Opened relief headquarters in nine regional districts of Italy.

Established a hospital for refugees at Rimini.

Planned and made appropriations for extensive work among the refugees in all parts of Italy.

RUMANIA, $2,676,369

Rushed more than $100,000 worth of medical supplies and foodstuffs into Rumania immediately after the retreat to Jassy.

Carried general relief work into every part of the stricken country not invaded by the Teuton and Bulgarian forces.

UNITED STATES, $8,589,899

Organized and trained 45 ambulance companies, totaling 5580 men, for service with American soldiers and sailors.

Built and maintained four laboratory cars for emergency use in stamping out epidemics at cantonments and training camps.

Started work of eradicating unsanitary conditions in the zones immediately surrounding the cantonments.

Established camp-service bureaus to look out for comfort and welfare of soldiers in training.

Supplied two million sweaters to soldiers and sailors.

Mobilized 14,000 trained nurses for care of our men.

Established a department of Home Service and opened training schools for home service workers.

Planned convalescent houses at all cantonments and training camps. Increased membership from a scant half million to approximately 22,000,000.

OTHER DISBURSEMENTS

For War Relief in other countries, including Great Britain, Russia and Serbia, $7,581,075.

To supply food to American prisoners in Germany, $343,304.

For supplies purchased for shipment abroad and for advances to chapters for material, $15,000,000.

Equipment and expenses in United States of personnel for Europe, $113,800.

Restricted as to use by donors, $2,500,410.

Working cash advanced for France and United States, $4,286,000.

Making a grand total of approximately $78,000,000.

To those who care to study the details of how each penny has been spent, printed statements covering all War Fund appropriations are obtainable from Chapter chairmen.

The foregoing covers some of the principal battle grounds in the Red Cross War against want and misery, but other millions are being constantly appropriated to meet new needs as they arise, and the War Fund must be replenished, for it is inconceivable that such work should ever be allowed to suffer for the lack of mere money.

Give to your Red Cross until your heart says stop—it is the Heart of the World.

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*Compiled from American Red Cross Reports.

Editorials

How About Next Winter?

IF REPORTS are any indication, the coal situation is far from satisfactory. To say the least, conditions are anything but reassuring, and the possibilities of experiencing a fuel shortage during the coming winter, as we did last, have not by any means been entirely removed. The Fuel Administration has been putting into effect very elaborate and no doubt effective plans and probably is doing all that is possible to meet the emergency so far as getting coal out of the mines and delivering it to the consumer. However, there is another side to the question—how the coal is utilized after being delivered to the consumer—and this is just as important to think about just now as the delivery of the coal. since every ton saved during the summer is a ton available next winter.

Almost simultaneously with an announcement that the coal situation was critical, the restriction on the use of advertising illumination was removed. Would it not have been more in-keeping with the seriousness of the fuel problem to have continued the restrictions until such times as we might look forward with some feeling of certainty that coal would be forthcoming next winter, when it is an absolute necessity to human existence in cold climates?

Preston S. Millar, in a paper presented before the Illuminating Engineering Society in New York City, February 15, pointed out that the net coal saving thought desirable through curtailment of lighting was equivalent to seven per cent. of twelve million tons used for the production of light by electricity, or eight hundred and forty thousand tons. The author expresses the opinion that the saving possible through the curtailment of light is so small compared with the coal saving possible by other adjustment as to make that obtained by the curtailment of lighting of little consequence.

However, we must not overlook the fact that this saving is obtained after increasing industrial lighting fifty per cent. above the standard at that time, and increasing protective lighting two hundred per cent. If industrial lighting had not been increased as suggested by Mr. Millar, but maintained at its present standard, it would have made possible a total saving of approximately sixteen per cent., or two million tons of coal per year. But allowing that it is possible to save only eight hundred and forty thousand tons per year by lighting curtailment, this is something more than an insignificant item. If this amount of additional coal had been available last winter and had been used for heating homes, at least eight hundred and forty thousand families could have been kept warm for a month. Or if used for industrial lighting and power purposes, many of the industries that were forced to shut down or curtail their output for considerable periods last winter could have run at full capacity.

The fact that if each family in this country would decrease by one shovelful its daily use of coal the result would be an annual saving of fifteen million tons looks simple at first thought, but we must not overlook the fact that last winter tens of thousands of families in this country did not have the one shovelful to save and would have been only too glad to have had some of the six hundred thousand tons used for advertising illumination.

Let us not forget that there is another winter not very far ahead of us, and that all the time the demands for light and power in industries essential to the winning of the war are increasing. If the high rate of production that these industries have been establishing this last month or so is to be kept up the year around, it is absolutely necessary that they have an uninterrupted coal supply for light, heat and power and that the employees have comfortable homes during the cold season as well as in the summer. Until it is absolutely certain that the coal supply is adequate to meet this demand, it would seem that we can do with somewhat dimmed white ways, which have become a part of our city life.

Pseudo Data

C. E. STROMEYER is reported in *Engineering* to have said during discussion of a meeting of the Institute of Mechanical Engineers, London, that personally he disliked associating boiler insurance with boiler inspection. As an instance of how insurance worked, he stated that in America there was no association which corresponded to those in England whose first duty is to inspect. The American boiler-insurance companies he said, published at intervals a leaflet giving the number of boiler explosions, the standard being the number of deaths caused. In England, for insured and inspected boilers, there were ten deaths per annum as against two hundred in America. That illustrated the significance of inspection.

As reported, the figures are significant of nothing. We do not question but that per unit number of boilers in service, we in America have more boiler explosions than occur in England. The excellent supervision by the Board of Trade and the service to members by the Manchester Steam Users' Association, for which Mr. Stromeyer is chief engineer, are influential factors in preventing boiler accidents. But data, or more correctly, perhaps, statistics, given or reported in such loose manner were better unsaid. The reader or listener should know what is considered as an explosion, what relation the terms of the ratio 10: 200 deaths per annum bears to the total number of boilers installed or in service in the two countries respectively.

The trend of business makes it increasingly important that engineering data be comprehensible as well as exact. This applies not only to such cases as the one cited, which is used merely as an example, but to data in general, and especially those presented in society papers. No national good can come of giving information that is subtle and that is used to achieve victory in argumentation for some proposals or practice regardless of their engineering truth either as pure science or as related to other conditions necessary to their industrial application.

Pseudo facts may well be used by lawyers (though by every consideration of justice and honesty they should not be); but these are wrong in engineering—wrong ethically and socially. In his most interesting book, "The Great News," which contains so many captivating phrases, but which one may gently criticize as a little too intangible, Charles Ferguson has a statement that applies well here, namely: " . . . there is absolutely no social will-power directed to the upkeep and improvement of the apparatus of civilization." The point is that each of us is too much concerned about making good our particular case, however much harm may be done or confusion created broadly.

The Golden Rule must be dragged out of a musty book, sincerely embraced and frankly applied by the professions and the trades—not in parlor discussions and philanthropical endeavors alone, but all during the working day. It must dull the narrow, personal and selfish conscience and stimulate the broad, national conscience to which the war's hardships and magnitude have given new life. Certainly the great blessing of the war will be the honest, altruistic coöperation and coördination of the forces of civilization to make the world a better place to live in. When each nation, bleeding, hungry and poor, emerges from the long struggle and turns to look over its shoulder at the fields and seas where lie its young and honored dead, it will resolve that nevermore shall science be the handmaid of holocaust; but rather that it shall serve the peaceful arts so well that the incentive which gives birth to wars will starve into extinction. To even make a good beginning, facts must be presented so as to be exposed top, bottom and all sides.

Looking Ahead

FROM coal heaver to general manager seems a long uphill climb—a journey that many begin and few finish—yet it is suprising how quickly some make the trip. It seems but yesterday that they were heaving coal and sweeping tubes, yet ten years have slipped by, and today they are directing the management of the whole plant and ever planning for improved conditions and greater things. These men kept their eyes front. By this it is not meant that they dared not glance sideways, but that they had a fixed goal—a beacon ahead upon which they kept their eyes fixed in order to steer the course that they knew would shorten their trip to that harbor of Success. These fellows were never afraid to tackle a job, no matter how much energy it required. To be sure, they must have had times when they questioned themselves as to whether they were capable of doing it—this is just what gave them confidence.

Never before in the history of this great nation has there been such a demand for men who can handle big tasks. Some of the ablest men in the field have gone to Washington and into the service of the country. Their posts in the plant had to be filled by their trained subordinates, which in turn meant a general shake-up all through the various grades in the plant, and those who were capable and ready were boosted up a step—sometimes two.

Our great merchant marine is incessantly calling for engineers with ability and courage; already it has made large inroads on the staffs of the power plants throughout the country.

Great shops and industrial centers have developed with astounding rapidity. One stops to wonder where they got the men with ability to fill the many positions of responsibility. It does not require much study to find where they came from. They were ready to answer the call—up from the ranks to take command. They were men who had faith in their ability to develop themselves by study and increasing work. Where are you in this great change that is being wrought? Surely, you cannot be still thinking that there is no show—no opening for you—no chance to get into a better job. The only bid you can make for that better job is to outgrow your present one.

You would not now be reading this article if all your ambition were dead. You would not have this magazine in your hands if you were not trying to find something that would help you. Men don't read technical papers for pastime—they do it to keep informed and to better themselves.

The Coal-Zoning Plan

THE importance of an adequate coal supply in the winning of the war cannot be minimized or ignored. Decreased or interrupted production may result in stoppage of industries engaged on war contracts, the enforced idleness of labor, and eventually a condition similar to that of last winter, when thousands of homes found themselves without heat.

The zone system of coal distribution put into effect by the order of the United States Fuel Administration represents a serious and at the same time an ambitious attempt to cope with the difficulties of the fuel situation. It is not the outcome of ill-advised haste or snap judgment, but rather a plan resulting from months of study and careful consideration.

It would be futile to expect that a scheme so far-reaching in its scope could be put into effect without some disruption of established relations. The urgent necessity for diminishing the burden on transportation facilities involved restrictions and prohibitions that had previously been unknown; but wherever it could be done, long-established trade relations were preserved, since this would reduce the confusion and disorganization attendant upon the adoption of the new plan.

So many interests must be considered in the working out of a successful scheme of fuel regulation that the situation is exceedingly complex, and so it becomes necessary to provide for a certain measure of flexibility in order to meet changing conditions and unforeseen emergencies. This has been done by providing for a system of special permits to be issued by the Fuel Administration whenever circumstances warrant. Thus, while the zone system as announced may show faults and imperfections as it comes to be more widely applied, the special-permit provision makes possible a prompt adjustment to prevent injustice or unnecessary hardships.

Correspondence

Second-Hand Boilers in Bad Shape

A few months ago I took charge of a plant where they were installing a second-hand Scotch marine boiler that had been purchased by the general manager from a second-hand dealer who represented that it had been inspected by a state and also by an insurance inspector and passed to carry 110 lb. pressure. I made a thorough inspection of it and found things in good condition until I crawled into the combustion chamber, and there I saw a sight.

The ends were burned off from about three-fourths of the tubes, and some of them were so badly corroded that they only stuck halfway through the tube sheet. The leakage had been so bad that sediment almost choked up some of the tube ends. How inspectors could have passed the boiler if they inspected it at all, and I don't believe they did, is more than I can say. We had to remove the tubes, have ends welded on, and replace them again before the boiler was fit for service. This cost the company about two hundred dollars besides the trouble and delay in getting the boiler into service. It is in good condition now and giving satisfactory service, but the incident goes to show that it is mighty dangerous and expensive for a man without practical knowledge of boilers to buy second-hand ones without having a thorough inspection made. S. A. REILLY.

Orrville, Ohio.

Saving Ammonia and Coal

Nearly all engineers know that they should not try to save ammonia by not putting in the proper charge at the beginning of the season. One can make up for a weak or insufficient charge only at the expense of the coal pile. This applies to absorption machines particularly. They are commonly run with insufficient ammonia, as it is so easy to get the capacity by circulating a little more weak liquor per pound of anhydrous needed to do the refrigerating.

This is bad practice. The weight of weak liquor circulated per pound of anhydrous should be kept as low as possible, say 6 to 7 lb.; 12 or 14 lb. is not unusual in some plants.

The speed of the aqua pump should be as steady as possible. Most manufacturers furnish a regulator to care for this pump.

With coil absorbers with the separate mixer on each coil there is a tendency for the liquid to "dump" or come in irregularly. When this happens, there occurs a loss due to not having the strong liquor from the pump to the generator at as high a temperature as it would have if it had passed in a steady flow through the exchanger and analyzer. The flow of weak liquor from the generator through the exchanger is almost constant, and for the exchanger to heat the strong liquor as much as possible and cool the weak liquor also, both must pass in a steady flow.

Although machines fitted with this type of absorber have a large aqua receiver which helps to take care of irregularities, the men will often give the pump too much steam, causing too fast a flow of liquid. Where such conditions obtain, I would disconnect the regulator and let the men control the pump by hand; they will soon get it set so it will not stop and race.

I know of one plant where the irregular speed of the aqua pump caused the temperature of the exchanger to vary so that one of the head gaskets blew out, with a loss of some ammonia and loss of the machine for four days during the summer's rush. Keep the pump operating steadily and watch the liquid seal on the ammonia receiver so as not to blow any gas over in the cooler or ice tank. Every pound of gas carries with it the latent heat plus the superheat.

Keep the strong-liquor pump rod packed so as not to leak ammonia out and air into the system and you will have little trouble with non-condensable gases, which always cause some loss of ammonia when purging.

Make it a rule when you go on watch to look things over, then take your sulphur stick and examine the machines for leaks, for many small leaks will go unnoticed if one depends only on one's nose to find them, especially if coils are located on the roof.

Machines with double-pipe or submerged cooling coils, where the ammonia from a leak will be absorbed by the water or brine, make it necessary to test this brine and water with Nessler's reagent. This should be done at least three times a week.

The formula for making Nessler's reagent was published in the Jan. 15, 1918, issue of *Power* and may be found in most handbooks on refrigeration. Sensitive paper is useful for locating leaks on the water side of the machine, but cannot be depended upon in calcium brine, as such brine turns the paper red whether the brine does or does not contain ammonia.

Jersey City, N. J. BERNARD LAMB.

Horseshoe Magnet a Handy Tool

The suggestion, by W. H. Bennett, page 447 in the issue of Mar. 26, for removing drill chips is a good one. I have also found that a horseshoe magnet, one taken out of an old house telephone for instance, is mighty useful for the same—and many other purposes. If the magnet is too large to go into the hole, it can be put in contact with a small rod as an extension or the rod can easily be magnetized if near a plant that has magnetizing coils.

Two or three magnets tied together will be found useful to wiremen when a knife, screwdriver, pliers or other tool is accidentally dropped down an open partition as sometimes happens. Just lower the magnet on a string until it comes in contact with the tool, then "haul away." R. L. PETERSON.

Knoxville, Iowa.

Home-Made Pipe and Drilling Vise

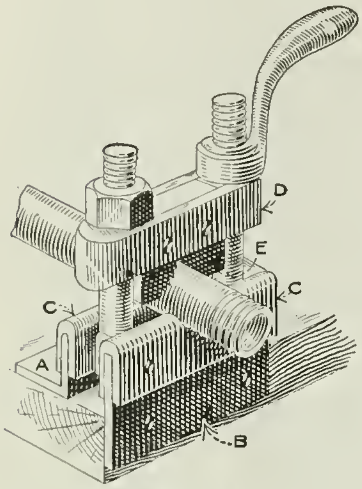


FIG. 1. DETAILS OF CONSTRUCTION

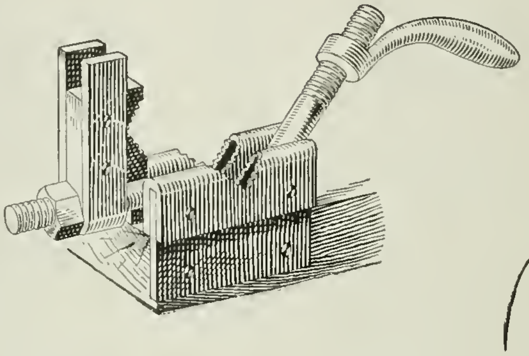


FIG. 2. VISE SHOWN IN THE OPEN POSITION

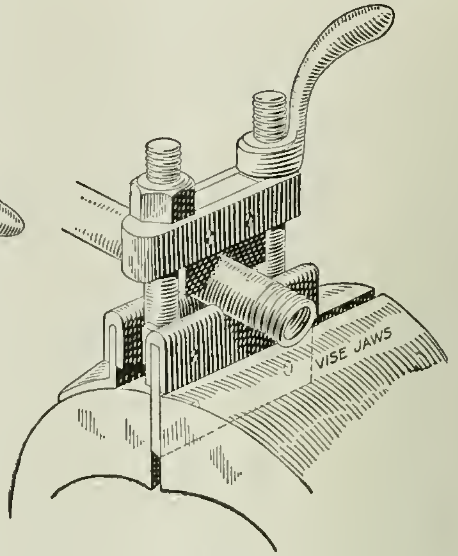


FIG. 3. CLAMPED BETWEEN VISE JAWS

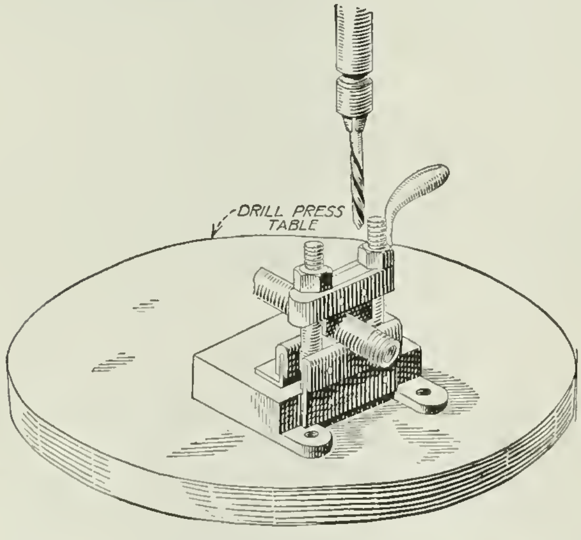


FIG. 4. VISE CLAMPED TO DRILL-PRESS BED

A handy pipe vise that can be made by any engineer who is not in a position to purchase one is shown in the accompanying illustrations. The grip on pipes should be, as much as possible, around the entire cylindrical surface, otherwise the pipe is easily scored. The device described was built in three sizes. The largest size, fitted with brass jaws, is used for gripping small pipe or rods for various light operations. When mounted on a block, Fig. 2, it serves as a handy vise for drilling round stock. It can be attached directly to the bench, Fig. 1, or gripped in the vise, Fig. 3, for threading, or clamped to a drill-press bed for drilling holes in round stock, Fig. 4. The vise is composed of two plates. Plate *A*, Fig. 1, is made of angle iron for fastening to a block or bench; *B* is of steel plate of the same length and can be used for fastening to a bench or for being gripped between the jaws of a bench vise. Both pieces are reinforced on the upper edge by a piece of steel, *C*, riveted on. In the center of these assembled plates a V-shaped way is sawed, which is provided with fine teeth for gripping purposes. The movable jaw *D* is made from a U-shaped strap, in the center of which is riveted a solid block *E*. This upper jaw is guided between the two lower jaws by means of a bolt pivoted between them, as shown. A handle nut is also provided for quick action in opening or closing.

New York City. J. A. **Lucas.**

Burning Fuel Oil

Why do we not get more articles on the subject of burning crude oil? Plants in both Texas and California are large users of fuel oil, and in a great many small plants it is burned very inefficiently. Engineers of large plants are beginning to realize that large combustion chambers give the best results, and when setting new boilers, raise them from two to three feet higher than the old-style setting. The bridge-wall is placed about ten feet back from the doors, and the grates are covered with loose firebrick. Most of the air should be admitted under and on each side of the burner, with just enough admitted under the flame to raise it away from the grate and keep the grate cool.

As every engineer knows, an excess of air means a loss in economy and all brickwork is more or less leaky. By using the damper to control the air supply, the difference in pressure between the inside and outside of the setting can be kept at the lowest point.

With from 3½ to 4 sq.in. of clear air space through the grates for each normal horsepower rating, a draft from 0.05 to 0.1 in. of water next to the damper is sufficient to give air enough to carry better than normal rating on the boiler, and certainly there won't be as much air leakage as when the ashpit doors are used to control the air supply and a difference of from 0.3 to 0.4 in. is maintained between the inside and outside by leaving the damper wide open. L. D. **Harris.**

Houston, Tex.

[We welcome and pay well for contributions, articles and letters on the subject of oil burning—as well as on all subjects of value to power-plant engineers and others interested in the generation and distribution of power. —Editor.]

Fires in Turbo-Generators

M. A. Walker's article on "Fires in Turbo-Generators," in *Power*, issue of Jan. 22, is, I believe, a live subject and one worthy of serious consideration. As Mr. Walker points out, the modern turbo-generator contains material that will burn and, once ignited, makes a difficult fire to fight on account of its location and the great amount of blinding and suffocating smoke given off.

My experience has convinced me that one of the best preventives of these fires is to get the machine off the line and kill the field at the first sign of trouble. I have seen four or five cases where doing this prevented a fire, and others where it was not done caused serious fires, totally destroying the insulation on the ends of the stator coils, besides damaging the tie rings and laminations.

The first cases that came under my observation were on 4500-kv.-a. 13,200-volt three-phase 60-cycle machines. On the first machine to give trouble, the insulation broke down on the top coil in a slot, and burned this coil off, damaging the insulation of the bottom coil and the top coil in an adjacent slot. These three coils had to be taken out; two were reinsulated on the job and put back, and a third had to be replaced by a new coil. In three other cases in this plant we lost from one to three coils in like manner, all of these breakdowns being near the center of the slot length.

Practically all these burnouts were preceded by line trouble causing a heavy surge, and as there were no reactances in the line, the generators received the whole strain. The first indication of trouble would be a groan from the generator, then a few sparks mixed with dust. As these machines had an air outlet on top that was easily seen by the switchboard operator, he generally discovered the trouble when it first started and cleared the machine.

In one case there was a new operator on the board; two machines were in parallel when the trouble started. The switchboard attendant tried to prevent interrupting the load by holding the defective unit on the line until the engineer brought another machine up to speed. The result was that both coils in one slot were completely burned out, copper and all, and the insulation at each end of the winding was set on fire.

These generators had small plates near the top of each end bell, giving access to the inside of the machine. Although these covers got almost red-hot, we succeeded in removing them and in a short period had the fire out by the use of two ¾-in. water hose—but not before the insulation was entirely ruined on both ends of the winding, and the tie rings, which were wood, were also consumed. The arc in the slot welded the laminations together so that the stator core had to be taken down and the iron restacked, and between three and four tons of laminations replaced by new stock.

Two other cases that came under my notice were of 5000-kw. vertical units which burned out within ten minutes of each other. The cooling air for these units was drawn in at the top of the housing and discharged at the bottom, on top of the turbine casing. This made it very difficult to get at the fire. In one unit the burnout occurred right over the side where the throttle valve was located, so that the operating crew could not get to it to shut the steam off. The melted copper, iron, etc., from the burnt-off coils clogged the valve gear in the open position so that things were in excellent shape for a speed wreck, but fortunately the flame was so intense that it melted off the trip rod, from the emergency governor, thus releasing the throttle and allowing it to close.

These were old units which had seen hard service and, at the time they failed, were carrying heavy loads on account of another larger unit being out of service owing to a similar burnout. This latter unit failed at the end of a slot, doing some damage to the laminations as well as burning the ends of the coil on that end of the winding.

Another burnout that comes to mind was that of a large machine in which the trouble started at the end of one slot. The first indications of trouble were a few sparks for a short time before the actual burnout, which took the form of an explosion, shooting flame and smoke out of the air outlet on top of the generator. It required over two hours to put this fire out. In this instance the laminations were not injured, but all the coils were damaged and most of the tie rings were burned or cracked so that they had to be replaced. I believe that if this generator had been cut out at the first sign of fire, the trouble would have been localized and only one or possibly two coils damaged.

From these experiences I believe the surest way to localize the trouble is to kill the machine at the first sign of sparks or smoke. This may cause a shutdown for a short time, but that is better than burning out a machine, putting it out of service from two to eight weeks, depending on its size and the extent of the damage; besides, the cost of repairs may easily run up to several thousand dollars on large units.

Mr. Walker's suggestion for fire-fighting inlets or connections is an excellent one and should be adopted for all units. It appears to me that an effective scheme could be worked out by placing a ring of pipe around the ends of the stator just back of where the coils leave the slots, or in any suitable location where there is room, with sprinkler heads, such as are used with automatic sprinkler systems, at intervals of six or eight inches along the pipe so that they point in toward the coils; the melting point of the head to be, say, 50 deg. F. above the maximum allowable temperature of the generator, and the pipe line to be carried outside of the generator to a valve and connected to the water supply. There should be a drain opening between this valve and the sprinkler ring, which should be kept open so that any leakage of the main valve may be detected.

The pressure should not be kept on the sprinkler system all the time, as something might cause it to leak and damage the generator. In case there was a burnout or the attendant saw sparks or smoke coming from the generator, he could turn the water into the sprinkler system. If there was a fire at any point, one or more of the heads would be open and the water would be played on that point and not all over the machine as from a hose. If there was no fire serious enough to open the sprinkler heads, no water would reach the windings to cause damage. If the fire tended to spread around the armature, additional heads would open up to extinguish it.

This system could also be used in connection with carbon tetrachloride or carbon dioxide, as suggested by Mr. Walker, for fighting these fires, by connecting the system to tanks containing these chemicals under suitable pressure, instead of to a water supply. When using these chemicals, smaller-sized piping could be used to advantage.

I do not know whether this scheme has ever been used, but I see no reason why it would not work out satisfactorily, and the cost of installing the apparatus would be little compared to the expense of rebuilding a generator and the loss of service during the repairing.

The use of shutoff doors or dampers in the air inlets and outlets to the generator is another important detail, since with a turbo-generator with the field open, there is from a quarter of an hour to an hour in which the rotor will be turning and forcing air through the generator if these openings are not closed. These dampers should be controlled from the floor, where the engineer could reach them without leaving the throttle of the turbine. They should not be automatic in operation.

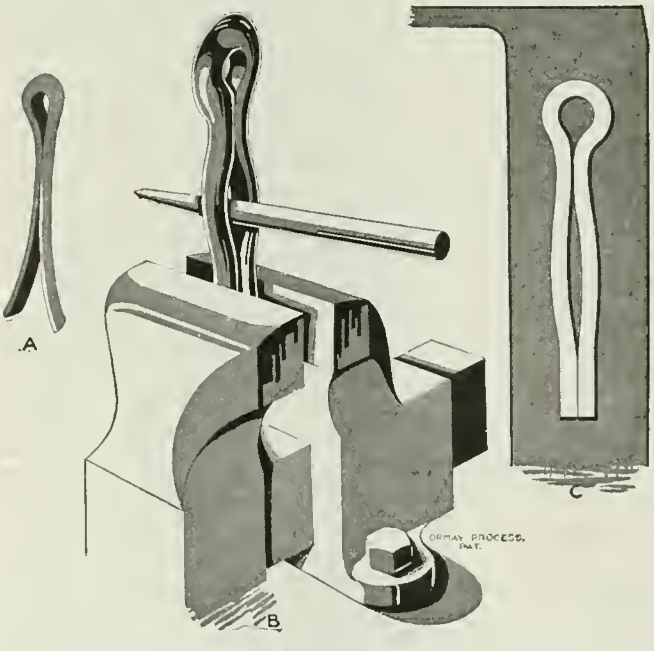
All of us who are in the business are interested in this subject, and I feel that it is very important to do what we can to help prevent these fires. They are not only a loss in profits to our companies, but are a waste, and at this time it behooves all of us to prevent such waste, whether of fuel, food, labor or material.

Claymont, Del. **Everett Palmer.**

Reusing a Cotter-Pin

The next time you try to replace a used cotter-pin that is spread at the end (as shown in the illustration at *A*), instead of trying to hammer the ends together, which cannot be done, try kink *B*. This produces a cotter of the shape shown at *C*, which is easily reëntered. This is a simple kink, and no doubt many readers will say, "Any fool oughter know that," but it has come to my notice that a lot of wiseheads do not make use of it, so I am passing it along. **C. H. Willey.**

Concord, N. H.

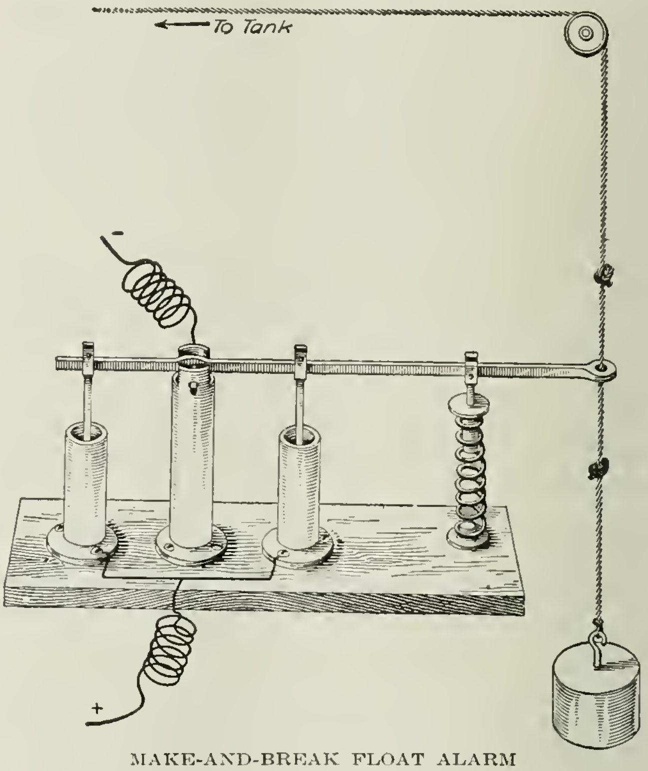


MAKING A COTTER PIN EASY TO ENTER

High and Low Water Alarm

I have made a successful high and low water alarm out of a couple of dashpots taken from old arc lamps and partly filled with mercury. A lever is pivoted, as shown in the illustration, so that when the long end is depressed or elevated by a knot on the float-cord passing through the eye at the end, contact will be made between the points on the lever and the mercury, completing the electric circuit, which lights a pilot lamp or rings a bell. The lever is held in a central or neutral position by the coiled spring until one of the knots forces it one way or the other, and the difference in the water level in the tank before an alarm is given depends on the distance between the knots.

Paxton, Ill. **S. R. Rodgers.**



MAKE-AND-BREAK FLOAT ALARM

Pump Strokes Irregular

In the plant where I am employed one 5½ x 3½ x 5-in. Worthington boiler-feed pump began giving trouble on one side. The right side would make the stroke all right, but the left would jerk and pound. At first I tried adjusting the valves, but this did no good, so I took the head off the water end and found that the night engineer in repacking the right side had put in four rings of packing instead of three, causing more friction on that side. So I added one ring to the left side and the trouble stopped.

The 14-in. by 30-ft. leather belt from a 75-hp. motor to an air compressor had been burned on one side, causing that side to stretch, and it flapped every time that part went over the motor pulley. I turned the belt over and the noise and disagreeable flapping stopped.

Provo, Utah. **O. W. Mann.**

Six new authorized United States battleships are designed to be of 41,500 tons, the largest battleships in the world.

Inquiries of General Interest

Use of Piston Valves on Compound Engines—For compound engines, why are piston valves frequently used for the high-pressure and flat slide valves used for the low-pressure cylinders? D. L.

For the high-pressure side, piston valves are preferable because they can be balanced and operated with little friction, and although repairs for making this type of valve steam-tight are more difficult than repairs to flat valves, tightness against valve leakage is of less importance on the high-pressure than on the low-pressure side of the engine.

Trapping Returns Discharged Below Boiler—Our heating system is supplied with steam at reduced pressure from boilers that carry high-pressure steam for power purposes. The returns from the heating system must be discharged about 10 ft. below the boiler. How can the return water be trapped to the boiler? J. E. H.

Place a return trap below the returns of the heating system and have this trap discharge to another return trap placed above the boiler for returning the condensate to the boiler. The most rapid operation will be obtained for the purpose by employing return traps whose receivers are vented to the atmosphere while filling.

Water-Hammer in Pump Suction Line—How can water-hammer be prevented in a pump suction pipe? A. H.

Water-hammer results from sudden checking of the velocity of the water at each reversal of the pump. It can be prevented by connecting an air chamber to the pump suction pipe in such a manner that when the column of water is stopped or checked by action of the pump, the direction of flow may continue past the pump suction chamber or valves to the air chamber. The energy of the moving column of water can thus be expended directly on the confined air; but an air chamber will be of little benefit if connected to the side or top of the suction pipe so the water passes under or at right angles to its connection.

Intrinsic or Internal Energy of Steam—What is the difference in signification of the terms total heat, intrinsic energy, internal energy and intrinsic heat of steam? A. D. B.

The term "total heat of steam" in any given state is understood to mean the amount of heat required to heat at constant pressure, a unit weight of water from the temperature of melting ice to the state under consideration. During the period of vaporization the volume of a pound of water is changed to the much larger volume of steam and the external work done in order to reach the state of the steam is called the "constant pressure external work." The terms intrinsic energy, internal energy and intrinsic heat are each used to signify the same thing, meaning the heat energy contained within the steam above 32 deg. F., and it is equal to the total heat less the constant-pressure external work.

Delta-Connected Transformer Banks Connected in Parallel—Would there be any objection to connecting two transformer banks in parallel, each bank being grouped in delta on both the primary and secondary? One bank consists of three 75-kw. units and the other bank of three 100-kw. units. D. C. A.

It would not be considered good practice to parallel two banks of transformers of different capacity such as indicated in the question. The chief objection to this practice is the difficulty that would be experienced to get the load to divide in the proper proportions between the two banks. To a certain extent this difficulty could be taken care of by connecting a resistance in series with the leads of the bank that has a tendency to take more than its share of the load. Even if the banks were the same capacity, it would not be good practice to operate them in parallel. If possible, each bank should supply a separate load.

Taking Gas- or Oil-Engine Suction-Stroke Diagrams—Diagrams made with the ordinary stiff spring necessary for use for indicating gas and oil engines afford little information of the action of the valves during the suction stroke. How can appropriate diagrams be obtained? A. E. R.

The events in the suction stroke must be obtained separately with a weak spring in the indicator. The spring should be protected from excessive pressure of the explosion stroke by inserting a suitable stop to prevent undue compression of the spring. For that purpose a distance piece may be made of a small brass tube slipped over the piston rod of the indicator or, for an indicator with an inside spring, the distance piece may consist of a thin brass tube that will freely pass over the outside of the spring and inside of the indicator cylinder while resting on the top of the piston.

Scale-Forming Impurities in Feed Waters—What are the usual scale-forming impurities in boiler feed waters? C. N. D.

Those most often present and in largest quantities are:

Calcium carbonate (lime), chemical formula	$CaCO_3$
Magnesium carbonate, chemical formula	$MgCO_3$
Calcium sulphate, chemical formula	$CaSO_4$
Magnesium sulphate, chemical formula	$MgSO_4$

The impurities less frequently found and usually in small amounts are:

Iron carbonate, chemical formula	Fe_2CO_3
Calcium chloride, chemical formula	$CaCl_2$
Magnesium chloride, chemical formula	$MgCl_2$
Potassium chloride, chemical formula	KCl
Sodium chloride, chemical formula	$NaCl$

Some iron oxides, calcium phosphate, silica and organic matter also may be found, though usually in small quantities.

Effect of Clearance on Air Compressor—What effect has cylinder clearance on the capacity and power required by an air compressor? S. E. M.

In single-stage compression, clearance reduces the volumetric efficiency or ratio of the volume of free air, actually admitted and compressed in the intake cylinder, to the volume of piston displacement. The percentage in reduction of capacity is greater than the percentage of cylinder clearance, as the piston must travel back a larger percentage of the return stroke before the air previously compressed into the clearance spaces has expanded to atmospheric pressure, permitting the free air supply to flow into the cylinder. Since the volume which the expanded clearance air occupies increases as the pressure increases, the loss in capacity by clearance is directly proportional to the pressure. The loss of volumetric efficiency due to clearance is less for two-stage than for single-stage compression because, for given capacity, the low-pressure cylinder of two-stage compressors is practically of the same size and has the same percentage of clearance as the cylinder of a single-stage compressor, and the terminal pressure of the two-stage machine is much lower with less expansion of the compressed clearance air back into the cylinder volume. The work required for compressing the clearance air to receiver pressure in expanding back to atmospheric pressure helps to move the piston on the return stroke and as the loss of heat during expansion is negligible there is practically no loss of power from clearance excepting that its presence increases the size of compressor required to deliver a stated amount of air, thereby requiring more power for its operation.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Notes on the Operation of Submarine Diesel Engines*

By LIEUT. F. C. SHERMAN, U.S.N.

The following notes have been made as the result of practical experience in operating submarine Diesel engines of the two-stroke-cycle Nürnberg type of New London Ship and Engine Co. manufacture. They are particularly applicable to that engine, but it is felt that some of the ideas evolved may be adaptable to engines of other types when similar troubles have been experienced.

IN spite of the widespread reports of unreliability of submarine Diesel engines of the past few years, the writer has always maintained that every effort should be made to make the material operate satisfactorily before condemning it as unsatisfactory and unreliable. In many cases further investigation has shown that inexperienced personnel are to blame and not the long-suffering and almost always blamed material.

In the type of engine upon which this discussion is based, the crank case is totally inclosed and the oil from the lubricating system, after cooling the piston heads, is drained into the crank case, from which it runs into the settling tank and is used over again. The scavenger air for the working cylinders is compressed in a scavenger cylinder in tandem with the working cylinder, and the piston is of the stepped type, the lower step working in the scavenger cylinder and compressing the scavenger air which is forced into a housing around the scavenger cylinder and above the crank case. The scavenger cylinder makes a joint between the crank case and the scavenger housing.

Crank-Case Explosions

Now, in every case of crank-case explosions it was found that there was a leak from the scavenger housing to the crank case. This joint was packed with soft packing and proved to be very difficult to keep tight, due to the scavenger cylinder holding-down bolts working loose from continual shock. But in every case of crank-case explosion, a leak of scavenger air to the crank case was found, and when it was corrected the explosions stopped. The permanent care taken following this discovery was to test the scavenger housing at frequent intervals for tightness with air pressure and to examine frequently the scavenger cylinder holding-down bolts and to keep them set up tight every time they came loose. These tests were made about once a month, and following this care, practically all crank-case explosions and their destructive results were eliminated.

Another remedy adopted, not as a cure but to reduce the effect of a crank-case explosion, was to install a vent to the crank case. The crank case is totally inclosed only to retain the oil used in the lubricating system and prevent its being splashed about in the engine room. The result was that when a crank-case explosion occurred the gas had no place to escape without wrecking something, blowing off the crank-case doors or housing. To prevent this, a 2½-in. pipe was led from one end of the crank-case housing and left entirely open. The main purpose of the pipe was to furnish an opening to the crank case to allow the expanding gases of the explosion to get out without blowing something out.

Another feature of the leak in the scavenger housing was found to be that the scavenger-housing temperature increased unduly, especially when running at higher powers. This undue rise of temperature probably resulted from slight burning of the oil vapor around the leak causing an increase of the temperature without, however, causing an explosion. A correction of the air leak always resulted in a decrease of scavenger-housing temperatures. These leaks from the scavenger housing, it must be understood, were not sufficient to cause trouble from drop in scavenger-air pressure and would ordinarily not be expected to give any trouble.

Closely allied with the crank-case explosions, but of an entirely different nature, were scavenger-housing explosions. These were found to be due to two causes; namely, presence of a superfluity of oil in scavenger housing and leaky or defective scavenger valves. If there was too much oil in the scavenger air and the scavenger valve to the working cylinder remained open an instant too long or leaked after it was closed, the compression temperature or flame from the working cylinder would be transmitted to the scavenger housing and set off the oil and vapor in that chamber, resulting in an explosion liable to wreck the housing, as relief valves fitted there were never efficient in quickly releasing the excessive pressure formed. The remedy for this form of explosion was to keep excessive oil out of the scavenger housing through drains fitted at the bottom and to keep the scavenger valves to the working cylinders functioning properly.

Piston and Cylinder Troubles

Cracked piston heads, cracked cylinders, cracked pistons and piston seizures are almost all traceable to defective cooling of the piston head. On the particular type of engine in question, the pistons were cooled by lubricating oil forced up from the lubricating system through the connecting-rod and wristpin and then up through a pipe leading to the hollow piston head and thence down on the opposite side through a drain pipe to the crank case, whence it drains by gravity to the settling tanks.

The most frequent cause of defective cooling of the piston heads was the presence of salt water in the lubricating oil which remained in the piston head owing to the location of cooling-water inlet and outlet. Due to the temperature to which the oil was subjected, the water would quickly evaporate, leaving a salt deposit in the oil which was black in color, giving the appearance of carbon. For a long time this deposit was thought to be carbon, on account of its color, but an analysis showed it to be over 90 per cent. salt. This salt would form a black, gummy mass and would soon collect in the piston heads and the pipes leading to them and result in decreasing or blocking altogether the supply of cooling oil to the piston heads, which would instantaneously get hot and either crack or seize, or heat would travel to the cylinder or piston itself, resulting in cracking the cylinder with its cooling water outside or the piston seizing and cracking.

Obviously, the remedy for this is to keep salt water out of the oil. However, with an engine using salt water for its cylinder-cooling and oil-cooling medium, this is not as easy to do as it sounds; but it can be done if proper care is exercised. On the vessel on which the writer served it was never completely accomplished until the circulating water pumps were removed from over the crank case where water leaking slightly past the plungers and stuffing-boxes found its way into the crank case and there mixed with the oil.

Troubles from Oil Coolers

Another frequent source of trouble were the oil coolers, where the oil is cooled by circulating water before being again used in the engine system. The oil passed through nests of tubes surrounded by cooling water, and trouble was experienced in preventing tubes from pitting through and gaskets from leaking. Whereas the oil pressure when the engine was running was greater than the water pressure, the leak would become effective when the engine was shut down and the lubricating-oil pumps stopped. Water would

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*Abstract from the "Journal of the American Society of Naval Engineers."

then leak in and cause trouble on the next run of the engine. Another source of leaks was from slight cracks in cylinders, sometimes quite imperceptible to the eye when the cylinder was cold, but allowing slight leaks of cooling water to crank case when warm. All these leaks, wherever they may be, must be prevented to insure proper cooling of piston heads and to prevent troubles ensuing from this source.

WRISTPIN TROUBLES

Wristpin troubles, in brief, are due to insufficient lubrication, insufficient clearance, undue wear on bushing or pin and heating resulting from hot piston or piston head. The trouble due to insufficient lubrication is sometimes traceable to the salt water in the oil. In other cases, however, it may be due to improper grooving of the wristpin bushing or bearing surface. This subject must be studied in connection with the approved forms of oil grooves for bearings, and steps taken to insure that the oil is being properly distributed on the wristpin bearing.

On engines with forced-lubrication pumps operating from the main engine shaft, hot wristpins frequently develop on first starting up an engine. This is probably caused by lack of lubricating oil in the wristpin bearings, the highest part of the system, when the engine is first turned over. This can be prevented on engines with an independent lubricating pump by starting up the auxiliary lubricating pump several minutes before attempting to turn over the main engines and running it long enough to insure getting lubricating oil to all parts of the system. This should always be done before starting up, as frequently wristpins will run hot and wipe in the few minutes before oil from the attached pumps can get to them.

Insufficient clearance on wristpin bushings sometimes results in not allowing sufficient lubricating oil to form a good film on the bearing and causes wiping or heating of the wristpin. Good practice is to allow about 0.002 in. vertical clearance between the pin and bushing and about 0.006 to 0.008 in. clearance on the sides. This additional side clearance gives no more play in the bearing, as the pressure is always vertical, but gives the oil a better chance to circulate in the bearing and form the oil film or lubrication.

Undue wear on wristpin bushings results in loss of lubricating oil from the bearing due to leakage, and also in loss of compression in the cylinders from the dropping down of the pistons. Consequently, anything that can be done to prevent undue wear on the wristpin bushings is important. In addition, loss of compression in the cylinders causes inefficient combustion of the fuel, reducing the economy of the engine, and necessitates frequent overhaul and insertion of liners under connecting-rods to increase compression, or frequent renewal of wristpin bushings.

The bushings should be of phosphor bronze, of as tough and durable a composition as possible. The wristpins are of steel, hardened on their wearing surface by either the bone or cyanide process. The wristpins furnished us originally were bored out from one end only and that end plugged with a threaded brass plug. We found that the pins would take a more uniform heat and better hardening if the pins before hardening were bored clear through and both ends plugged with the threaded brass plugs. This was a slightly more costly process, but resulted in much better pins, and is recommended for all wristpins for Diesel engines.

AIR-COMPRESSOR TROUBLES

Diesel engine air-compressor troubles comprise valve trouble, cooler leaks and explosions. They are due to the high temperatures created when the air is compressed in two or more stages from atmospheric pressure to approximately 1000 lb. per sq.in. In the type of engine mentioned at the beginning of this paper, the compressor was designed to take its suction from the scavenger-air housing, and it was then compressed in two stages in tandem to 800 lb. to 1000 lb. per sq.in. This air was cooled from each stage in a cooler consisting of nests of small, straight tubes around which circulated cooling water. The air from the second-stage cooler passes to the spray-air bottle which acts as a reservoir on the way to the spray-air line of the engine. It will be seen that when the two-stage air compressor takes its suction from the scavenger housing containing air at 7 lb. pressure (above atmosphere) it virtually makes a three-stage compression. On our engine, however, there was always so much oil in the scavenger housing that it was considered dangerous to compress air containing so much oil and subject it to the temperatures reached, and in practice it gave considerable trouble. So the suction to the scavenger housing was disconnected and a suction direct to the atmosphere substituted which gave a straight two-stage compression from atmospheric pressure to 1000 lb. per sq.in. This worked much more satisfactorily as regards presence of oily vapor in the compressed air and occurrence of cooler explosions.

A common practice in Diesel-engine design seems to be to have a restriction in the spray-air line between the reservoir and the engine. The only object of this, that I have been able to discover, is to enable a higher pressure to be carried in the reservoir than is needed on the spray-air system, so as to build up a reserve for starting after the engine has been shut down. If this is its purpose, it never was successful for us, and only resulted in reducing the amount of spray air we were able to get through to the fuel valves. Furthermore, it would frequently clog up and catch dirt and oil to further reduce the opening, so that in general it was more of a nuisance than anything else. Acting on this belief, the restriction on the spray air was removed entirely and much better results in every way were obtained. Whereas, before poor fuel combustion had been obtained when carrying 800 lb. to 900 lb. pressure on the spray air, after removing the restriction perfect combustion was obtained with as low as 550 lb. to 600 lb. pressure on the spray air.

Another point in regard to air-compressor trouble is cylinder lubrication. The principal danger is too much lubrication, allowing oil to be carried into the compressed air and causing high temperatures or explosions from burning or combustion of the oil vapor. The best practice is to eliminate direct cylinder lubrication entirely and depend on the moisture and oily vapor in the engine-room atmosphere to furnish sufficient lubrication. In practice this worked very well for us, and we had no trouble from lubrication while using no oil whatsoever directly on the air compressors.

VALVE TROUBLES

The principal valve trouble which we experienced was due to the valve springs losing their temper after a few hours' running, due to the high temperatures of the uncooled air to which they were subjected. The second-stage suction valve was the principal source of trouble, and when its spring gave out it would leak, allowing second-stage pressure to back up in the first-stage receiver and increase the work on the first stage and in general raise hob. Another source of valve trouble was the gradual collection of carbon deposits on the valve seats due to the presence of oil in the air and causing the valves to leak.

Cutting off the oil used for cylinder lubrication helped both troubles. But the greatest assistance to correct these faults was a water cup installed on the first-stage air suction and set to feed a small quantity of fresh water into the compressor with the air. This water cup was simply a large oil cup arranged for drop feed, filled with fresh water instead of oil. A fairly rapid feed was set on it, about two to four drops per second, and this water was dropped through the top of the air-suction pipe and drawn into the compressor with the air. The action of this fresh water was found to be as follows: It helped to lubricate the valves and cylinder walls and prevented the deposit of carbon. The high temperature almost immediately turned it into steam, absorbing some of the heat without rise of temperature in the form of latent heat, and thus keeping down the temperatures developed due to compression. In addition the steam kept the carbon from collecting and gumming up the valves, and the reduced temperatures resulting prevented the springs from losing their temper. This fresh-water cup was a fine thing, and I strongly advise other Diesel-engine operators to try it on their air compressors.

Cooler leaks were probably caused by high temperatures and possibly some electrolytic action on the tubes. The installation of the water cups kept down the temperatures and also kept carbon and oil from collecting in the coolers and restricting the heat transference. To prevent electrolytic action the outside of the copper tubes was tinned and small zincs were placed in the cooler. These precautions eliminated almost all of our air-compressor troubles. In addition all clearances were kept down to a minimum, about 1-64 in. on both stages.

AUXILIARIES

The principal troubles experienced with auxiliaries were with those geared to the main shaft. These pumps were the reciprocating type and comprised a fuel-feed pump, a lubricating-oil pump and a circulating-water pump, all driven by one large crosshead operated by a crankshaft geared to the mainshaft. The first trouble experienced was with the fuel-oil supply pump, which leaked, in spite of efforts to keep it tight, a small amount of fuel oil into the crank case. After mixing with the lubricating oil this caused rapid deterioration of the latter for lubricating purposes, as well as scavenger and crank-case explosions from its low flash point and volatility. To obviate this trouble the fuel-pump was removed and a gravity fuel feed substituted, the gravity fuel tank being supplied by a small motor-driven rotary pump, secured to the bulkhead. This removed all possibility of getting fuel oil into the lubricating oil and prevented recurrence of its evils.

The lubricating-oil and circulating-water pumps were the next to give trouble. They were high-speed reciprocating pumps, and it was almost impossible to keep salt water from leaking from the circulating-water pump and finding its way to the crank case and, ultimately mixing with the lubricating oil, causing all the troubles already enumerated. In addition, mechanical difficulties with these reciprocating pumps caused by momentary high pressures when the pump became air-bound or through defective valve action, resulted in frequent stripping of gears and breaking of pump crankshafts. These breakdowns finally became so frequent that independent motor-driven rotary-type pumps were installed for both lubricating oil and circulating water. The reciprocating-pump connecting-rod was disconnected and lashed clear, and the salt-water connections were blank-flanged to prevent any possibility of salt water leaks, and these pumps were not used but were kept available for connecting up in case of failure of the independent pumps. In nearly two years of operating they were never needed, the independent pumps operating entirely satisfactorily. As a result of this, we became strong advocates of independent auxiliaries for submarine Diesel engines.

The fuel-measuring pumps were of the plunger type, driven by an eccentric off the mainshaft. The regulation was by means of the suction valves being held open for a part of the discharge stroke to control the quantity of fuel oil discharged to the fuel valves. This regulation was made by the operator through a handwheel controlling the rocker arm operating the valves. These pumps gave very little trouble except from wear, and it was necessary to renew the plungers and barrels about every six months to a year on this account. The plungers were required to fit the barrels very closely on account of loss of pressure through leakage past the plungers. Aside from this amount of wear these pumps gave no trouble, and the method of control was entirely satisfactory.

Inspection of Governors

Ninety per cent. of flywheel accidents are due to a failure of the governor mechanism, therefore the following points should be carefully observed: (a) That the governor mechanism works freely and does not stick in any way; (b) that the governor belt is of ample strength, and does not slip, due to oil or other cause (do not use an old oil-soaked belt); (c) that the governor pulley or gears are tight on their shafts.

Engines have run away due to a key dropping out of the bevel gear on the vertical spindle of the governor, or to the loosening of a setscrew on the governor pulley.

Do not under any circumstances remove or set back the safety-cams on a releasing valve gear or block the governor, so that the governor stop is made inoperative.

Always remove the stop-pin from the governor stand immediately after starting up. This precaution is so often forgotten or neglected that the adoption of a simple semi-automatic device is strongly recommended. It may consist of a small lever pivoted to the governor standard and so balanced that it drops out of place automatically when the momentum of the balls becomes sufficient to lift the governor-rod off it.

A refinement of the same idea, which obviates the necessity of the engineer holding the "pin" in place when shutting down, or else of lifting the governor rod up on the "pin" after the engine has stopped, is shown. This appeared in *Power and the Engineer* for Feb. 2, 1909, from which the following description is quoted:

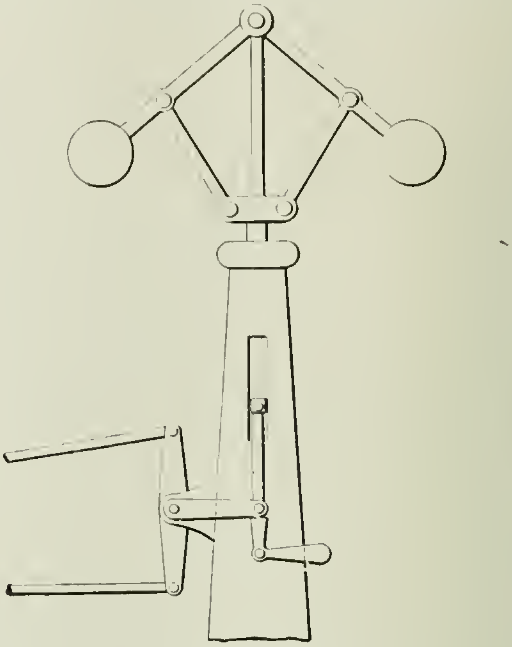
FIG. 1. HANDY AND SAFE STOP PIN

> The device is simple and any engineer can make and attach one himself. The illustration shows three positions. The first is that in which the stop is placed just after closing the throttle and before the speed is much reduced. It will be noted that the fork is not directly under the end of the rod that comes down from the collar. As this rod drops the fork centers and allows the small dog to drop, as shown in the second view. When the engine is again brought up to speed, the rod rises, and the fork is pulled over to one side out of the way by the weighted end as shown in the third view. This leaves a clear path for the rod should anything happen to stop the governor.

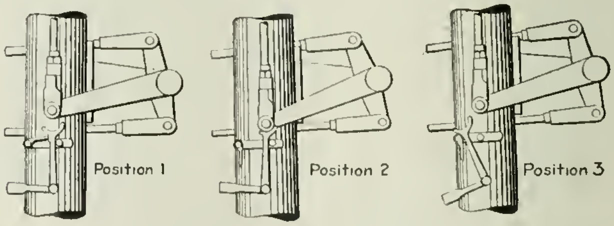

FIG. 2. MODIFIED FORM OF SAFETY STOP PIN

Never put heavy grease in the oil pot of the governor.

Examine all screws at frequent intervals, especially those in the cutoff and safety cams, to make sure that they do not work loose. The working loose of the lower screw in a cutoff cam some time ago was the cause of a flywheel wreck.

Be sure the stop collar of the governor is in such position that steam is cut off when the balls drop near the low limit. Also be sure that when the governor balls are at the upper limit, the knockoff cams shut off all the steam and do not pass clear under the crab claw and get caught. This was the cause of a flywheel wreck not long ago.—*National Safety Council.*

Plant Records and the Importance of Keeping Them

The following is from a lecture prepared by Prof. L. P. Breckenridge as part of his fuel conservation work for the Fuel Administration:

Unless records are kept, it will be impossible to know whether the boiler plant is operating at a good or a bad economy. Well-kept records are valuable, and reference to them from month to month, or even from year to year, frequently reveals some unsuspected and wasteful method of operation or shows the value of one kind of coal as compared with another. Where records are kept, it gives the fireman a chance to watch the effect of different methods of running; and this of itself will often lead to economy sufficient to repay fully any cost of installing suitable facilities for keeping the records as well as the slight cost of recording the necessary daily observations. When it is known that records are kept, the operating staff begin to take more interest in securing good records.

RECORDS FOR THE SMALL PLANT

It might be well to classify steam-power plants arbitrarily according to their size, and the writer would suggest the following: The small plant, 10 to 100 hp.; the medium plant, 100 to 500 hp.; the large plant, 500 to 5000 hp.; the commercial plant, 5000 to 300,000 hp.

It is in the small plants that is usually found the greatest waste of both coal and steam. Frequently, in these plants as much as ten pounds of coal per hour is used to produce one horsepower. This is much too large an amount. There may be conditions of operation that would sometimes justify this large consumption, but such cases need not be many, and the coal consumed to produce one horsepower should not exceed five pounds per hour even for the small plant. For the small plant the following daily records should be kept in connection with the operation of the boiler: (a) The kind and size of coal used; (b) the steam pressure; (c) the temperature of the feed water; (d) the weight of coal burned; (e) the weight of water evaporated; (f) the weight of ash.

In the medium plant, in addition to the foregoing records, the following should be kept: (g) The temperature of the escaping gases; (h) the temperature of the boiler room; (i) the composition of the escaping gases; (j) the draft pressure in furnace and base of stack; (k) the quality of the steam; (l) the heating value of the coal.

It is, of course, necessary to have the dimensions of boilers and furnaces in order to make the necessary calculations for which these records are kept.

For the large plant and for the commercial plant a few additional records are desirable, but for these plants the records as now usually kept are quite complete, and for many plants the records are continuously recorded.

The coal consumption per horsepower per hour in a medium plant varies greatly, but it is probable that if a large number of plants were taken as they are running today it would be found that at least five pounds of coal was used for one horsepower, when it ought easily to be possible to reduce this to three pounds per horsepower per hour.

In the large plant and in the commercial plant the possibilities for economy increase with the size of the plant; here the coal consumption per hour should never exceed three pounds per horsepower, should usually be well under two pounds, and in some plants operating under best conditions the consumption may soon be as low as 1¼ pounds per horsepower per hour.

HOW RECORDS SHOULD BE OBTAINED

It is not within the scope of this lecture to explain in detail how the specified records should be obtained. There are available numerous excellent laboratory manuals giving full instructions for the installation and use of instruments necessary or useful in connection with any plan for keeping records. It should, however, be observed that the records suggested for this small plant are very simple and may easily be obtained; for example, the steam pressure is read from the gage on the boiler, a special thermometer is procurable which may be screwed into a fitting in the feed line, or a mercury well with a simple glass thermometer may easily be arranged for the purpose of reading the temperature of the feed water. The weight of coal and ash will require a pair of scales, but a record of wheelbarrow loads properly trimmed off to a known weight is better than no record at all. The weight of water fed to the boiler can best be determined by installing a meter on the feed line. Meters are made for hot or cold water. They are not always accurate, but are easily checked up once or twice a year and for comparative purposes are quite satisfactory. With this simple equipment much valuable information may be obtained. It has been suggested already that consumers of coal must know how it is used, that in the future extreme waste may be prohibited.

HOW TO USE THE RECORDS

There are two ways of making good use of the records: (a) Compare your results with the best records obtained with similar equipment elsewhere; (b) compare your daily, weekly or monthly records with one another, with the object of increasing economy or reducing cost of operation. The records should be inspected by someone whose duty it is to look after "waste." If a graphic chart is made from the records, it will often show at once the influence of some unseen leak, the defect of equipment by breakage or improper setting, poor method of operation or change of coal. Corrections may then be made before the "waste" has continued a month or more. Someone in charge of power-plant operation must submit a monthly report to the general manager or owner, and this report must be given some interest and attention. The fireman must be shown his records from month to month and encouraged to fire in accordance with the best-known methods.

Any attempt to reach a conclusion as to what is a satisfactory performance leads to endless discussion. This is natural because of the commercial importance which necessarily must be considered as a part of the problem. When a power plant is manufacturing electrical energy for distribution and sale, the cost of the coal used may constitute 60 per cent. or more of the entire cost of producing its product. If, on the other hand, a power plant is generating 300 hp. for the manufacture of boots and shoes, it may be found that the cost of coal required for power generation and heating is less than 1 per cent. of the cost of production, so that frequently manufacturers have not given much attention to their power-plant operation.

The table is presented with the hope that it may be some indication of what economies may reasonably be expected in the operation of several types of power and heating plant boilers both for the production of steam and the generation of power.

REASONABLE ECONOMIC PERFORMANCE

(Stationary Steam Plants)

Type of Plant	Efficiency of Boiler and Furnace Per Cent.	Coal per Hour, Lb. Per Kw.
1. Central Stations:		
(a) Large, 10,000 kw. and up... .	70–76	3–2
(b) Small, 2,000–10,000 kw......	68–74	4–2½
2. Manufacturing power plants:		Per I.Hp.
(a) Small plants up to 100 hp.....	60–70	8–5
(b) Medium plants 100 500 hp ..	68–72	5–3
(c) Large plants 500–2,000 hp...	68–74	4–2½
3. Heating plants:		Per Boiler Hp.
(a) Central 1,000 hp. and up ...	68–74	4–3
(b) Office buildings, public bldgs.	50–70	6–3
(c) Residences	50–65	..

Even better results than those indicated are now frequently found, but it is a fair question if plants should be allowed to operate under conditions which give efficiencies below the low points indicated.

In order to standardize the form of report submitted by engineers and also to suggest approved methods of testing the different kinds of equipment, the American Society of Mechanical Engineers appointed in 1909 a Power Test Committee. This committee has prepared the "Power Test Code" of the A. S. M. E. This code was printed in 1915 and is available. It is being revised and extended and will soon be in excellent form for general use for all engineers and manufacturers. It is hoped that all important tests will conform to this code. In it will be found not only forms and methods, but also much detailed information as to the installation and use of the various instruments of precision employed in connection with tests of all kinds. All students of engineering should become familiar with this "Code of Rules for Conducting Performance Tests of Power Plant Apparatus."

The Fuel Administration's Regulations as to Clean Coal

The order of the United States Fuel Administration regarding the production of clean coal went into effect Mar. 11, 1918. According to its terms, district representatives of the Fuel Administration are authorized to appoint inspectors in sufficient numbers to carry out the provisions of the order.

The duty of each inspector is to make frequent and thorough inspections of the coal mined in the particular territory to which he is assigned and to observe the conditions under which it is mined and produced. If he finds the coal in any part of a mine to be naturally of such character as to be unfit for market, the district representative may order mining suspended in that part of the mine until proper cleaning methods are adopted; but work cannot be so suspended if it endangers life or if it may result in flooding or squeezing.

The inspector must make a daily report to the district representative of the Fuel Administration, stating the number of mines inspected, the condition of the coal as loaded, the methods used to prepare and clean the coal, and whether, in his judgment, the product being shipped to market is a well-prepared and merchantable product.

If an inspector finds coal loaded in railroad cars at the mines and is not of the opinion that it is properly prepared, he may condemn it. But he must immediately notify the district representative and the operator by wire or in person and in writing, giving the car numbers and initials of any and all cars so rejected and stating the reasons for his action.

If the district representative approves the inspector's report, he must notify the operator at once. If the operator does not unload the rejected coal at once and reprepare it, the consignee is permitted to deduct 50 cents per ton from the authorized price for the grade of coal in the car; but the consignee, after examining the coal, may at his option pay, and the operator may receive, the full authorized price.

Each invoice covering the sale of condemned coal must bear a notation to the effect that the reduced price is fixed by the United States Fuel Administration as a penalty for improper preparation. The operator must immediately report to the United States Fuel Administration at Washington and to the district representative how he disposed of the condemned car or cars of coal and a copy of the invoice must accompany his report.

The terms, conditions and validity of existing contracts are not affected or altered by the clean-coal regulations; but all new contracts are subject to the provisions of the order.

The object of the order, of course, is to discourage the marketing of slate, bone and other impurities at the same price as clean coal. But the regulations apparently contain a "joker." For, after stating that the consignee may purchase the condemned coal at a reduction of 50 cents a ton, they add:

> . . . provided, however, the consignee, after examining the coal, may, at his option, pay and the operator receive the full authorized price.

Commenting on this provision, a writer in *Fecony* pertinently remarks:

> Why were such pains taken to permit a producer of poor coal, a waster of our National resources, to receive "the full authorized price?" The coal market is a "sellers' market," and it will be for some time to come. Every coal producer knows that most manufacturers have very small reserves, and that once a car of coal is on a consumer's side-track, it is ten to one that he will not reject the coal, especially as he has probably been counting on the arrival of that car. How easy it will be to insist on "the full authorized price." Even if the original consignee is in a position to reject a particular car, every coal producer knows it is a safe bet that there is at least one near-by plant that will be glad to take anything to tide over a temporary shortage at any price. What chance is there of an operator actually suffering any penalty for poor preparation, and besides how many of the seven or eight million carloads shipped to manufacturers and retail dealers are going to be "inspected"?
>
> Careful provision is made in the order for notifying almost everybody by telegram of the condemnation of a car, except the consignee. If the Fuel Administration is really interested in the maximum manufacturing efficiency, why wasn't provision made for prompt notice to the consumer that a car of condemned coal is on the way? Is the operator going to do it voluntarily? Is he going to rush off by special-delivery mail the invoice, showing that the car contains condemned coal, so that the consumer can make other arrangements for coal to take its place?

Carbocoal

A paper prepared by Charles T. Malcolmson, president of the Malcolmson Briquette Engineering Co., Chicago, for presentation at the Colorado meeting of the American Institute of Mechanical Engineers in September of this year, describes a process for the manufacture of smokeless fuel from high-volatile coals and for the recovery and refinement of the coal-tar products derived therefrom. The products of the process are a fuel called carbocoal, which, for convenience in handling, is prepared in briquet form; a yield of tar more than double that obtained in the ordinary byproduct coking process; ammonium sulphate in excess of that normally recovered in the ordinary byproduct coking process; and gas in amount approximately 9000 cu.ft. per ton of coal carbonized, which is at present used in the process.

The raw coal, after being crushed, is first distilled at a temperature of 850 to 900 deg. F., and the volatile contents are thereby reduced to the desired point. The result of this first distillation is a large yield of gas and tar and a product rich in carbon, termed semi-carbocoal. This product is mixed with a certain proportion of pitch obtained from the tar produced in the process, and the mixture briquetted. The briquets are then subjected to an additional distillation at a temperature of approximately 1800 deg. F., resulting in the production of carbocoal, the recovery of additional tar and gas, and a substantial yield of ammonium sulphate.

The carbocoal represents more than 72 per cent. of the weight of the raw coal, the exact percentage depending upon the volatile content of the latter. It is dense, dustless, uniform in size and quality, and can be handled and transported long distances without disintegration. It is grayish black in color, slightly resembling coke, but in density more nearly approaches anthracite. It is applicable to about the same kind of service as anthracite would be, one of its most valuable characteristics being that of smokelessness.

Uruguay Requires Use of Metric Units

One of the measures recently adopted by the Government of Uruguay, says *Commerce Reports*, makes the use of metric units in all trade transactions obligatory. A decree of Feb. 8 provides that merchants dealing in articles susceptible of being sold by weight or measure must adhere to the metric system and forbids them to sell by the piece or package or for a fixed sum of money, even when the customer so demands. Where merchandise is sold in sealed wrapping, cans, boxes, packages, bottles, demijohns, etc., the net contents or weight contained must be indicated on the wrapping in an easily visible manner. In books of account and invoices the weight or measure of merchandise sold must be stated. Merchants dealing in articles of prime necessity must post in their places of business the daily prices of such articles, stating the weight or measure.

It is very advisable to have more than one way of getting out of a boiler or engine room, even if one of them is not very handy.—*Marine Engineering.*

Power for the Nitro Powder Plant

The United States Government has not only entered into a contract with the Virginian Power Co. of Charleston, W. Va., to furnish power from its plant at Cabin Creek Junction, near that city, for the mammoth powder plant at Nitro, about 16 miles below Charleston, but has arranged for an interchange of current between the Virginian Co. and the Appalachian power concerns, the two largest power companies in the state.

To insure adequate current for the Government needs at Nitro, the producing capacity of the Virginian's plant is being trebled, and an expenditure said to be in the neighborhood of $1,000,000 will be necessary to cover all the improvements. Some time ago, the company actually began to install new machinery sufficient to double the capacity of the plant, but owing to the condition of the money market was unable to finance the completion of such improvements. Not long ago officers of the company presented to the Government the proposition of assisting in the enlargement of facilities without waiting for an easier money market. It is believed that the negotiations led to the contract that has been made between the Government and the Virginian company.

General Manager H. G. Scott has made this statement in connection with the new arrangement:

> It was announced to the Public Service Commission that the Virginian Power Co. has concluded a contract with the United States Government whereunder all the electric-power requirements of the power plant at Nitro will be taken care of by the Virginian Power Co. from its plant at Cabin Creek Junction.
>
> The contract provides that two circuits over two separate and distinct routes shall be constructed for the service of the powder plant only. The contract was so arranged by the Government as to provide for the full power requirements of the coal mines. The equipment now being installed at the company's plant is practically the same which the company has had ordered for about a year. This contract, however, provides not only for the completion of the installation, but that it shall be done immediately.
>
> It is planned to physically connect the power systems of both the Virginian Power Co. and the Appalachian Power Co. in order that these companies may interchange power for the purpose of sustaining the service in the most continuous and economical manner. This plan has been successfully carried out in California, where all the larger companies are interconnected.

Injury by Defectively Repaired Boiler

"A steam boiler is inherently dangerous, and one who repairs it owes a duty of proper care to avoid injury, not only to the property and employees of the purchaser, but to all persons who may be thereby subjected to injury, and to that end must perform his work properly." This language was lately used by the Appellate Division of the New York Supreme Court in the recent case of Rosenfeld vs. Albert Smith & Son, Inc., et al.; 168 New York Supplement, 214. The court affirms judgment for death of a youth who was standing near a boiler in the power plant of a hotel building when the rear boiler head bulged out and steam escaped in fatal volume.

A hotel company holding a lease on part of the building contracted with the appellant, Albert Smith & Son, for the replacing by the latter of tubes in two boilers, the work to be done in a first-class manner and to be "perfectly tight." In the process of doing the work, appellant's employees used shims 1/32 in. thick to fill the spaces between the ends of the tubes and the inner surface of the boiler heads. But the shims were not continued all the way around each tube, being tapered or scarfed at the ends and extending only about halfway around the tubes. Apparently it was not claimed that there was any negligence in failing to bead the tubes, instead of using shims, but plaintiff offered evidence tending to show that the shims should have been extended all the way around, and that they should have projected beyond the boiler heads instead of being flush as they were, and should have been flared with the tube ends so that they would tend to resist the pressure from within and prevent the bulging out of the boiler heads. It was found after the accident that the rear boiler head had bulged out on a vertical line three-fourths of an inch, resulting in 27 tubes in the center dropping inside the boiler and the other tubes being left barely holding.

The assistant engineer testified that the gage registered only 97 lb. a few minutes before the accident, although after the tubes had been installed the boiler had been subjected to hydrostatic tests of 160 and 190 pounds.

Appellant contended in the suit that, even if it were conceded that the boiler was negligently repaired by its workmen, still the engineer in charge of the plant had tested and accepted the boiler as being in satisfactory condition. But the court decided that, under the facts established, it did not appear that the engineer was authorized to waive any defects in the boiler, and that the only bearing the tests had was as evidence on the question whether the boiler was skillfully repaired or not.

The court further held that the jury's finding that the work was negligently performed was partly sustained by testimony showing that on the first test 29 tubes were found to be leaking and sweating, and other testimony tending to show that the final test, made after further repair, was not properly or sufficiently made. Concluding, the court said:

> The appellant is chargeable with notice of the fact that the tubes were not merely intended as conduits for heat, but that they were intended to support and sustain the boiler heads, and it failed to install them in such manner that they would afford proper support in that regard. The appellant was chargeable with knowledge of the dangers to those lawfully on the premises in the event that the boiler head gave way, owing to its negligence in making the repairs. A steam boiler is inherently dangerous, and one who repairs it owes a duty of proper care to avoid injury, not only to the property and employees of the purchaser, but to all persons who may be thereby subjected to injury, and to that end must perform his work properly.

Perhaps You Can Render Valuable Service to Your Country

Important chemical and other technical engineering work necessary for the prosecution of this war is being carried on by the Bureau of Mines Experiment Station, at Washington, D. C. The services of trained men of the following classifications are urgently needed: Bacteriologists, biologists, chemists (inorganic, organic, physical and electro-), chemical engineers, draftsmen, electrical engineers, instrument makers, laboratory assistants, laborers, machinists, physiologists, plumbers, steamfitters, stenographers, skilled labor of various kinds.

If your training fits you for any of these occupations, send to the Bureau of Mines, American University Experiment Station, Washington, D. C., for blank forms. When properly executed and returned, these forms will be placed on file, and when a vacancy occurs you will be considered for it and will be notified if your services are desired.

If you are a registrant in the draft and have not yet been ordered to camp, it may be possible to have you immediately inducted into the service for work here.

If you are not in the draft, but feel that you wish to serve your country in the present crisis, you can enlist or serve as a civilian. Serve your country where you can serve it best.

A Washington contemporary says it leaked out in the Department of the Interior that the commission of eminent scientists appointed by Secretary Lane to judge whether the inventor, Garabed Giragossian, is right or wrong, the names of whom have been kept a secret, will be headed by James Ambrose Moyer, of Norristown, Penn. Professor Moyer is Director of the State Department of University Extension in Massachusetts and has been in charge of the Department of Mechanical Engineering at the Pennsylvania State College; also an engineer with Westinghouse Church Kerr & Co. and engineer of the Steam Turbine Department of the General Electric Co. He is the author of works upon Steam Turbines, Thermodynamics and Power-Plant Testing.

Tube Thickness Considered at Massachusetts Hearing

A recommendation that the minimum thickness of tubes in water-tube boilers be standardized in accordance with the A. S. M. E. Code and inserted as an additional section in the Massachusetts Code of Boiler Rules was presented at Boston, May 2, to the Board of Boiler Rules by the Mutual Boiler Insurance Co., Boston. This matter and a petition that the rules be altered to permit the use of the Breakey type of automatic gage-glass cutoff were the only subjects brought before the board at the semiannual hearing, at which George A. Luck, deputy chief of the Boiler Inspection Department of the Massachusetts District Police, presided.

The first petition urged the addition of Sec. 7 to Part 3 of the 1917 Rules, to read as follows:

Tubes for Water-Tube Boilers

The minimum thicknesses of tubes, circulating pipes and nipples used in water-tube boilers, measured by Birmingham wire gage for maximum allowable working pressures not exceeding 165 lb. per sq.in. shall be as follows:

Diameters under 3 in	No. 12 B.w.g.
Diameters of 3 in. or over, but under 4 in	No. 11 B.w.g.
Diameters of 4 in. or over, but under 5 in	No. 10 B.w.g.
Diameter of 5 in	No. 9 B.w.g.

The above thicknesses shall be increased for maximum allowable working pressures above 165 lb. as follows:

Above 165 lb., but not over 235 lb	1 gage
Above 235 lb., but not over 285 lb	2 gages
Above 285 lb., but not over 400 lb	3 gages

Tubes over 4 in. in diameter shall not be used for maximum allowable working pressures above 285 pounds per square inch.

John A. Collins, secretary of the Mutual company, urged the above incorporation on the ground of increased safety. He said that water-tube boilers are now being built in Massachusetts for 200 lb. pressure, using No. 10 B.w.g. tubes. For the past fifteen years the Mutual company has been recommending even heavier tubes than are called for in its petition. Nothing was included in the section relative to tube quality, but in answer to an inquiry, Mr. Collins stated that seamless-drawn tubes are greatly to be preferred to lap-welded. This was not incorporated in the recommendation because of the great difficulty today in obtaining seamless-drawn tubes.

J. F. Molloy, chief inspector of the Mutual company, said that he knew of a public-utility company in Massachusetts which is installing ordinary standard-gage No. 10 tubes in water-tube boilers for 200 lb. pressure; and it is not known what the actual thickness of the tubes is. These tubes may run as small as No. 11 or No. 12 for all that the inspecting company can tell. Another plant, soon to be operating at 300 lb. pressure, is putting in No. 7 gage. Under the present Massachusetts rules the use of No. 25 gage would be possible in this case. Mr. Molloy said that most accidents his company had noted in water-tube boilers came from the rupture of the tubes. No trouble has been experienced from the collapsing of fire tubes. The company has issued specifications for No. 11 gage tubes in boilers operating at 175 lb., in some of its practice. It is an open boast today among boilermakers that they would rather bid on the Massachusetts Code than on the A. S. M. E. There was no opposition to the proposed new section.

L. I. Breakey, Marshall, Mich., petitioned the board for a change in Rule No. 27, Part 3, Sec. 6, page 98, Rules of 1917, which prohibits the use of an automatic shutoff valve on a water-glass connection. The petition stated that a large number of states have changed this rule so as to admit the use of automatic shutoffs, of which there are now several makes. The Breakey shutoff is indorsed by the Ohio State Board of Boiler Rules and the Pennsylvania Industrial Board as applied to steam boilers, and it meets the A. S. M. E. Code as governing water gages. The proposed change in the rule reads as follows:

No water-glass connection shall be fitted with an automatic shutoff valve except where the automatic shutoff valves are so constructed that the two connections to the water glass can be blown through and the steam connection cannot be entirely closed thereby; means must also be provided for the renewal and inspection of the upper and lower ball check valves while the boiler is under working pressure.

There was practically no discussion of this recommendation with the exception of a comment by James Stewart, Stewart Boiler Works, Worcester, Mass., who queried the continuous reliability of any spring-actuated device and who emphasized the great importance of making such equipment foolproof. The hearing was then closed.

Government Will Open Up Fuel Oil Reserve

The naval fuel-oil reserve in California will be opened up by the Government immediately to prevent an oil famine. Assurance to this effect was given to a delegation of prominent newspaper publishers from the Pacific Coast after conferences with Secretary of the Navy Daniels, Bernard M. Baruch, chairman of the War Industries Board; Mark L. Requa, director of the oil division of the United States Fuel Administration, and representatives of eighty litigants who have numerous claims against the property now included in naval reserve No. 2.

Requa, the oil director, after the conference served notice upon the litigants that if they do not adjust their differences with the Government within two weeks so amicable settlement of disputes can be made after the war, the fields will be commandeered as a war measure.

Secretary Daniels, who took the precaution four years ago to conserve the great oil fields, gave his hearty consent to the opening up of the naval fuel-oil reserves.

Baruch said he not only could see the great and pressing need for it, but would suggest to President Wilson the commandeering of the entire Pacific Coast oil industry, if such steps were necessary.

The publishers, who were headed by F. W. Kellogg, of the San Francisco *Call*, first went to see Baruch. They explained the serious fuel-oil situation that faced not only the coast but the whole country.

They said fuel commissioners had told them there were in storage on Jan. 1, 19,000,000 bbl. of fuel oil. There will be produced under the present maximum conditions 78,000,000 bbl. of oil this year. The consumption at the present rate will require 96,000,000 bbl. This would leave only 1,000,000 bbl. at the end of the year. The reserves are decreasing at the rate of 1,500,000 bbl. a month.

Of the 2,400,000 hp. produced on the coast, nearly 75 per cent., or 1,500,000, is developed by fuel oil, 380,000 by water, 100,000 by coal and 100,000 by gas.

Fifty-seven per cent. of all the fuel oil is now used by railroads and vessels, including naval ships. The shipping board's program contemplates the use of fuel oil in about 35 per cent. of the merchant fleet. Unless this is met by additional and immediate increase in production industries depending on fuel oil will be paralyzed.

According to *Commerce Reports*, a new syndicate has been formed by Einar Steensrud, of Skien, Norway, for the consolidation and developing of a number of small waterfalls, aggregating 200,000 hp. The present intention is to utilize this power for the manufacture of nitrate, aluminum or carbide, according as the demand develops. The annual report of the Norsk Hydro has appeared, covering the year ended June 30, 1917. The net profit was $6,650,000, compared with $4,900,000 in the previous year. The capital stock is $15,450,000. This company operates waterfalls of about 300,000 hp. for the production of electrochemical commodities like nitrates and carbide. In the production of all of these commodities great heat is generated, and heretofore much of it has been wasted. By a new arrangement the waste heat is now to be utilized for the production of low-pressure steam to operate turbines.

The noncompressibility of water, coupled with the thickness of some men's heads, has helped the repair shops to several millions of dollars of work. We cannot change the nature of water, but we can do something with the men's heads.—*Marine Engineering.*

Detroit Engineering Societies' Joint Meeting

The Detroit Engineering Society and the Detroit Section of the American Society of Mechanical Engineers held a joint meeting Friday evening, May 3, in the Board of Commerce Auditorium. Dean Cooley, of Michigan University, announced a course in elementary drawing and training for women at the summer school this year, to meet the demands of the drafting room. These women will be taught to do the more elementary work, thus relieving the regular draftsmen and designers. The movement was promised the hearty coöperation of both societies, which passed a resolution to place the graduates and give the matter the necessary publicity to interest other schools in this line of endeavor.

The paper of the evening was by R. H. Kuss, consulting engineer, of Chicago, on "Coal Conservation as Applied to Boiler-Room Operation." Mr. Kuss pointed out that coal is the greatest factor in this war, one-third of the cost of living reverting to this product. A table of the use of coal was shown.

ESTIMATED EFFICIENCY WHEN BURNING BITUMINOUS COAL

	Stationary Plants			
	High	Low	Locomotive	Domestic
Poor practice, per cent	50	40	60	30
Fair, per cent	64	56	66	40
Good, per cent,	72-74	62	70	50
Available, per cent	76	68	72	55
Available decrease, per cent	12	14	9	15
Available saving, tons	25,800,000		17,100,000	20,250,000

Total available saving, 63,150,000 tons on 1917 basis.

These figures are based on observations and statistics for 1917. The available percentage is not a theoretical saving, but is based on actual practice in carefully watched plants. The available decrease is the percentage that could have been saved by careful methods, with improvements in present equipment. Considering that the output of bituminous coal for 1917 was 540,000,000 tons and the estimated requirement for 1918 is 619,000,000 tons, the necessity of preventing this waste may readily be seen.

Mr. Kuss put the problem to the engineers as their own. He showed that under new district regulations coal would be burned in fireboxes not fitted for its proper combustion and that it is the engineers' duty to see that janitors and owners of homes are taught to fire properly.

He pointed out the steps to be followed in good practice, such as tight fireboxes; the necessary combustion-chamber construction so that the air and distilled gases may have time to mix and combine before coming in contact with the relatively cold surfaces; frequent cleaning of both sides of heating surfaces. Great stress was laid on the draft control and the proper supply of air, it being as wasteful to use too much air as to use too little. Mr. Kuss spoke of the difficulties the efficiency engineers would encounter and suggested ways of overcoming them, such as: Keep in touch with the chief operator, he knows the conditions better than anyone else; study the plant over a long period; talk to the men so that the suggestions for improvement may come from them, and in some cases use opposition so that the operator will work hard to prove his point.

The engineers were warned that in the near future the Government would compile a classification list of the boiler plants in an attempt to show the grade of equipment, and that coal will be distributed on virtue of existing boiler plants.

The societies passed a resolution to maintain a joint committee to aid the Fuel Administration along the lines of good practice.

Responsibility for Injury in Horse-Play

If a fireman employed in a boiler room left his employer's premises to chase a man who had called him "Turkey," and was injured while so engaged, there can be no award under the New York Compensation Act on a theory that the accident occurred in the course of the fireman's employment. (New York State Industrial Commission's December, 1917, Bulletin, p. 82. Sullivan vs. Beach Gasper Company.)

Thermal Values of Soft Coals

From Selected Free-Burning and Caking Soft Fuels. From U. S. Geological Survey Bulletin No. 332 and U. S. Bureau of Mines Bulletin No. 23.

State	Test No.	Kind of Fuel	County	B.t.u per Lb
Alabama	375	Soft—caking	Bibb	13,671
Alabama	484	Soft—free-burning	Jefferson	14,447
Arkansas	293	Soft—caking	Sebastian	13,705
Arkansas	308	Semi-anthracite—caking	Johnson	14,125
Arkansas	340	Lignite	Ouachita	9,549
Georgia	481	Soft—free-burning	Chattooga	12,865
Illinois	448	Soft—free-burning	Williamson	12,920
Illinois	511	Soft briquets	St. Clair	13,271
Illinois	509	Soft—caking	Saline	13,621
Indiana	428	Soft—free-burning	Greene	13,099
Indiana	435	Soft—caking	Pike	13,545
Indiana	464	Soft briquets	Parke	11,930
Indian Territory	437	Soft—free-burning		13,932
Indian Territory	449	Semi-anthracite		14,682
Kansas	311	Soft—free-burning	Linn	12,343
Kentucky	434	Soft—free-burning	Union	14,026
Maryland	490	Soft—free-burning	Allegany	14,515
Maryland	518	Soft briquets	Allegany	14,717
Missouri	319	Soft—caking	Randolph	11,747
Montana	477	Lignite—free-burning	Carbon	11,628
New Mexico	392	Soft—caking	Colfax	13,059
New Mexico	387	Soft—free-burning	Colfax	12,721
Ohio	483	Soft—free-burning	Belmont	13,381
Pennsylvania	473	Soft—caking	Indiana	14,240
Pennsylvania	499	Soft—free-burning	Cambria	14,119
Pennsylvania	514	Soft briquets	Westmoreland	14,382
Tennessee	409	Soft briquets	Claiborne	14,092
Tennessee	368	Soft—free-burning	Campbell	14,008
Tennessee	363	Soft—caking	Grundy	13,257
Texas	291	Lignite—free-burning	Wood	11,131
Utah	404	Soft—free-burning	Summit	12,586
Virginia	482	Anthracite—free-burning	Montgomery	12,679
Virginia	507	Soft—caking	Tazewell	14,177
Washington	290	Sub-bit.—free-burning	King	11,772
Washington	359	Soft—free-burning	Kittitas	12,996
West Virginia	305	Soft—free-burning	Marion	13,964
West Virginia	439	Soft—caking	Kanawha	13,995
Wyoming	399	Soft—free-burning	Carbon	12,222
Wyoming	400	Sub-bit.—free-burning	Uinta	12,488

These values give in B.t.u. the theoretical thermal value of soft coals as obtained at the St. Louis Testing Plant from 139 samples of coal, and were established by "actually burning one grain of the air-dried coal in oxygen in a Mahler-bomb calorimeter."

Melting Points of Different Metals

	Deg. F.		Deg. F.
Aluminum	1,400	Iron (cast)	2,450
Antimony	810	Iron (wrought)	2,912
Bismuth	476	Lead	608
Brass	1,900	Platinum	3,080
Bronze	1,692	Silver (pure)	1,873
Copper	1,996	Steel	2,500
Glass	2,377	Tin	446
Gold (pure)	2,590	Zinc	680

Bulletin Board Series No. 650

Bulletins Are Read by 4,500,000 Workmen Each Week

NATIONAL SAFETY COUNCIL, CHICAGO, ILL.

REPAIRMEN

(Cuts Courtesy of the Travelers Standard)

Never do any work on Steam Pipes While They Are Under Pressure

Additional copies of this Bulletin can be secured at cost price from the National Safety Council, [illegible] South La Salle Street, Chicago, Ill. [illegible]

Compensation Act Applied

A novel question was presented to the Connecticut Supreme Court of Errors in the late case of Richards vs. Indianapolis Abattoir Co., 102 Atlantic Reporter, 604. Plaintiff, an employee engaged in work disconnected from the company's power plant, found it necessary to wait for about fifteen minutes before he could use an elevator in proceeding with his work, and sat down on a near-by keg in the power plant, close to a firebox and boiler. Being tired, he dozed off to sleep and awakened a few minutes later to find that his clothing had caught fire, either from radiated heat of the firebox or from a flying spark. His demand for compensation to cover resulting injury was resisted on the ground that he was not injured in the course of his employment, but the court permitted recovery, saying: "The falling asleep of the claimant was natural in the case of a man who has been engaged in hard work for the whole morning in the cold, and who at the time was sitting in a hot place. The falling asleep was not the result of any conscious effort on the part of the claimant, but came simply from drowsiness which crept over him as the result of his previous exertion. The accident occurred when the claimant was at a place where he might reasonably be. There was no turning aside on his part, no attempt to serve ends of his own."

New Publications

ELEMENTARY MECHANICS FOR ENGINEERS. By Clifford Newton Mills. Published by D. Van Nostrand Company, New York City. Cloth, 5 x 7¼ in.; 127 pages. Price $1.

This is another of a number of similar books which have appeared in the last three or four years and is arranged for students who have previously studied trigonometry. It is intended as a basis for a semester's work of three hours per week. The subject matter is divided into three parts—kinematics, kinetics and statics. Throughout many problems have been given, so that the students may master the subject by working on the many problems given The problems are well presented and for the man who has been through trigonometry, the book is well worth a dollar.

HANDBOOK OF ENGINEERING MATHEMATICS. By Walter E. Wynne and William Spraragen. Published by D. Van Nostrand Co., New York City. Flexible leather, 4¾x7 in.; 220 pages. Price, $2.

Many engineers and students will greatly appreciate this little book, which, as the introduction by Prof. Ernest J. Berg, consulting engineer. General Electric Co., Schenectady, N. Y., states is intended primarily for students in engineering schools and colleges and should serve as a convenient reminder of things that are easily forgotten, but are likely to be needed in their later work. This is certainly the most useful purpose of the book.

The authors have endeavored to supply a ready means of reference to theoretical and applied mathematics as used in engineering, and it includes the underlying engineering data and applications as well as the mathematical formulas. The first 89 pages are devoted to pure mathematics including everything from algebra to calculus and theoretical mechanics, the latter embracing gravity, inertia, impact forces, friction, etc. The remaining chapters treat of the mechanics of materials, hydraulics, flow of liquids, electricity, to measurement and physical and chemical constants. Pages 185-213 are devoted to tables of circumferences and areas of circles; powers, reciprocals; common logarithms; natural logarithms; trigonometric functions; hyperbolic sines and cosines.

It is a mighty good little book to have around to refresh the memory, and we shall be glad to keep it on the shelf near our desk.

STEAM TURBINES. By William J. Goudie. Published by Longmans, Green & Co., New York City. Size 6 x 9 in.; 519 pages; illustrated Price $4.

This is one of two unusually good books on steam turbines to appear in recent months. [The other is "Steam Turbines," by G. J Meyers, Lieut. Comm. U. S. Navy, and published by the United States Naval Institute; it will be reviewed in an early issue of "Power".] It has been the aim of Mr. Goudie to present a volume to suit the requirements of engineering students, chiefly, though there is indeed much to interest the designer and operator; in fact, the book is one that should be of considerable help to anyone interested in steam turbines. Condensers and condensing apparatus are not discussed.

The chapter on classification of turbines has some diagrams showing the behavior of velocity and pressure in turbines of the various types, which we are glad to see in a book of this kind. Such diagrams are of considerable aid to the student particularly. Throughout the book there are many excellent line drawings of sections of turbines of various types; in these drawings details are well illustrated.

The book is particularly pleasing because one finds something of what one looks for —and one looks for many data, drawings, tables, etc., on turbines these days This thoroughness, which is true of all the sixteen chapters, makes the volume the kind one wants within reach. We have had our review volume a long time, using it for reference and checking—the best way to review a book, of course. The chapter headings are: Classification of Turbines; Impulse Turbines; Reaction Turbines; Combination Turbines; Properties of Steam; Entropy Diagrams; Nozzles; Blading; Rotors; Mechanical Losses; Reheat Factors; Steam Consumption; Determination of General Proportions of Turbines. There are three chapters dealing with this last subject, and in them the author has given many excellent formulas. The last chapter deals with governing.

ELEMENTS OF FUEL OIL AND STEAM ENGINEERING. By Robert Sibley and Charles H. Delany. First Edition Published by the Technical Publishing Co., San Francisco, Calif. Cloth, 6 x 9 in.; 320 pages; illustrated. Price, $3.

The authors have had considerable experience in fuel-oil burning, on the Pacific Coast particularly. In their preface they state that it has been their underlying aim to study fuel-oil power-plant operation and the use of evaporative tests in increasing the efficiency of oil-fired plants. To accomplish this end, the subject matter has been treated in three main divisions: First. an exposition of the elementary laws of steam engineering; second, the processes involved in the utilization of fuel oil in the modern power plant; third, the testing of boilers when oil-fired. In treating the first subdivision, the elementary laws of steam engineering are set forth in a new manner in that the viewpoint is taken from that of the oil-fired instead of the coal-fired plant operator. In the second division the results of considerable labor and analyses are set forth from the collecting and collating of data involved in boiler-furnace and fuel-oil tests, many of which have appeared heretofore in disconnected form and in widely varying sources. In the first subdivision the authors have given definite suggestions for fuel-oil tests—largely suggestions recently presented personally by them at the invitation of the power test committee of A. S. M. E. The matter which deals altogether with fuel oil does not begin until Chapter 12 is reached; but from here on the authors have placed much that is of value on the subject, which for the East particularly, grows in importance. One can justly criticize some of the illustrations used in the book because of their smudgy appearance, which is not due to printing. The text matter is so well arranged that it seems unfortunate that so many of the illustrations should have been reproduced from cuts that were evidently made direct from other printed matter. There are, however, some excellent halftones throughout the book, among which are the views of the economy measuring apparatus installed at the Long Beach plant of the Southern California Edison Co.

Altogether the book is a desirable addition to the few volumes now available on this subject.

ELECTRIC WELDING MANUAL

The Wilson Welder and Metals Co., New York City, has issued a 45-page booklet devoted in part to instructions for installing and using its system of electric welding. Wiring diagrams and tables, dimensions of motor generators, brackets, etc., are given Tables showing the melting points of various metals and alloys, and instructions for the care of metals appear in the booklet. Pages 37-39 show typical examples of prepared and finished work.

PURCHASING COAL BY SPECIFICATION AND METHODS OF SAMPLING

The Pennsylvania State College, Engineering Experiment Station, has completed a reprint from the annual report of 1913-14 in which are set forth methods of purchasing coal by specification and of sampling coals for analyses. The subject is treated of by J. A. Moyer and J. B. Calderwood. The pamphlet contains 158 pages and gives the methods of gathering coal samples as used by the Bureau of Mines, Interboro Rapid Transit Co., New York City, United States Steel Corporation, General Electric Co., and Detroit United Railways. Methods of coal sampling and analyses of the American Chemical Society and of the American Society of Mechanical Engineers, also are given. Discussion of the determination of volatile matter in coal is given on page 149 of the bulletin and is of interest. We understood that the bulletin is for distribution free.

U. S. STEEL CORPORATION'S METHODS FOR SAMPLING AND ANALYZING GASES

The second edition of this valuable pamphlet (6 x 9 in., 60 pages) by the Chemists' Committee of the corporation, has been completed. In the methods set forth in the bulletin there has been an unwavering purpose to eliminate, as far as possible, tedious analytical procedure and the use of cumbersome forms of apparatus. It has been desired to adopt methods correct in principle which, in conjunction with the simplified apparatus, will insure the requisite expediency at times so necessary in commercial work without an appreciable sacrifice in accuracy of results The pamphlet deals, of course, with all the gases met with by the various companies in the corporation. Among these are blast-furnace gas, the analysis of which becomes of increasing importance because of the extensive use of this gas in waste heat boilers; producer gas; byproduct gas; flue gas; and natural gas.

On page 48 an interesting table is given: The products of combustion from burning pure carbon would contain 20.9 per cent. carbon dioxide, since it has the same volume as the oxygen used The byproducts of combustion of coal contain less CO_2 than 20.9 due to the fact that the hydrogen of the coal requires oxygen from the air, resulting in more nitrogen than if pure carbon were burned The percentages of carbon dioxide in the products of combustion resulting from perfect combustion of various coals have been calculated and are given here for comparison.

	Per Cent.
Anthracite culm, Scranton, Penn.	19.5
Semi-anthracite, Coalhill, Ark.	19.0
Semi-bituminous, W. Va.	18.8
Bituminous coking, Connellsville, Penn.	18.8
Bituminous noncoking, Hocking Valley, Ohio	18.7
Sub-bituminous, Unita County, Wyo.	18.9
Lignite, Milan County, Tex.	19.2

The latter pages of the booklet have three valuable tables giving the chemical symbol, specific gravity, weight, heat of combustion, volume of oxygen necessary for combustion, and the products of combustion. The second table, on aqueous vapor, gives the pressure in inches of mercury for different degrees F., and the weight in grains per cubic foot The third table gives factors for reduction of the volume of gas at standard conditions of 62 deg. 30 in. mercury.

The booklet is the best to come to our attention on the subject of gas sampling and analyzing.

J. N. Camp is chairman of the Chemists' Committee, United States Steel Corporation, Carnegie Building, Pittsburgh, Penn.

Obituary

E. C. Meier, president of the Heine Safety Boiler Co., died of heart failure at the Manufacturers' Club, Philadelphia, Tuesday afternoon, May 7, aged 50. Mr. Meier was attending a meeting of officials of the Emergency Fleet Corporation for which his company is making many boilers.

Personals

E. E. Maher has been appointed Chicago district manager of the Terry Steam Turbine Co., with offices at 1328-29 McCormick Building.

Norman G. Reinicker, formerly with the New York Edison Co., is now with the Du Pont interests in charge of the power plant at Nashville, Tenn.

John D. Stout has been appointed New York district manager of the Terry Steam Turbine Co. Mr. Stout has been assisting Mr. Herbert, formerly in complete charge of the district, but who will now have to devote his entire time to navy and marine requirements.

W. W. Erwin, for the past 18 years connected with the New York Edison Co., successively as mechanical draftsman, chief draftsman and superintendent of construction, has been appointed chief operating engineer of the company to succeed the late J. P. Sparrow.

The Association of Iron and Steel Electrical Engineers announces the following meetings: The Cleveland District Section on May 25 at Hotel Statler. A. E. Hogrebe will discuss the subject of Cranes. The Philadelphia Section will meet on June 15 and will hold its annual outing on this date at Valley Forge to take the place of the regular monthly technical session.

Engineering Affairs

The American Society for Testing Materials will hold its twenty-first annual meeting at Atlantic City, N. J., June 25-28, with headquarters at the Hotel Traymore.

The National Association of Master Steam and Hot-Water Fitters will hold its twenty-ninth annual convention in Chicago, June 3-5, with headquarters at the Hotel Sherman.

The American Society of Heating and Ventilating Engineers will hold its summer meeting at Buffalo, N. Y., June 26-28. This meeting is being held earlier than usual, partly to accommodate the members of the National District Heating Association, which association will not hold a meeting this year.

The American Society of Mechanical Engineers will hold its spring meeting at Worcester, Mass., June 4-7. The meeting will open and registration take place at the Hotel Bancroft on Tuesday forenoon. Wednesday will be New England Day. In the forenoon George H. Haynes will read a paper on "The Small Industry in a Democracy," and J. E. Rousmaniere one on "The Textile Industry in Relation to the War." These will be followed by visits to Crompton & Knowles Loom Works and to the plant of the Royal Worcester Corset Co. In the afternoon papers will be presented upon subjects relating to New England's industries under war conditions, and the following at the general session: "Foundry Cost and Accounting System," by W. W. Bird; "The Public Interest as the Bed Rock of Professional Practice," by Morris L. Cooke; "Moisture Re-absorption of Air-Dried Douglas Fir and Hard Pine, etc.," by Irving H. Cowdrey; "A High-Speed Air and Gas Washer," by Lieut. J. L. Alden; "Investigation of the Uses of Steam in the Canning Industry," by J. C. Smallwood. On Thursday forenoon at the general session will be given the following papers: "Efficiency of Gear Drives," by C. M. Allen and F. W. Roys; "Self-Adjusting Spring-Thrust Bearing," by H. G. Reist; "Air Propulsion," by Morgan Brooks; "The Elastic Indentation of Steel Balls Under Pressure," by C. A. Briggs, W. C. Chapin and H. G. Heil; "Electric Heating of Molds," by Harold E. White; "Stresses in Machines When Starting or Stopping," by F. Hymans. At the Fuel Session the paper will be: "An Investigation of the Fuel Problem in the Middle West," by A. A. Potter, and topical discussion on fuel economy, to be arranged for by the Fuel Conservation Committee of the Engineering Council. The various sessions will be held at the Worcester Polytechnic Institute.

Miscellaneous News

A Boiler Exploded at the Houston and Texas Central Railway shops at Ennis, Tex., on Apr. 13, killing one young man and seriously injuring another man.

Watervliet Arsenal is in urgent need of machinists for the conduct of its establishment and calls for the assistance of all instrumentalities which are available. One thousand skilled mechanics must be procured before Sept. 1. The character of the work and the high rates of pay should prove attractive to machinists.

Although 6600 Volts of electricity apparently passed through the body of John Hanifan, a lineman for the Virginia Western Power Co. at Ronceverte, he survived. When Hanifan's foot slipped his body came in contact with the high-power wire and a monkey wrench he carried came in contact with a guy wire, establishing a circuit. The "circuit-breaker" in a substation worked promptly, shutting off the current.

The Potomac Light and Power Co., of Martinsburg, W. Va., according to the statement of a man connected with the company, is expending $250,000 for machinery and transmission lines for a plant at Dam No. 5 on the Potomac River, about 10 miles northwest of Martinsburg. By the improvements to be made the company expects to increase its capacity 2500 hp. In addition to the steam-power plant at Martinsburg, a plant will be built at dam No. 4 and negotiations have been completed with the Hagerstown & Frederick Railway Co. under the terms of which the latter company will use the surplus power of the Potomac company when needed, and vice versa.

Business Items

The Clarage Fan Co., of Kalamazoo, Mich., announces the removal of its Chicago office to the Conway Building, 111 West Washington St., Room 1666, with Gardner J. Thomas in charge.

The Sprague Electric Works, announces the removal of its St. Louis office from the Chemical Building to the Pierce Building, Room 1352; and the removal of its Boston office from 201 Devonshire St., to 84 State St., Room 906.

The Alberger Pump and Condenser Co. announces the election of its officers as follows: Chairman of the Board of directors, George Q. Palmer; president, William S. Doran; vice-president, William R. Wilson; secretary, Richard C. Williams; treasurer, Frederick A. Brockmeir.

The Vulcan Soot Cleaner Sales Co.'s removal of main offices from Chicago to Du Bois, Penn., does not affect the Vulcan Fuel Economy Co., which controls boiler-room and fuel-conservation appliances, and remains at 230 South La Salle St., Chicago, with representatives in the chief manufacturing centers.

The Havard Coal Meter, which has been in general use for a number of years for measuring coal in boiler rooms as fed to boilers, has been awarded the Certificate of Merit by the Franklin Institute of the State of Pennsylvania. The award reads as follows: "In consideration of the invention of a meter for the measurement of granular material, which combines simplicity of construction with reliability in operation, is automatic in action and accurate in measurement within a reasonably small limit, the Institute awards the Certificate of Merit to Oliver D. Havard, of Allentown, Penn., for his invention of The Havard Coal Meter.

Trade Catalogs

A Business Trip With a Railway President. Perolin Railway Service Co., St. Louis, Mo. Pp. 16; 9 x 12 in. The story of Perolin as a boiler-metal treatment attractively presented as a drama in three acts, under the above title.

Lower Pumping Costs with E-M Synchronous Motors. Electric Machinery Co., Minneapolis, Minn. Bulletin 183. Pp. 23; 8½ x 11 in.; illustrated. Outlines in a general way the subject of centrifugal-pump development; the selection of a motor to drive a pump, etc.

The Smooth-On Manufacturing Co., of Jersey City, N. J., will send to anybody who requests it, a copy of the 16th edition of its new instruction book, which contains 144 pages of interesting and illustrated reading matter, showing how the different Smooth-On iron cements are used for repairing purposes.

NEW CONSTRUCTION

Proposed Work

N. H., Manchester—The Manchester Traction, Light and Power Co. has had plans prepared for the erection of a boiler house near Mast St. L. J. Farrell, Engr.

N. Y., Albany—The Chasm Power Co. of Chateaugay, plans to issue $25,000; the proceeds will be used to build an auxiliary power house and install and equip same with necessary machinery. W. T. Thayer, Gen. Mgr.

N. Y., New York—The United Electric Light and Power Co., 515 West 141st St., has purchased a site on West 97th St. and plans to build a power station on same.

N. Y., Utica—The Augusta Knitting Mills, 307 Niagara St., will soon award the contract for the erection of a 2 story factory. Estimated cost, $30,000. Motors, blowers, etc., will be installed in same.

N. J., Newark—The Heller and Merz Co., Hamburg Place, will soon receive bids for the erection of a power house. R. G. Corey, 39 Cortland St., New York City, Arch.

Md., Cumberland—The Kelly Springfield Tire Co., Cook St., Akron, is building a new plant here. Work includes the construction of a power station. Estimated cost, $1,000,000.

W. Va., Charleston—The Virginia Power Co. plans to build a 16 mile transmission line from here to Nitro. H. G. Scott, Gen. Mgr.

W. Va., Harpers Ferry—The Northern Virginia Power Co. plans to issue $500,000 bonds; the proceeds will be used to build a hydro electric plant. D. M. Swink, Winchester, Va., Gen. Mgr.

Ga., Reidsville—City voted to issue $10,000 bonds for the installation of an electric lighting plant.

Fla., Sarasota—City plans to install an electric lighting and power plant.

Ala., Goodwater—The Central of Georgia Ry. plans to build a coal chute and install electric power equipment. C. K. Lawrence, Ch. Engr.

Miss., Purvis—City will soon receive bids for the erection of an electric lighting plant. X. A. Kramer, Magnolia, Engr. Noted May 7.

La., Gueydan—City plans to install an electric lighting plant. About $15,000 is available for the project.

Ohio, Cincinnati—The Andrews Steel Co. 9th and Lowell Sts., Newport, plans to build a 6000 kw. electrical unit at its plant. W. N. Andrews, Secy.

Ohio, Cleveland—The Army and Navy Post, Grand Army of the Republic, care J. J. Sullivan, Central National Bank, Rockefeller Bldg., plans to build a memorial building and install low pressure boiler for steam heat.

Ohio, Cleveland—The J. P. Stotter Co., Leader News Bldg., plans to build a hotel on Euclid Ave and East 71st St., and install elevators, heating boilers, etc. Total cost, $200,000.

Ohio, Columbus—City is having plans prepared for the installation of a new heating system in the city hall. About $19,000 has been appropriated for this project.

Ohio, Gambrinus—(Canton P. O.)—The Wheeling and Lake Erie R. R., Electric Bldg., Cleveland, plans to build power and round houses here. About $95,000. W. R. Rohbock, Electric Bldg., Cleveland, Engr.

Ind., Indianapolis—The Citizens Gas Co. 47 South Penn St., plans to improve and extend its plant. Estimated cost, $750,000.

Wis., Peshtigo—T. A. Pamerin has purchased the local electric lighting plant and plans to install additional equipment and build a dam.

Wis., Stevens Point—The Jackson Milling Co., Grand Rapids, plans to build a 2 story, hydro electric plant About $500,000. L. A. Geers, Grand Rapids, Engr

Iowa, Monticello—The Monticello Electric Co. plans to extend its electric transmission lines from here into Linn County G. Adamson, Ch. Engr.

Kan., Alden—N. L. Jones has been granted a franchise by the City for the construction, maintenance and operation of an electric light and power distributing system.

Kan., Garnett—City plans an election to vote on $65,000 bonds; the proceeds will be used to improve its electric lighting plant and water works system. Black & Veatch, Inter State Bldg., Kansas City, Mo., Engrs.

Kan., Topeka—The St. Frances Hospital will soon award the contract for the erection of a brick and reinforced power house and laundry. Estimated cost, $20,000. E Forsblom, Topeka, Arch.

Neb., Norfolk—The Board of Directors of the State Insane Hospital, will soon award the contract for the erection of a power house and ward building. Estimated cost, $70,000. J. C. Stitt, Arch.

Mo., Kansas City—The Kansas City Railways, 303 Montgall St., will soon award the contract for the erection of a substation on Oak St. Estimated cost, $25,000. C. E. Fritts, 15th and Grand Ave., Engr. Noted Oct. 7

Mo., Lees Summit—The Green Light and Power Co. plans to extend its transmission lines from here to Little Blue.

Mo., West Plains—The Missouri Iron and Steel Corporation plans to build a large power plant near Henderson. Estimated cost, $750,000.

Tex., Denison—City plans to build an electric lighting plant.

Tex., Nixon—The Nixon Electric Light and Power Co., plans to install an alternator. W. L. Hoover, Mgr.

Okla., Bixby—City plans to install an electric lighting plant.

Okla., Jennings—City plans an election soon to vote on $25,000 bonds for an electric lighting plant.

Ariz., Snowflake—The Snowflake and Taylor Irrigation Co. plans to build a hydro electric plant. Plans for the project will mature about July 8.

Wash., Seattle—The Board of Public Works plans to build a sanatorium and will install a steam heating plant in same. About $60,000. A. H. Dimock, City Engr.

Ore., Estacada—The Portland Ry. Light and Power Co., Portland, has been granted permission by the Government to build a large power plant and dam here. About $1,000,000. O. B. Coldwell, Bway and Alder Sts., Portland, Gen. Supt.

Ore., Salem—The Crown Willamette Paper Co., Pittock Blk., Portland, has applied for permission to develop 200 second feet of water from Youngs River, near Astoria. Plans include the construction of a power house, dam, etc. Estimated cost, $150,000.

Ore., Toledo—The Lincoln County Light and Power Co. plans to enlarge its capacity by installing a 2000 hp. turbine and dynamo. J. Paquet, 112 East 12th St., Portland, Pres.

Calif., Modesto—The Sierra and San Francisco Power Co plans to build a hydro electric plant on the Middle Fork of the Stanislaus River. M. C. McKay, 58 Sutter St., San Francisco, Supt.

N. S., Barrington—The Town plans to build an electric lighting and power plant Estimated cost, $8000.

N. S., Berwick—Town plans to build an electric lighting and power plant. H. A. Cornwell, Clerk.

N. B., St. John—T. McAvity and Sons, Ltd., plans to install a new 550 hp. steam power plant in its plant now being built.

Ont., Hamilton—The Board of Governors of the City Hospital has plans under consideration for the construction of a power plant here.

Ont., Toronto—Milton & Prentice Traders' Bank Bldg., is in the market for two 250 hp. vertical steam engines.

CONTRACTS AWARDED

Mass., Middleton—Essex County Commissioners, Salem, have awarded the contract for the installation of a central heating plant, to Lynch & Woodward, 287 Atlantic Ave., Boston. Estimated cost, $35,764.

R. I., East Greenwich—The Andrews Mill Co., 221-4th Ave., New York City, has awarded the contract for the erection of a 2 story, 45 x 80 ft. brick and steel power house and a brick and steel weave shed, to be erected here, to the C. I. Bigney Constr. Co., 89 Weybosset St., Providence. Estimated cost, $200,000.

Conn., Bridgeport—The United Illuminating Co. has awarded the contract for alterations and improvements to its local power house, to the New England Iron Works, 94 Commerce St., New Haven.

N. Y., Buffalo—The Delaware, Lackawanna and Western R.R. has awarded the contract for the erection of a power house at East Buffalo, to J. W. Cowper, Fidelity Bldg.

N. Y., Mohawk—The Elastic Spring Knit Corporation, East Main St., has awarded the contract for the erection of a knitting mill to F. R. Edick, West Main St. Estimated cost $30,000. A steam heating plant will be installed in same.

Penn., Erie—The Board of Education has awarded the contract for the erection of a new school, to Sutherland Building and Contracting Co., Syndicate Trust Bldg., St. Louis. Boilers and a vacuum heating system will be installed.

Del., Wilmington—The Mullins Store Co. has awarded the contract for the installation of a heating plant, to Gawthrop & Bro. Co. Estimated cost, $11,270.

Va., Richmond—The Virginia Ry., and Power Co. has awarded the contract for improvements and alterations to its sub station, to Nicholas & Lindermann, 522 Sea Board Blk., Norfolk. Estimated cost, $11,700.

Ohio, Hamilton—The Shuler and Benninghofen Mills Co., Lindenwald St., has awarded the contract for the erection of an addition to its boiler house, to G. Lingler. Estimated cost, $7500.

Neb., Sidney—The Town has awarded the contract for improvements to its electric lighting and water works plant, to the O'Fallan Supply Co., Denver, Colo. Estimated cost, $30,592.

Ariz., Snowflake—The Snowflake and Taylor Irrigation Co. has awarded the contract for the installation of an electric lighting and power plant, to H. T. Loyd, Wickenberg. Noted Oct. 16.

Wash., Cheney—F M. Martin Grain and Milling Co., Hutton Bldg., Spokane, has awarded the contract for the erection of a concrete mill to Huetter Construction Co., Spokane. Equipment including motors, electric lighting outfit, etc., will be installed.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania..	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr Ago
Pea	$3.45	$2.80	$4.35	$3.70
Barley	2.15	1.50	2.40	1.75
Buckwheat ..	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes...	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va Splint
Prepared sizes...	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.65-3.25	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg....	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut.....	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen....	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed..	2.15-2.50	2.15-2.35	2.15-2.35

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba.	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, MAY 21, 1918 No. 21

Pointers to Success

PERHAPS one of the most convincing arguments in favor of education can be found in the large percentage of young men who are today filling the higher-up executive positions in all lines of business. While recently inspecting one of the largest central-station plants in New England, the writer was particularly impressed with the comparative youth of the executive personnel. Many of them were men from the ranks, who, by close observation and study, had fitted themselves for their present duties. Only three were college or university men with degrees. I asked the thirty-five year old superintendent of power, who has climbed the ladder by way of the boiler room, just how he had fitted himself for his position, and his reply is food for thought for many of the young fellows in the field today. He said:

"My heart and brain were in my work, and the best textbooks, papers and journals were my companions in most of my leisure time. I always solicited help in any problem from my fellow engineers, superiors and others who were able and willing to assist me. I had confidence in myself and never was content to remain at a standstill after I had made ready for the next step."

The secret of this man's success lay in the fact that he had made a decision early in his youth to have confidence in his ability to never stand still too long—to keep on climbing and to get help from the other fellows with which to boost himself up another rung on the ladder.

Look right about you among fellows you used to know. Some of them, no abler than you, are climbing, and what they are accomplishing you can accomplish. Studying alone—trying to teach oneself in spare time at home—is the hardest kind of work. Of course it is discouraging not to have assistance when you get stuck on some problem. Your studies can be lightened a great deal and made more interesting if you have the right kind of reading matter. The technical press is the workman's teacher, and some papers will even respond to appeals for help in understanding the principles of working problems.

Avail yourself of the privilege of laying your perplexities before some of the best men in the field, who will gladly help you through the pages devoted to plant problems. Often there are talks or lectures that you can attend, or perhaps there is an association of engineers to which you should belong and get some of the benefits of the discussions which take place. You will get some pointers at each meeting, and the personal contact with the local engineers is valuable. There are lots of problems to argue about, and this battle of wits will stimulate increased interest in your study of books and journals, for, when you get cornered in an argument, you will always look up the subject in the book or consult your trade journal, if you are a real engineer.

There are unlimited ways for you to train yourself for the bigger job if you are willing to sacrifice a portion of your time, energy and money. Nobody can push you ahead; your employer can open a path for you only when he is able to see increased value in your ability to handle the work. He may take a special sort of interest in you—but even this is of little help if he finds you are not training or assisting yourself. So it's up to you to make good. Many a man has been able to make himself so valuable that his services are always in demand, and this sort of man, you will always notice, is a close student of his calling.

Character, energy, brains, initiative and capacity for responsibility are the factors that make modern engineers command, instead of seek their positions. The envious attribute success to luck. Not every man can reach the top, for there are not enough places to go around. Some fellows soothe their minds with such thoughts, which are but lame excuses, for they are too lazy to study. They get just about so far and then plod along in a rut during their remaining years. The very sight of such men should stimulate a desire in you to avoid following in their path.

Contributed by C. H. Willey

Interconnected Power Systems of the South*

Hydro-electric systems of independent companies operating in five states are connected into one vast transportation system. These plants are mainly hydro-electric, but several steam stand-by plants are included. The United States Geological Survey has estimated the available power in the headwaters of the Appalachian Mountains at 2,800,000 hp., and the estimate for all the systems of the South is about 5,000,000 horsepower.

HYDRO-ELECTRIC power is a resource that will attract to a community a line of manufacturing that usually seeks cheap power as the prime requisite. The development of high-tension transmission systems has become common in many parts of the United States, but it was in the South that the logical and obvious thing was first done by interconnecting a number of systems with resultant advantages and economies. By this interconnecting of power plants the Southern States can boast a high-tension line approximately 1000 miles long from Nashville, Tenn., to Henderson, N. C. This ties together the hydro-electric systems of five companies operating in four states. In other words, all the great transmission systems of the South with the exception of that controlled by the Alabama Power Co. are interconnected. It is probably only a question of time until all properties will not only be interconnected but possibly owned and controlled by a master organization.

Among the advantages which follow from the interconnection of such systems none is greater than the improvement in the diversity factor. The difference of one hour in time between Henderson, N. C., and Nashville, Tenn., adds to the normal diversity factor of each system.

The United States Geological Survey has estimated the available power in the headwaters of the Appalachian Mountains at 2,800,000 hp. The estimate for all the systems of the South is about 5,000,000 hp. The Appalachian region has an enormous rainfall with a topography that is favorable to the development of low-head power plants. The illustration at the head of this article is typical of the Southern water powers. High heads as a rule do not exist and flumes and penstocks are little used. The absence of lakes in the region makes natural storage of water impossible.

Among the power companies in the United States and Canada having yearly outputs in excess of 100,000,000 kw.-hr., there are three Southern concerns, according to data given in the *Electrical World*, March 23, 1918.

System	Peak Load, Kw.	Yearly Output, Kw.-Hr.	Yearly Load Factor Per Cent.
Tennessee Power Co..	85,200	547,945,475	73.41
Alabama Power Co...	58,250	289,715,125	56.7
Georgia Railway & Power Co..	78,200	258,607,882	

FIG. 1. INTAKE DAM AT TALLULAH FALLS, GEORGIA RAILWAY AND POWER CO.

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*"Metallurgical and Chemical Engineering."

The properties owned by the Alabama Power Co. include several sites on the Coosa River, one site on the Tallapoosa River, one on Little River, and sites at Muscle Shoals on the Tennessee River. On these sites approximately 500,000 hp. can be developed. The hydro-electric stations of the company at present in operation are located at Lock 12 on the Coosa River, where a head of 68 ft. is available, and at Jackson Shoals, on Choccolocca Creek, where a head of 22 ft. is available. Sixty-cycle three-phase energy is generated at 6600 volts in the Coosa River plant and 2300 volts in the Jackson Shoals plant. The company has at present in operation 180 miles of steel-tower transmission lines equipped with suspension-type insulators and 00 stranded copper cable for transmitting energy at 110,000 volts to four substations over private rights-of-way. The substations are situated at Gadsden, Anniston, Jackson Shoals and Magella, near Birmingham. Substations operated at 22,000 volts are in operation at Talladega, Leeds, Lovick, Alexander City, Gadsden and Attalla. The high-tension substations are of the outdoor type. It is the purpose of the company to standardize these as to size and type on 3000-, 6000 and 10,000-kv.-a. ratings. At present 45,300 kv.-a. is installed in the four substations. The company has 25,000 kw. of available steam auxiliary apparatus, comprising a 12,500-kw. steam-turbine station at Gadsden[1], containing two 6250-kv.-a. units, and a 15,000-kw. steam-turbine and reciprocating-engine plant. With the available steam auxiliary of 25,000 kw. operating as required and furnishing approximately 7.55 per cent. of the total kilowatt-hour output, 62,400 kw. of primary power at 50 per cent. load-factor can be delivered as soon as another hydro-electric unit is installed. The Anniston substation is a switching station for two 110,000-volt lines which pass through it. The Jackson Shoals substation is also a switching station for three 110,000-volt circuits from the north, south and west. The Magella substation will have an ultimate rating of 67,000 kilowatts.


FIG. 2. COLUMBUS POWER CO.


FIG. 4. YADKIN RIVER POWER CO., BLEWETT FALLS, N. C., HYDRO-ELECTRIC PLANTS FROM NORTHEAST

Carolina Power and Light Company

The Carolina Power and Light Co., in addition to the property owned and directly operated, also controls the Yadkin River Power Co. and the Asheville Power and Light Co.

The last-named company operates the electric light and power service in Raleigh, Goldsboro, Henderson, Oxford, Sanford and Jonesboro, furnishing electric light and power service for manufacturing properties in Fayetteville, Clayton, Smithfield, Selma, Franklinton, Pine Level and Cumberland. It also supplies under contract the entire requirements of the municipal electric light and power systems in Smithfield, Selma and Clayton and all the privately owned electric light and power systems in Franklinton and Pine Level. The company operates 188 miles of high-tension transmission line connecting two hydro-electric and three steam plants with distributing systems in all the communities served. The larger of the hydro-electric plants is located at Buckhorn Falls on the Cape Fear River and has an installed capacity of 3300 hp. The smaller is a plant of 530 hp. on the Neuse River near Raleigh. The company has also in reserve a modern steam plant of 5000 hp. capacity at Raleigh, one of 950 hp. at Goldsboro and one of 300 hp. at Henderson. It operates nine substations with an aggregate capacity of 23,000 horsepower.

The properties of the Carolina Power and Light Co,


FIG. 3. THE GREAT FALLS PLANT OF THE SOUTHERN POWER CO.

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[1] Gadsden Steam Power Plant, "Power," Aug. 4, 1914.

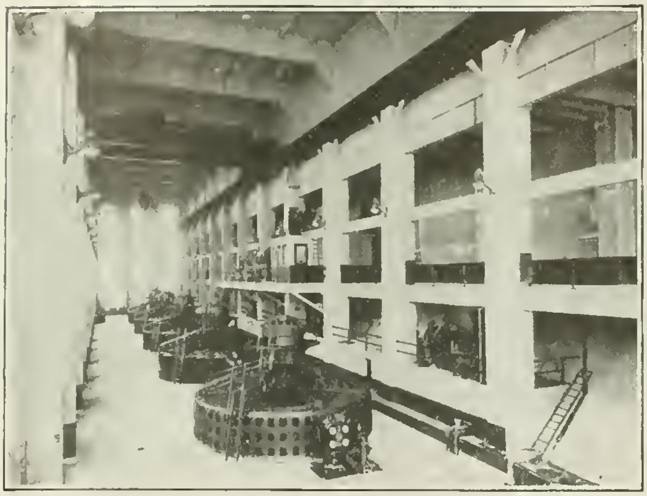

FIG. 5. 90,000-HP. GENERATORS—COOSA RIVER INTERIOR VIEW LOCK NO. 12 POWER HOUSE

are situated in the heart of the North Carolina industrial district. A large part of the electric energy sold by the company is supplied to cotton mills, cotton gins, cottonseed-oil mills, fertilizer works, veneer mills, furniture factories, machine shops, brick plants and other manufacturing establishments, and to municipalities for pumping water.

The Yadkin River Power Co. owns and operates a hydro-electric development on the Yadkin River, at Blewett Falls, near Rockingham, N. C., with an initial installed capacity of 32,000 hp. It has in operation 184 miles of high-tension transmission lines, located on private right-of-way, and 49 miles of distributing lines, five substations, with a total capacity of 4100 hp.; lighting and power systems in Rockingham, Hamlet, Wadesboro and Lilesville, N. C., and Cheraw, S. C., and an electric-power service in Lumberton, N. C., The transmission lines are connected with those of the Carolina Power and Light Co. and the Southern Power Co. The power station at Blewett Falls is one of the most modern in the South. It is 285 ft. long by 70 ft. wide, three stories in height, and is built of steel and brick with concrete foundations, floor and roof. The dam is of solid concrete construction. It has a total length of 1470 ft. and a maximum height of 50 ft. The dam has created a reservoir eight miles in length with a total area of 2500 acres. The station was placed in regular operation in June, 1912.

Like the properties of the Carolina Power and Light Co., those of the Yadkin River Power Co. are situated in the Carolina cotton-mill district, and a large part of the electric energy sold by the company is supplied to cotton mills, cotton gins and cottonseed-oil mills. It also supplies power to numerous other industrial plants, such as fertilizer works, veneer mills, furniture factories, brick plants and railroad shops, and to municipalities for pumping water.

Columbus Power Company

The Columbus Power Co. has three hydro-electric developments on the Chattahoochee River, two at Columbus having an aggregate rating of 9000 kv.-a. and one at Goat Rock, 15 miles north of Columbus, having 13,750 kv.-a. installed, making the total available 22,750 kv.-a. The City Mills development at Columbus comprises five generators with an aggregate rating of 1000 kw., the head being 10 ft. The North Highlands development has six generators, with an aggregate rating of 6900 kw., and waterwheels operating under a head of 42 ft. The Goat Rock development, where a head of 72 ft. is available, has three generators, two of which are rated at 3750 kw. and the other at 5000 kw. Three-phase 60-cycle energy is generated at 5500 volts and 11,000 volts. Two 4000-kw. transformers step up the potential to 66,000 volts for transmission. A 11,000-volt line on wooden poles with pin-type insulators connects the Columbus and Goat Rock properties, and a 60-mile steel-tower line equipped with suspension-type insulators and operating at 66,000 volts extends from Goat Rock at Newnan. There is 18 miles of wooden-pole line operating at 11,000 volts connecting Newnan and Hogansville. Four main substations are connected to the system: One at Columbus, rated at 1600 kw.; one at West Point, rated at 1875 kw.; one at La Grange, rated at 1875 kw.; and the fourth at Newnan, rated at 4000 kw. The system operates continuously on a 40 per cent. load-factor basis, and auxiliary steam-generating apparatus of the capacity of 3000-kw. turbo-generators is available. Provision is made for the transfer of 3000 kw. between the Columbus Power Co.'s system and the system of the Georgia Railway and Power Co.

FIG. 7. DUNLAP PLANT, GEORGIA RY. AND POWER CO.

FIG. 6. THE ROCKY CREEK PLANT OF THE SOUTHERN POWER COMPANY

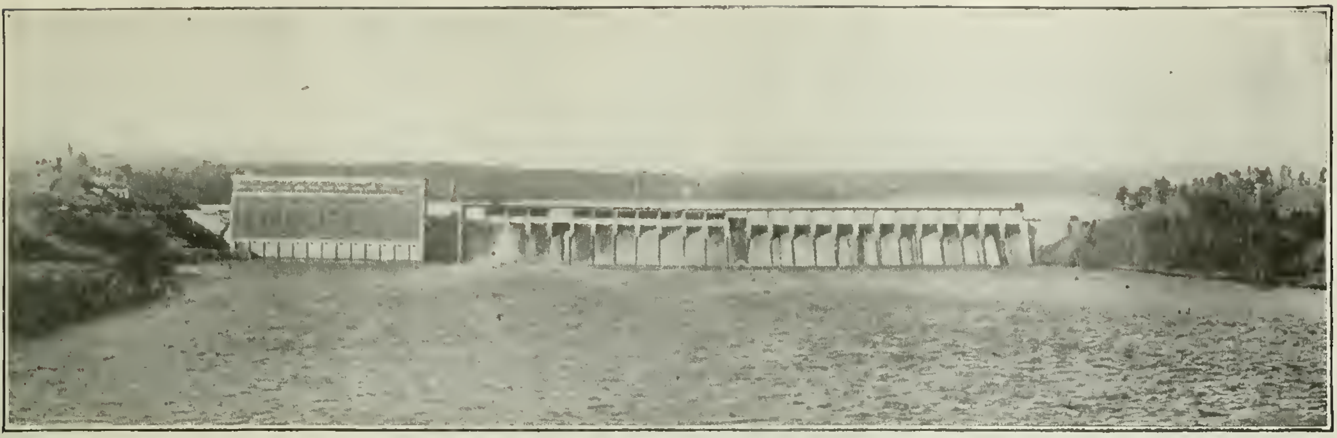

FIG. 8. LOCK 12. HYDRO-ELECTRIC PLANT—DOWNSTREAM VIEW

GEORGIA RAILWAY AND POWER COMPANY

The present coal-supply conditions emphasize the importance of existing water-power generating plants and the vital need of additional developments.

The 100,000-hp. plant of the Georgia Railway and Power Co. at Tallulah Falls[2] was barely finished when the rapid increase in the demand for hydro-electric power forced the company to undertake the construction of additional water-power developments, which, when completed, will nearly double the present capacity of its existing water-power plants.

The growth of the business in the last six years is shown in the following table of yearly outputs in kilowatt-hours:

1912	68,400,642	1915	179,976,596
1913	80,763,025	1916	211,872,638
1914	145,684,803	1917	258,607,802

This shows an increase in that period of nearly 300 per cent.

The water power furnished by the company to its customers in 1917 would have required approximately 475,000 tons of coal if generated by them by steam. The additional water power which it is estimated will be generated at the new plants now under construction, and which has already been largely sold, will take the place of and save approximately 400,000 tons of coal annually—a total combined saving of approximately 875,000 tons of coal per annum.

The new developments now being constructed are as follows:

The Burton storage reservoir, to be in service by the end of year 1918, is three miles north of the present Mathis storage reservoir and will flood approximately 3000 acres of land. It requires the construction of a dam 700 ft. long and 100 ft. high of cyclopean masonry. The reservoir will store approximately five billion cubic feet of water. The water contained in this reservoir, exclusive of the average flow of the river, will produce at the Tallulah Falls and Tugaloo generating plants 65,000,000 kw.-hr. and will increase the annual capacity of those plants to that extent. This reservoir will also make possible the equalization of the river flow, or in other words, the even distribution of all available rainfall run-off from its contributary watershed throughout every month in the year, the stored water being drawn out for use in the dry months and replaced in the wet season. The water that can be stored in this reservoir is equivalent to the available energy in 130,000 tons of coal.

The Tugaloo development is about two miles below the present Tallulah Falls power house on the Tugaloo River where the Tallulah and the Chattooga Rivers come together and form the Tugaloo. The water available at this point for power purposes comes from both the Tallulah and the Chattooga Rivers. The average flow of the river, including the effect of the Mathis storage reservoir, it is estimated will produce at this plant approximately 120,000,000 kw.-hr. It will require only 1½ miles of transmission line to connect this development with the present Tallulah Falls transmission lines. The Tugaloo dam of cyclopean masonry is

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[2] Tallulah Falls Development, "Power," Jan. 27, 1914.

FIG. 9. LOCK 12. HYDRO-ELECTRIC PLANT—UPSTREAM VIEW

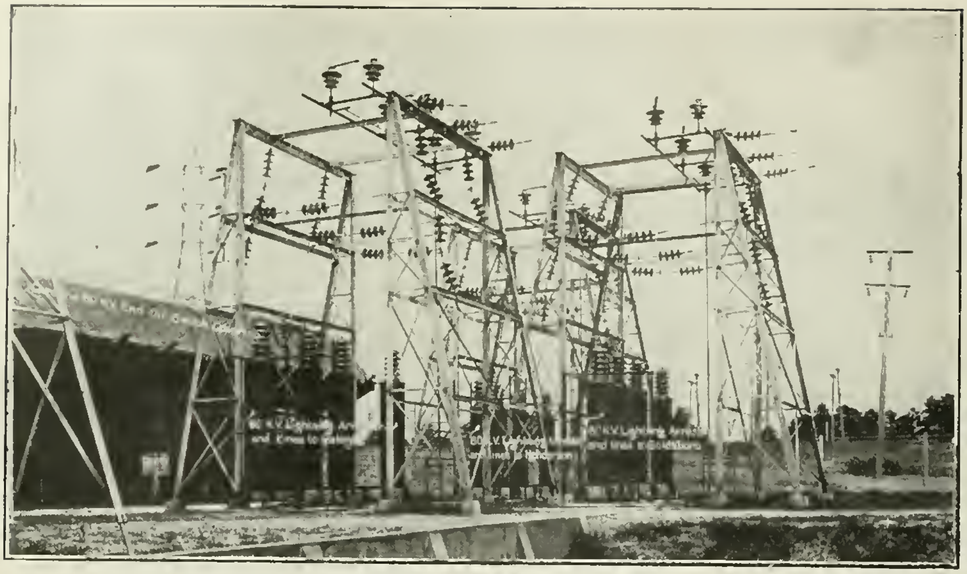

FIG. 10. METHOD (N. C.) OUTDOOR SUBSTATION LOOKING NORTH. CAROLINA POWER AND LIGHT CO.

800 ft. long and 140 ft. high. The Tugaloo plant will develop approximately 65,000 hp., and it is estimated that two years time will be necessary in which to complete it.

The Tallulah Falls power plant was constructed and designed for six units of 12,000 kw., or about 17,000 hp. each. Five units are now installed. The sixth has been ordered and will be ready for service some time during the summer of 1918.

Contracts were let for all the required equipment for the three developments during the summer of 1917 and construction is now actively under way.

The estimated total cost of this construction is $5,000,000. The necessary financing to carry on the work was completed in June, 1917. The company was fortunate in this respect because the war has since brought such changed financial conditions that the necessary capital could not be secured at the present time and this has been continuously true since the financial arrangements were concluded.

The Georgia Railway and Power Co. upon completion of the plants now under construction will have waterpower plants of approximately 200,000 hp. developed and in service. The company controls approximately 300,000 undeveloped horsepower in addition, or a total developed and undeveloped of approximately 500,000 horsepower.

A large part of the power generated by the company is used by enterprises making war materials or supplies necessary to the successful prosecution of the war. This shows how doubly vital it is in war times that money for such developments should be available. It also points the lesson that many of us appreciated years ago; namely, the necessity of a broad and generous policy on the part of the Government in the development of the water powers of the nation. Water power should be provided to meet the increasing demand due to the war. But war conditions have made money unobtainable through the usual banking channels. From now on and as long as present conditions exist such developments cannot be made unless the National Government will furnish the needed capital with which to carry on the work.

The French government realized early in the war the vital need of largely increasing the available power for industrial purposes from other sources than coal and is now constructing water-power developments in Southern France on a large scale under the direction of an American engineer.

The power actually furnished by the Georgia Railway and Power Co. in 1917, if generated by its customers by steam, would have required 11,875 cars of coal of 40 tons capacity each, and the estimated power which will annually be generated by the plants now being constructed, will be the equivalent of 10,000 cars of coal of 40 tons capacity each additional, or a combined saving in coal consumption per annum of 21,875 cars of coal of 40 tons capacity each, or a total of 875,000 tons. If the remaining 300,000 hp. of undeveloped water power

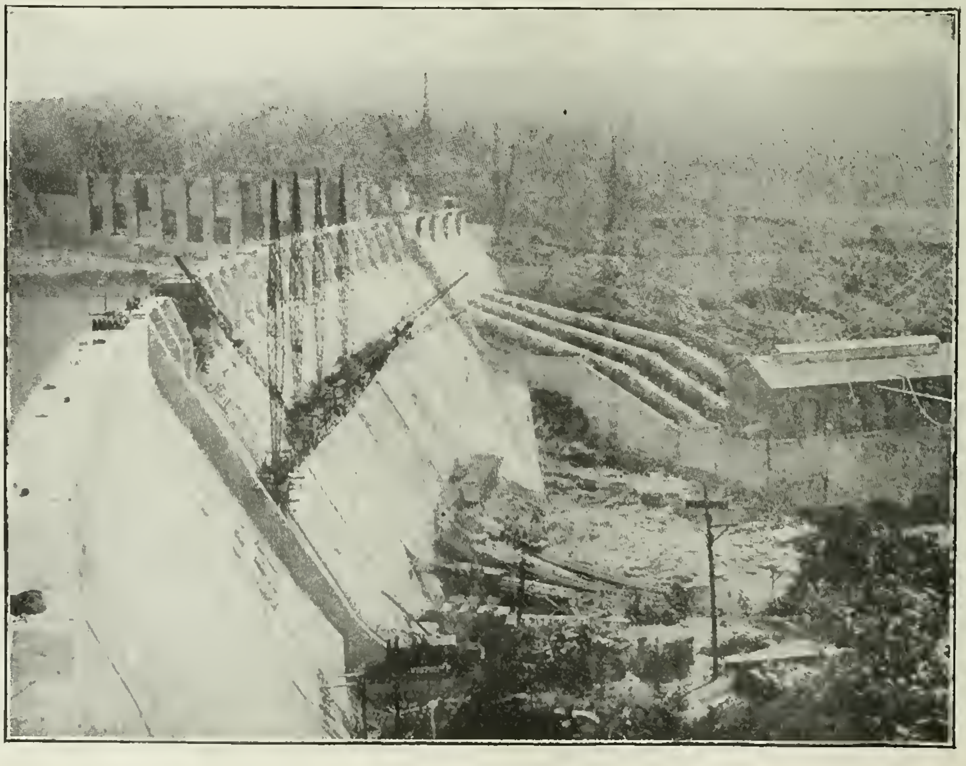

FIG. 11. THE TALLASSEE POWER CO., YADKIN RIVER, BADIN, N. C.

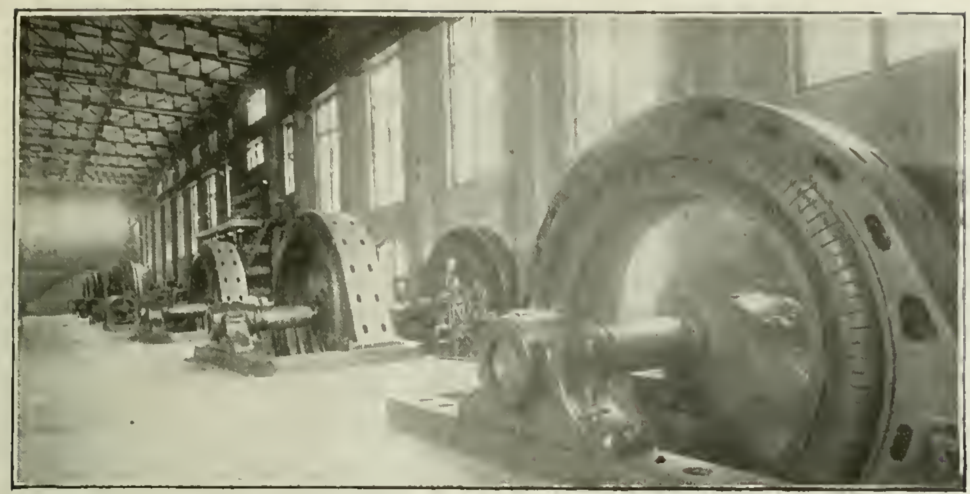

FIG. 12. YADKIN RIVER POWER CO. THREE 4500 Kv.-A., THREE 6000 Kv.-A. 4000 VOLT 60 CYCLE G. E. GENERATORS

controlled by the company could be developed and put to work, the saving would be two and one-half times as great, or a total of 54,687 cars of coal of 40 tons capacity each, or 2,187,480 tons of coal conserved with all its collateral economies.

If capital were now available for the construction of the necessary generating plants sufficient to utilize the undeveloped water power controlled by the Georgia Railway and Power Co., and the National Government would bring about the electrification of the steam railroads, all the important railroad mileage in Georgia would be operated by electric power generated by that company. The operating expenses of the railroads themselves would be materially reduced, their service much improved, and in addition the coal now consumed by them conserved, and the present regular business of the company supplied and developed as at present. This under present and past conditions is worth while.

SOUTHERN POWER COMPANY

The Southern Power Co. is connected to the Carolina Power and Light Co. at a point between Durham and Raleigh, N. C., and with the Georgia Railway and Power Co. of Tallulah Falls. The location and maximum ratings of the company's various stations are given in the accompanying table.

Electricity is generated at 2200, 6600 and 11,000 volts, three-phase, sixty-cycle, there being one 8000-kv.-a. 2300-volt and two 8000-kv.-a. 11,000-volt steam-driven generators, twenty-two 3000-kv.-a. 3000-volt generators, three 7800-kv.-a. 6600-volt generators, four 900-kv.-a. and 750-kv.-a, 11,000-volt generators. The last 33 units are of the water-wheel type. There are also connected to the system 65 high-voltage transformers having an aggregate rating of 169,400 kv.-a. The lines of the company cover a territory of 300 miles in a northeasterly and southwesterly direction and 100 miles in a northwesterly and southeasterly direction. The first transmission system of the company is designed for 11,000 volts. With the expansion of the company and its activities, a 44-000-volt transmission system was built, and all of the recent transmission lines erected by the company have been designed for 100,000 volts. All lines are looped in together, and the 11,000-volt and 100,000-volt systems are tied together with tie-in transformers. Aluminum and copper are both used for conductors, the size ranging from No. 4 solid copper to No. 000 stranded. By far the greatest amount of the lines are of No. 00 copper stranded and No. 00 equivalent aluminum stranded. This is run on both steel towers and wooden poles with pin-type and suspension-type insulators, depending upon the voltage. There are 103 substations connected to the system, con-

DATA ON SOUTHERN POWER COMPANY'S STATIONS

Location	Maximum Rating	Head, Ft
Great Falls, S. C	24,000 Kw.	72
Rocky Creek, S. C	24,000 Kw.	63
Ninety-nine Islands, S. C	18,000 Kw.	72
Catawba, S. C	6,600 Kw.	25
Lookout Shoals, N. C. (under construction)	24,000 Kw.	76
Greenville, S. C. (steam)	8,000 Kv.-a.	
Greensboro, N. C. (steam)	8,000 Kv.-a.	
Mount Holly, N. C. (steam)	8,000 Kv.-a.	

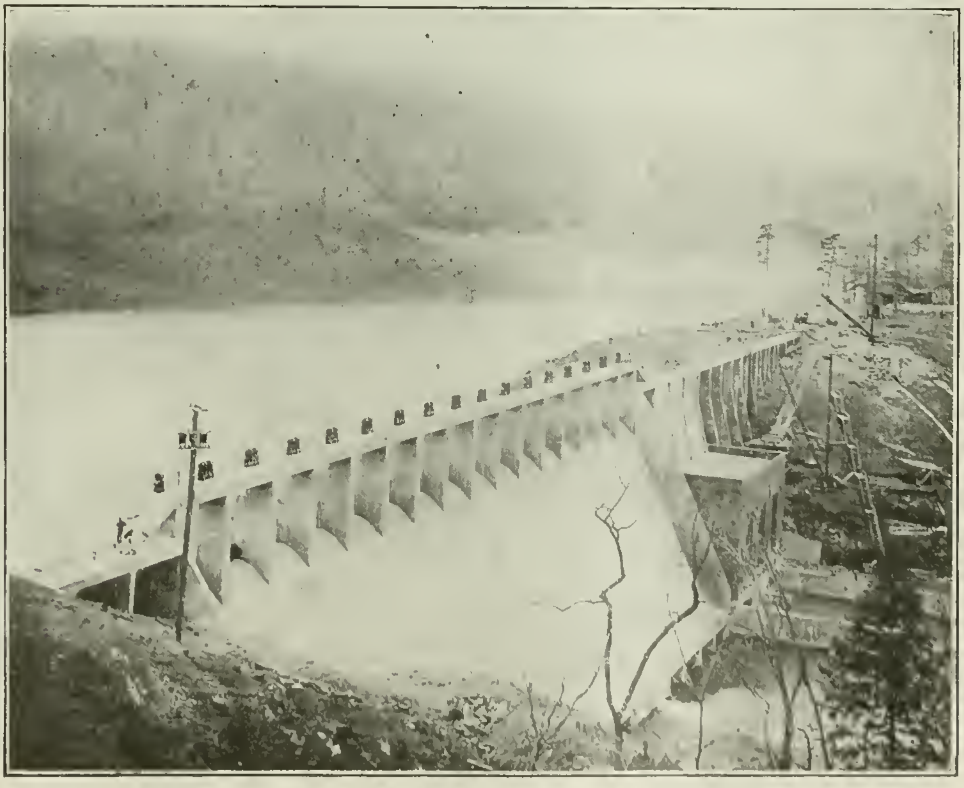

FIG. 13 MATHIS DAM, GEORGIA RAILWAY AND POWER CO.

FIG. 14. YADKIN RIVER POWER CO., BLEWETT FALLS, DAM AND POND

taining 352 transformers, with an aggregate rating of 241,162 kv.-a.

The circuits of the Southern Power Co. are connected on the north with those of the Carolina Power and Light Co. with two 100,000-volt lines. The amount of power that can be transferred is limited only by the carrying capacity of these lines, as no transformers are required in order to effect this connection. On the south the Southern Power Co.'s system is connected with that of the Georgia Railway and Power Co. of Tallulah Falls, with two 100,000-volt lines, and the power which can be transferred between the two companies at this point is limited only by the carrying capacity of the lines.

It should be pointed out that the rating of the hydro-electric stations of the Southern Power Co. is based upon the continuous rating for the continuous amount of 12-hour power which the station can generate for eight months in the year. The company maintains three 8000-kv.-a. turbo-generator steam plants for emergency and supplementary service. The fires under the boilers are banked, and all three stations can be got under way to feed energy to the lines within fifteen minutes.

TENNESSEE POWER CO.

The present hydro-electric stations owned and operated by the Tennessee Power Co. are as follows:

Ocoee No. 1, located in Polk County at Parksville, Tenn., on the Ocoee River, approximately 50 miles from Chattanooga. The equipment in this plant consists of five horizontal direct-connected waterwheel-driven generators, each one having a capacity of 3750 kw., the total station capacity being 18,750 kw. The dam at this plant backs up the Ocoee River, forming a lake approximately eight miles long. Sufficient water is impounded to operate the station over a period of two or three weeks during reduced stream flow.

Ocoee No. 2,[3] located in Polk County on the Ocoee River, about ten miles east of Parksville. This plant is equipped with two horizontal waterwheel-driven generators, each having a capacity of 7500 kw., the total capacity of the station being 15,000 kw. This plant uses the stream flow from the Ocoee River, which is diverted by means of a low dam, five miles above the power station, from which the water is conveyed by means of a flume to a forebay above the power house. The operating head at this plant is 255 feet.

Great Falls Station, at the northwest corner of Warren County, about halfway between Nashville and Chattanooga. This plant uses the flow of the Caney Fork and Collins Rivers. Just below the confluence of the two rivers a low concrete dam diverts the two streams, which are conveyed to the waterwheel by means of a tunnel and penstock. The plant is equipped with one vertical waterwheel-driven generator, the capacity being 9750 kilowatts.

Hales Bar,[4] on the Tennessee River about 20 miles west of Chattanooga. This plant is equipped with fourteen 3000-kw. vertical turbines, the total capacity of the

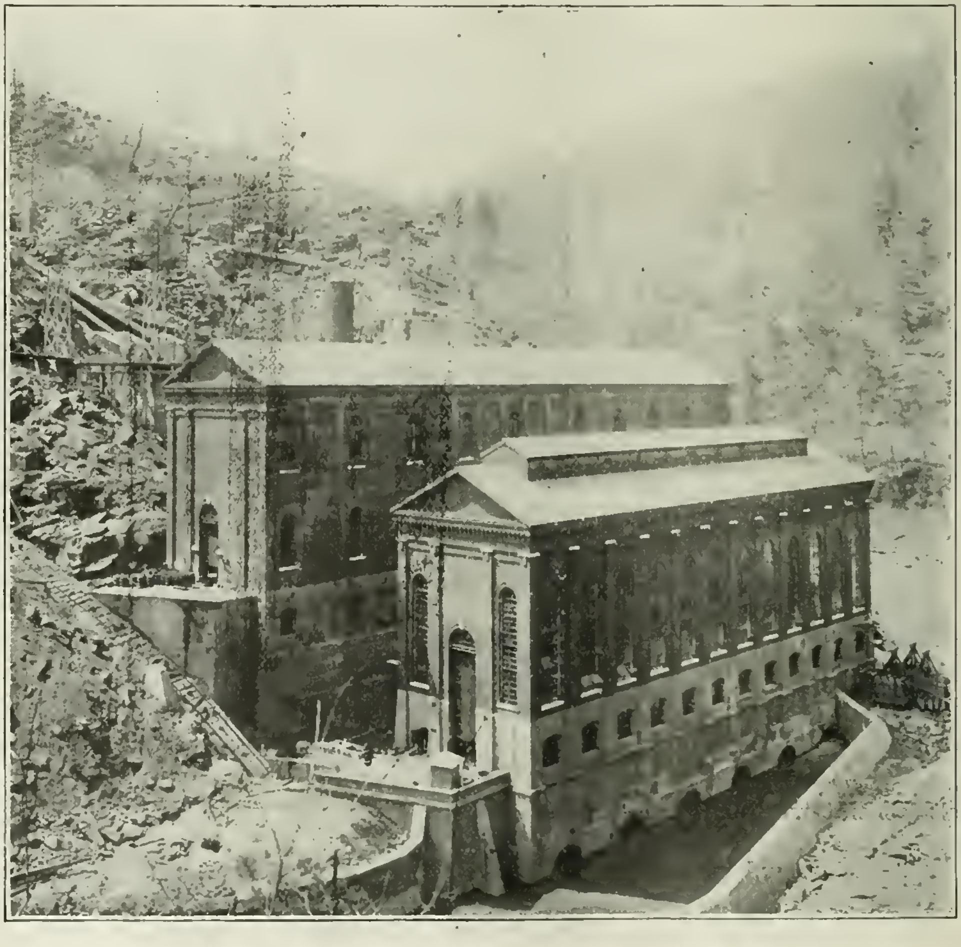

FIG. 15. TALLULAH FALLS POWER HOUSE, GEORGIA RAILWAY AND POWER CO.

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[3] Completion of the Hales Bar Works, "Power," Dec. 2, 1913.

[4] Hydro-Electric Plants of the Tennessee Power Co., "Power," May 17, 1914

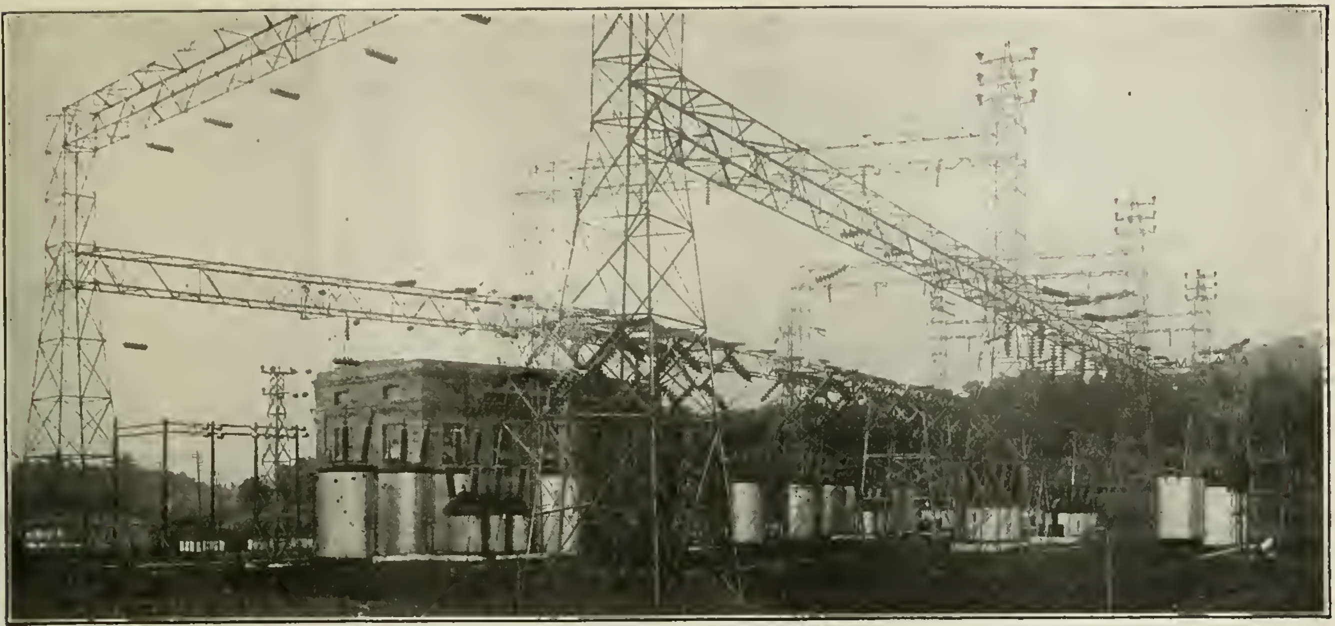


FIG. 16. SUBSTATION—ALABAMA POWER CO., COOSA RIVER HYDRO-ELECTRIC PLANT

station being 42,000 kw. The concrete dam across the river at the power-house site backs up the water and makes the river navigable to Chattanooga. The spillway is 1200 ft. long. The dam is of necessity provided with a boat-lock which is operated by the Government.

The combined capacity of the present hydro-electric stations is 85,000 kilowatts.

Additional developments have been considered, and rights obtained for three more stations on the Ocoee River, to be known as Ocoee Nos. 3, 4 and 5. The additional capacity from these three stations will be in the neighborhood of 35,000 kilowatts.

The Tennessee Power Co. has an arrangement with the Chattanooga Railway and Light Co., the Nashville Railway and Light Co. and the Knoxville Railway and Light Co. whereby the steam plants at these three cities may be operated at the direction of the Tennessee Co. to supplement the output from the hydro plants during low water. The capacities of the steam stations are as follows:

	Kilowatts
Chattanooga	5,000
Nashville	15,000
Knoxville	4,000
Total	24,000

The Tennessee Power Co. generates the electrical energy used in Chattanooga, Nashville, Knoxville and a large number of the small cities in eastern Tennessee. In addition it supplies power to the Aluminum Company of America at Maryville, Tenn., 16 miles south of Knoxville, and also to the American Zinc Co. at Mascot, Tenn., 15 miles northeast of Knoxville. The total transmission-line mileage of this system is approximately 600.

The rates for electrical energy are in accordance with the following tabulation:

A fixed charge of $1.25 per month per kilowatt of maximum demand based on the highest fifteen minute demand during the month, but in no event shall the fixed charge be less than 60 per cent. of the total kilowatt capacity contracted for.

In addition to the above demand charge, the following kilowatt-hour charge for electrical energy consumed during the month:

	Kilowatt-Hours
4c. per kw.-hr. for the first	500
2c. per kw.-hr. for the next	1,000
1½c. per kw.-hr. for the next	1,500
1c. per kw.-hr. for the next	17,000
0.7c. per kw.-hr. for all over	20,000

A discount of 5 per cent. will be allowed upon all bills paid within ten days from their date.

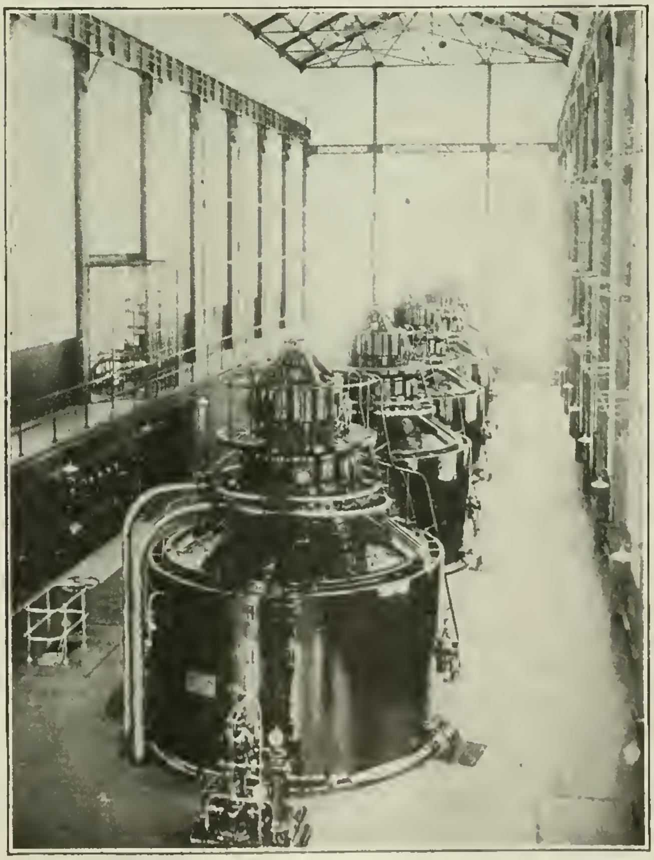


FIG. 17. GENERATORS, TALLULAH FALLS POWER HOUSE, GEORGIA RAILWAY AND POWER CO.

Coals of the United States

Gives the proximate analyses on the "as received" basis of typical coals of the United States. These analyses are given as the first of some articles on fuels, and types of stokers and furnaces best adapted to them, published to assist consumers who are confronted with the, to them, unusual combustion problems by reason of the zone system for the distribution of bituminous coal recently put into effect by the Fuel Administration.

TO GREATLY cut down transportation of coal on the railroads and to insure a larger supply of the Eastern bituminous coals to the states of the Atlantic Seaboard, the zone system for the distribution of bituminous coal has been put into effect by the Fuel Administration. Nearly all the states of the Middle West, heretofore large consumers of the high-grade coals of West Virginia and the East, must learn to burn the high-volatile, high-ash coals, also the lignites, in which the Middle West, North Dakota and Texas abound.

Power for May 14 gave full particulars about the zone system as it affects power plants particularly. See that issue to learn what coals are permitted to come into your state or zone. Knowing the coal you have been using, you can, by reference to the table here, find the chief differences between the coal or coals you now use and those you will hereafter use.

The analyses are selected from Bulletin No. 22 of the Bureau of Mines. The names on the same lines with the figures are those of the mines or towns.

TABLE OF PROXIMATE ANALYSES

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	British Thermal Units
			Per Cent.			
ALABAMA						
Bibb County						
Belle Ellen	3.12	31.41	59.70	5.77	1.24	14,031
Garnsey	3.03	30.94	55.31	10.72	0.49	13,034
	2.72	29.46	53.40	14.36	0.55	12,461
Blount County						
Lehigh	2.93	29.06	65.28	2.73	0.65	14,693
Jefferson County						
Cardiff	2.88	29.56	56.91	10.65	2.04	13,459
Dolomite	3.16	25.40	67.75	3.69	0.56	14,616
ARKANSAS						
Franklin County						
Denning	2.91	12.65	66.93	17.51	3.12	12,312
Johnson County						
Coal Hill	1.38	14.76	76.91	6.95	1.52	14,330
Ouachita County						
Lester	39.43	26.49	24.37	9.71	0.49	6,356
Sebastian County						
Bonanza	1.99	15.90	75.05	7.06	1.05	14,087
Burma	0.80	17.80	72.71	8.69	1.95	14,281
Huntington	3.24	17.46	66.69	12.61	1.24	13,129
Jenny Lind	0.95	17.91	71.52	9.62	2.07	14,096
	2.19	19.47	66.71	11.63	1.28	13,464
COLORADO						
Boulder County						
Lafayette	19.15	30.82	44.27	5.76	0.25	9,61
Delta County						
Bowie	3.29	39.74	52.16	4.81	0.62	13,379
El Paso County						
Colorado Springs	22.19	34.58	37.40	5.83	0.47	8,503
Fremont County						
Canon City	11.19	36.77	45.75	6.29	0.92	11,286
Garfield County						
Cardiff	12.20	34.23	48.60	4.97	0.48	11,104
Newcastle	3.51	38.38	53.17	4.94	0.54	13,266
South Cañon	7.44	36.18	53.90	2.48	0.47	12,685
Gunnison County						
Crested Butte	2.98	33.62	56.16	7.24	0.39	13,428
Somerset	5.49	35.65	55.79	3.07	0.60	13,217
Pitkin County						
Coal Basin	0.96	21.49	68.93	8.62	0.52	14,330
Rio Blanco County						
Meeker	9.41	37.97	45.38	7.24	0.75	11,324
Routt County						
Axial	13.15	36.44	47.54	2.87	0.57	11,390
ILLINOIS						
Franklin County						
Zeigler	9.58	29.18	50.24	11.00	0.52	11,428
Logan County						
Lincoln	14.77	32.90	39.75	12.58	3.95	10,406
Madison County						
Collinsville	11.87	36.57	39.98	11.58	4.75	10,768
Livingston	14.25	35.52	40.79	9.44	3.72	10,892
Saline County						
Harrisburg	7.81	33.54	50.27	8.38	2.36	12,418
INDIANA						
Greene County						
Linton	13.53	33.54	45.38	7.55	0.95	11,738
	10.30	36.31	41.64	11.75	4.23	11,218
Pike County						
Hartwell	10.57	35.03	42.75	11.65	3.87	11,266
Sullivan County						
Mildred	13.25	35.81	41.78	9.16	1.87	11,360
Vigo County						
Terre Haute	10.68	37.17	39.91	12.24	4.38	11,261
Warrick County						
Boonville	10.41	39.18	41.96	8.45	3.51	11,819
IOWA						
Lucas County						
Chariton	18.69	31.80	41.78	7.73	2.39	10,505
Marion County						
Hamilton	14.21	33.17	37.40	15.22	4.66	10,019
Wapello County						
Laddsdale	11.35	38.65	39.49	10.51	4.72	11,345
KANSAS						
Cherokee County						
Scammon	2.54	35.31	52.28	9.87	4.47	13,340
Crawford County						
Yale	2.44	35.16	51.80	10.60	5.63	13,043
Linn County						
Jewett	11.13	28.83	47.44	12.60	2.41	11,219
KENTUCKY						
Bell County						
Straight Creek	2.91	36.01	57.55	3.53	0.89	14,322
Hopkins County						
Barnsley	7.98	37.55	45.17	9.30	4.03	11,965
Earlington	8.49	38.05	46.36	7.10	3.53	12,344
Johnson County						
Van Lear	6.43	36.20	54.13	3.24	1.17	13,455
Ohio County						
McHenry	10.03	36.06	46.24	7.67	2.56	12,076
Pike County						
Hellier	3.41	32.08	58.78	5.73	0.53	13,928
Webster County						
Wheatcroft	6.29	31.97	54.13	7.61	1.35	12,874
MARYLAND						
Alleghany County						
Eckhart	2.3	14.5	75.0	8.2	1.10	14,020
Washington	2.31	17.49	71.51	8.69	1.62	14,022
Frostburg	3.06	17.01	73.54	6.39	0.96	14,274
Lord	2.47	18.17	73.06	6.30	0.79	14,328
Midland	2.54	18.22	72.01	7.23	0.92	14,283
MISSOURI						
Adair County						
Kirksville	14.59	32.05	39.45	13.91	3.69	10,260
Novinger	17.19	34.05	39.48	9.28	2.76	10,598
Audrain County						
Vandalia	10.36	39.28	38.03	12.33	4.89	11,347
Bates County						
New Home	4.92	38.28	42.28	14.52	5.34	11,975
Henry County						
Windsor	13.51	33.24	41.88	11.37	4.08	10,779
Lafayette County						
Corder	12.34	34.36	41.97	11.33	4.55	10,998
Macon County						
Bevier	14.74	38.53	38.95	7.78	3.79	11,185
Randolph County						
Higbee	13.38	34.17	42.43	10.02	4.48	11,084
Ray County						
Camden	15.83	32.80	41.46	9.91	2.97	10,622
MONTANA						
Broadwater County						
Lombard	2.78	24.53	42.95	29.74	8.23	10,062
Carbon County						
Bear Creek	10.05	37.22	46.71	6.02	1.44	11,194
Bridger	14.83	26.93	44.89	13.35	0.33	10,037
Red Lodge	11.05	35.90	42.08	10.97	1.73	10,539
Cascade County						
Belt	6.37	27.55	45.20	20.88	2.04	9,866
Eden	4.54	27.44	47.95	20.07	4.09	10,472
Stockett	6.01	28.43	51.42	14.14	2.38	11,153
Chouteau County						
Chinook	21.41	28.00	41.60	8.99	0.58	8,937
Havre	22.84	29.31	34.61	13.24	0.80	7,898
Custer County						
Miles	29.21	26.15	35.45	9.19	0.75	7,668
Dawson County						
Glendive	34.55	35.34	22.91	7.20	1.10	7,090

TABLE OF PROXIMATE ANALYSES—Continued

	Moisture	Volatile Matter	Fixed Carbon Per Cent.	Ash	Sulphur	British Thermal Units
Fergus County						
Buffalo	17 03	27 34	43 83	11 00	4 14	8,894
Lewistown	12 31	28 41	51 31	7 97	3 88	11,149
Gallatin County						
Chestnut	2.05	16 42	73.22	8 31	0.86	14,092
Storrs	4 01	34 54	45 48	15.97	0 51	11,860
Musselshell County						
Aldridge	1 67	19 79	54 74	23 60	0.44	11,320
Sweet Grass County						
Nye	6 75	32 37	44 47	16 41	0.53	10,679
Yellowstone County						
Buckey	16 95	30 78	39 64	12 63	0 49	8,597
Musselshell	22 77	27 00	45.58	4 65	0 32	8,863
Roundup	13 4	28 0	52 4	6 2	0 40	11,050
NEW MEXICO						
Colfax County						
Blossburg	2 25	33 19	52 19	12 37	0 75	13,030
Brilliant	2.19	35 95	50 75	11 11	0 57	13,063
Raton	2 12	36 06	50.22	11 60	0 64	12,965
Yankee	5 02	36.78	46.20	12 00	0 56	12,064
M'Kinley County						
Clarkville	14 49	37 08	44 58	3 85	0 41	11,468
Gallup	9 68	41 42	40 82	8 08	1 55	11,623
	11 00	42 63	42 44	3 93	0 55	11,885
San Juan County						
Putnam	15 79	34 99	39 85	9 37	1 78	9,970
Santa Fe County						
Madrid	5 70	2 18	86.13	5 99	0 69	13,268
Socorro County						
Carthage	3 91	38 87	46 82	10 40	0 70	12,742
NORTH DAKOTA						
Billings County						
Medora	38 45	28 02	27 84	5 69	0.54	
Bowman County						
Scranton	41 43	23 86	28 45	6 26	0 74	6,241
M'Lean County						
Wilton	40.53	27 05	27.37	5 05	0 76	6,644
Stark County						
Lehigh	42.06	24 55	25 73	7 66	1 13	6,158
Ward County						
Tasker	36 64	22.64	30 74	9 98	0.45	6,394
Williams County						
Williston	36 60	32 93	25 69	4 78	0 48	6,824
OHIO						
Belmont County						
Bellaire	3 10	40 76	50 11	6 03	3 42	13,595
Neffs	3 99	38.77	49.17	8 07	3.49	13,102
Guernsey County						
Danford	6 28	35.81	50.61	7 30	3 55	12,701
Jackson County						
Wellston	7 71	38 32	42.02	11 95	4 61	11,515
Jefferson County						
Bradley	4 06	38.49	49 70	7 75	3 67	13,147
Rush Run	4 34	35 53	52 83	7 30	1 72	13,178
Perry County						
Dixie	8 92	38 58	46.65	5 85	3 00	12,328
Shawnee	10 78	34 86	48 23	6 13	1 11	11,993
Vinton County						
Clarion	6 79	40 01	45 54	7 66	3 34	12,514
OKLAHOMA						
Coal County						
Lehigh	6 50	39 01	45 18	9 31	3.67	11,842
Haskell County						
Chant	2 37	19 26	69 54	8.83	1 03	13,840
Latimer County						
Wilburton	2.96	35 97	55 95	5 12	1 05	13,707
Okmulgee County						
Henryetta	8.87	34 82	47 68	8.63	1.62	12,096
Pittsburg County						
Hartshorne	4 45	36 15	48.40	11 00	1 52	12,607
OREGON						
Coos County						
Beaver Hill	14 27	34.46	43.20	8 07	0.74	9,626
Libby	20.84	34 04	36.75	8 37	1 17	10,348
Marshfield	19.7	31 5	35.0	13.8	0 80	8,400
PENNSYLVANIA						
Allegheny County						
Bruceton	3 67	34.03	56.84	5 46	1 37	13,874
Cambrio County						
Bakerton	3 3	16.5	74 6	5.6	1 10	14,422
Sterling	2.7	19 5	71.1	6 7	1 70	14,160
Johnstown	2.03	14 47	75 31	8.19	2.26	14,081
South Fork	1.13	15.95	75 2	7 72	1.35	14,387
Stineman	2 1	15 0	77.7	5.2	1 11	14,630
Windber	2.4	14 5	75.0	8 1	1 90	14,200
Clearfield County						
Grampian	4 1	23.0	66.8	6 1	1.91	14,000
Madera	2 4	20.5	70.8	6 3	1.66	14,330
Fayette County						
Connellsville	2 82	29 97	59 84	7 37	1.22	13,991
East Millsboro	4 08	32 44	53.98	9 50	1 64	13,268
Lackawanna County						
Scranton, anthracite culm	5 41	7 02	71 79	15 78	0 74	12,047
Somerset County						
Jerome	3 67	15 62	72 84	7 87	0 77	13,808
Washington County						
Acheson	2 60	32.46	59 31	5.63	1.19	14,184
Anderson	1.70	37 20	55.83	5 27	1.13	14,335
Ellsworth	3 01	33 46	58 70	4 83	0 73	14,197

TABLE OF PROXIMATE ANALYSES—Concluded

	Moisture	Volatile Matter	Fixed Carbon Per Cent.	Ash	Sulphur	British Thermal Units
TENNESSEE						
Campbell County						
Gatliff	4 25	35.31	56 31	4 13	0 93	13,666
Lafollette	3 03	34 01	58 05	4 91	1 77	13,858
Marion County						
Orme	3 31	31 71	51 87	13.11	1.30	12,193
TEXAS						
Houston County						
Crockett	33 50	39 50	16.25	10 75	0 56	7,142
Milam County						
Olsen	36 01	27 95	28 66	7 38	0 77	7,132
Wood County						
Hoyt	28 86	35 96	27 26	7 92	0 50	7,996
UTAH						
Carbon County						
Castlegate	5 42	36.32	52 16	6 10	0 54	12,220
Emery County						
Woodside	9 01	31 78	51 03	8 18	0 46	10,863
Iron County						
Cedar City	10 35	36 33	43 70	9 62	5 82	10,874
Summit County						
Coalville	14 07	37 21	42 46	6 26	1 28	10,471
VIRGINIA						
Montgomery County						
Blacksburg	2 98	10 94	64 14	21 94	0 68	11,669
Russell County						
Dante	2 28	35 69	55 03	7 00	0 66	13,936
Tazewell County						
Pocahontas, Baby	1 63	17 17	75 34	5.86	0 75	14,672
	5 89	17 26	72.61	4 24	0 79	14,256
	3.8	15 5	77 8	2 92	0 63	14,860
Wise County						
Toms Creek	3 05	31 65	60 82	4 48	0 67	14,470
WASHINGTON						
King County						
Bayne	5 06	33 82	42 69	18 43	0 63	11,063
	5 35	33 03	47 11	14 51	0 70	11,590
Black Diamond	7 98	37 69	45 95	8.38	0.45	11,732
Coal Creek	12 05	36.82	40 72	10.41	0.34	10,414
Ravensdale	11 15	39 72	45 13	4 00	0 52	11,768
Renton	14 73	33 19	40.49	11.59	0.47	9,868
Taylor	5 6	36 0	44 0	14.4	0 94	11,550
Kittitas County						
Roslyn	3 68	34 33	48 59	13.40	0.36	12,253
Pierce County						
Carbonado	2.74	36.31	52.83	8.12	0.49	13,538
WEST VIRGINIA						
Fayette County						
Ballinger	3 7	23.0	70.8	2.47	0 59	14,590
Claremont	3 54	17.03	73 28	6 15	0 51	14,099
Derryhale	3.33	17.34	75.68	3 65	0 83	14,593
East Sewell	3.34	21.25	73 18	2.23	0 56	14,821
Layland	2 72	16.3	75 49	5.49	0 66	14,440
Glen Jean	3 7	16 0	75.2	5 1	1 15	14,310
Kilsyth	2 86	17 63	75 16	4 35	0 94	14,539
Macdonald	2 96	22 74	69 29	5.01	0 89	14,425
Minden	3.4	21.0	72.4	3 2	0 60	14,670
Prudence	3.85	19 08	72 05	5 02	0 84	14,256
Harrison County						
Clarksburg	1 98	40 54	48 40	9 08	4 20	13,466
M'Dowell County						
Ashland	2 8	14 5	77 4	5 33	0 64	14,550
Big Sandy	4 1	15 0	77 1	3 78	0 64	14,580
Coalwood	2.19	13 91	75 25	8 65	0 57	13,995
Davy	3.7	13 5	78.9	3 85	0 60	14,620
Eckman	3 3	13 5	78 0	5 17	0 59	14,480
Elkhorn	3.24	13 13	79 00	4 63	0.49	14,598
Crozer	2.74	13 94	78 38	4.94	0 59	14,645
Norfolk	3.73	14 62	78 22	3 43	0 53	14,632
Powhatan	3 3	14.5	77 7	4 49	0 55	14,630
Switchback	4 1	14 5	77 3	4 1	0.52	14,510
Vivian	2 3	12.5	80 8	4 44	0 58	14,720
Mercer County						
Goodwill	2 9	14 0	79 4	3.68	0.53	14,830
Simmons	3 8	13.5	79 4	3.34	0 80	14,670
Raleigh County						
Raleigh	3 6	15 5	76 1	4 75	0 79	14,460
Slab Fork	2 7	13.0	78 5	5.76	0.55	14,450
Tucker County						
Thomas	2 39	22 39	70 04	5 18	0 67	14,557
WYOMING						
Bighorn County						
Kirby	16.11	32 96	48 09	2 84	0 50	11,211
Carbon County						
Fort Steele	8.85	36 58	50.99	3 58	0 92	12,062
Hanna	11 45	42 58	39 33	6 64	0 38	10,890
Iron	18.41	34.50	43.38	3 71	0 28	9,130
Crook County						
Oxus	28 55	29 43	38 31	3 71	0 28	8,233
Johnson County						
Buffalo	29 05	29 07	34 67	7 21	0.39	7,627
Sheridan County						
Dietz	24 70	37 55	33 04	4 71	0 39	8,903
Monarch	22 63	35 68	37 19	4 50	0 59	9,734
Sweetwater County						
Black Buttes	18 86	29 17	47 85	4 12	0.49	10,283
Rock Springs	11.64	36.37	48 58	3.41	0 81	11,768
Superior	13.67	32 43	51 00	2 90	0 72	11,563
Bondurant	14 36	32 48	48 73	4 43	3 56	10,303

The Electrical Study Course—Characteristic Curves of Shunt and Series Generators

The effects of varying the load on a shunt and a series generator are discussed, and the external characteristic curves shown.

ELECTRIC generators and motors act in certain ways under given conditions; for example, as the current is increased in the field coil of a shunt generator, the voltage will increase in value until the iron in the polepieces becomes saturated. Beyond the saturation point the voltage remains practically constant irrespective of the value of the current in the field coils. By plotting the volts at the armature terminals against the amperes in the field coils, as explained in the lesson in the Apr. 9 issue, the result will be a curve similar to that shown in Fig. 1.

Similarly, the effect of the load on the voltage of a generator may be shown in a curve. This is done by connecting a voltmeter across the armature terminals and an ammeter in series in the circuit, as shown in Fig. 3; and after adjusting the voltage to normal, say 110 volts, put a load on the machine of, assume, 30 amperes, as indicated in Fig. 4. This, as shown in the last lesson, will cause the voltage to drop at the armature terminals: First, owing to the resistance of the armature, and second, the current in the field coils will also be slightly reduced because of the decrease in volts at the armature terminals. Assume that the volts at the armature terminals decrease 1.5, this will leave $E_a = 108.5$ volts available at the load and will give point *a* on curve *A*, Fig. 2, which is obtained by taking the 30-ampere division at the base of the curve and running up vertically until it intersects the horizontal line running out from the 108.5-volt division, as indicated by the dotted lines.

If the load is now increased to 60 amperes, the volts at the armature terminals will further decrease, say to 107; then plotting the load current of 60 amperes against the voltage at the armature terminals, 107 volts, gives point *b* on the curve. Increasing the load to 90 amperes will cause the voltage to drop accordingly, or, as shown at point *c* on the curve, to be 105.5. Now, if the load is further increased, a corresponding decrease in voltage is obtained. However, it is evident that this process cannot keep on indefinitely, because if it did, eventually a point would be reached where an infinitely large current would be obtained on an infinitely small voltage.

What actually happens in a shunt generator is that the voltage decreases as the current is increased up to a certain value and then both volts and current decrease to zero or approximately so. This is shown on the curve; when the current has increased to 241 amperes, the volts have dropped to about 55. At this point, if the resistance of the circuit is further decreased to increase the current, the voltage and current begin to decrease and come back to zero, or theoretically so. However, on account of the residual magnetism in the polepieces maintaining a small voltage at the armature terminals, the volts and current will only approximate zero.

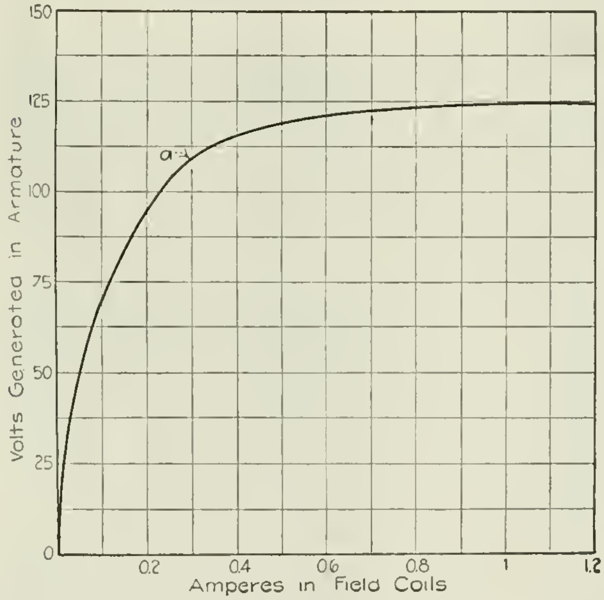


FIG. 1. DIRECT-CURRENT GENERATOR VOLTAGE CURVE

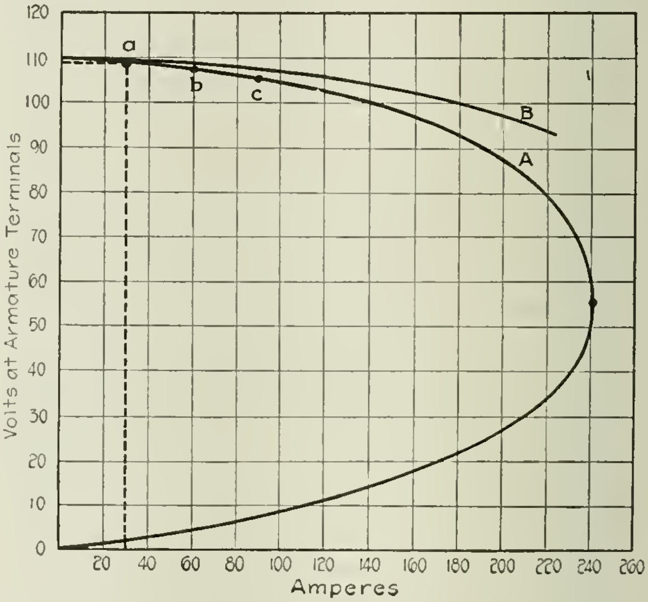
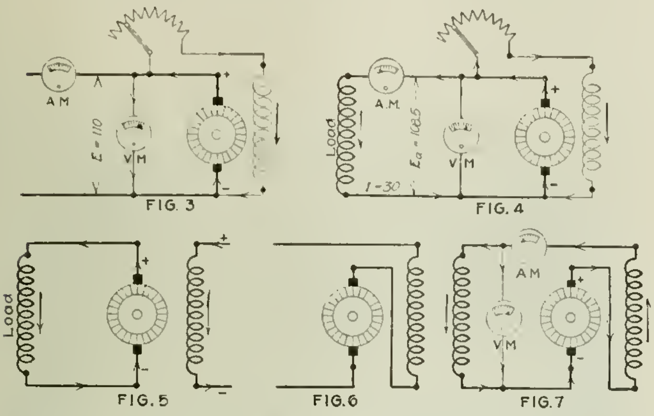


FIG. 2. LOAD-VOLTAGE CURVE OF SHUNT GENERATOR

What has just been stated regarding the shunt machine indicates that if it was short-circuited, the voltage and current would drop to zero and no harm would be done. This is true of the self-excited shunt generator, but not of the other types, as will be seen in the following:

If the field coils of the shunt machine are energized from an outside source, as in Fig. 5, then the field current will be maintained constant irrespective of the load. Consequently, the voltage generated in the armature will remain practically constant, and the volts drop at the armature terminals will be due to the armature resistance only. Therefore, the volts at the armature terminals will not decrease so rapidly as when the field coils are connected in parallel with the armature. The resultant curve for a separate-excited shunt generator will be similar to the curve *B*, Fig. 2.

In the series-connected generator, Fig. 6, the machine cannot produce any voltage when it is disconnected from the load except that generated due to the residual magnetism in the polepieces. Consequently, at no load the voltage of a series machine is approximately zero, as against the shunt machine in which the voltage is at a maximum value at no load. By connecting a voltmeter and an ammeter to the series machine, as in Fig. 7, and taking readings for different loads, a curve will be obtained as in Fig. 8. It will be seen that the shape of the curve from zero to point *a* approximates the shape of the saturation curve, Fig. 1, from zero to point *a*.



FIGS. 3 TO 7. DIAGRAMS OF SHUNT-CONNECTED AND SERIES-CONNECTED GENERATORS

The series generator as its voltage builds up with the load has not only to produce pressure to cause the current to flow through the external circuit, but also through the armature and field windings. The volts drop in the armature and field windings varies as the product of the current in amperes and the resistance of the windings in ohms. However, the total voltage generated in the armature winding does not increase as the current in the field winding. Referring to Fig. 1, it will be seen that up to point *a* on the curve, the increase in volts is quite rapid as the field current is increased, but beyond this point the increase is very slow, being practically zero at the upper end of the curve. It is this latter fact that makes the voltage of the series generator decrease above a certain load.

In Fig. 8 the first 20-ampere load energizes the field coils to the extent that 50 volts is generated at the armature terminal. When the load is increased to 40 amperes, the volts only increase to about 73 and at 60 amperes about 91 volts, until at 130 amperes, the maximum, or 114 volts, is developed at the armature terminals. From this it is seen that the volts at the armature terminals increase rapidly at first, but that the increase becomes less for a given number of amperes increase until an increase in load does not cause the volts to become greater but less, as in this case, when the load is made higher than 130 amperes.

Now, if we assume the resistance of the armature and field windings to be 0.2 ohm, then with a 20-ampere load on the machine the volts drop will equal amperes × ohms, or 20 × 0.2 = 4 volts; that is, the armature is actually generating 54 volts when supplying 20 amperes to the external circuit, but 4 volts is used up to cause the current to flow through the armature and field windings; therefore, only 50 volts is available at the armature terminal. At a 60-ampere load the volts drop in the armature is 60 × 0.2 = 12 volts. Hence, the armature is generating a total voltage at this load of 91 + 12 = 103 volts. When the load has increased to 130 amperes, the volts drop in the armature is 130 × 0.2 = 26 volts, and there is generated 114 + 26 = 140 volts. However, 26 volts is used up in the machine's windings, consequently only 114 is available at the armature terminals. Assume that the load is increased from 130 to 180 amperes. Then, the drop in the armature will be 180 × 0.2 = 36 volts. Further assume that this increase of load only causes the total voltage to increase to 143.5. Then, the available volts at the armature terminals is 143.5 — 36 = 107.5. Hence, it is seen that the increased volts generated in the armature due to the increased load is not enough to compensate for the increased drop in the windings, and the available volts decrease with an increase in load. Hence, it is evident that the volts at the armature terminals on a series generator will increase in value with an increase in load until the iron in the magnetic circuit is near saturation; beyond this point the volts begin to decrease with an increase of load.

The curves, Figs. 2 and 8, are sometimes referred to as external characteristic curves of the generator, from the fact that they are plotted from conditions existing outside the machine. If the voltage values existing in the armature windings were used in the curves, we would have to add the volts drop in the armature at the different loads to the voltage at the brushes corresponding to these loads, which would have given a higher pressure than that indicated on the curves in the figures. A load-voltage curve plotted by using the total voltage generated in the armature instead of that at the brushes is called an internal-characteristic curve.

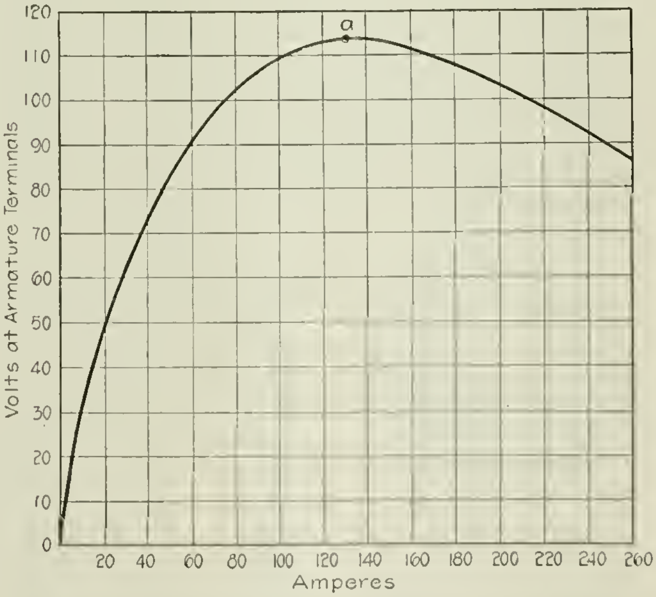


FIG. 8. LOAD-VOLTAGE CURVE OF SERIES GENERATOR

The problem given in the last lesson was: "In transmitting 540 amperes over a circuit 425 ft. long one way, there is a drop of 16.5 volts in the line. How large are the conductors in cross-section? How much will the conductors have to be increased in size to reduce the line drop to 10 volts?"

The size of the conductors is obtained by the formula,

$$Cir.mils \quad \frac{21.7DI}{E_d} = \frac{21.4 \times 425 \times 540}{16.4} = 299{,}469$$

which is approximately a 300,000-cir.mil conductor. The size of a conductor that would cause only a 10-volt drop under the foregoing conditions can also be determined by the circular-mil formula, or in this case,

$$Cir.mils = \frac{21.4 \times 425 \times 540}{10} = 497{,}130$$

or approximately 500,000 cir.mils. Then the size of the conductor would have to be increased 500,000 — 300,000 = 200,000 cir.mils.

A voltmeter has 12,000 ohms resistance, and when connected to two points of a circuit reads 36 volts. Find the current taken by the instrument. If 3.6 amperes is passing through the section of the circuit that the instrument is connected across, find the resistance of the section.

If the resistance of a voltmeter is 15,000 ohms and when connected across a given circuit 0.01 ampere flows through it, does the instrument indicate the correct voltage of the circuit if the needle points to 140 on the scale?

Dry Crown-Sheet Firebox Boiler

By S. P. Black

The illustrations show a type of boiler that most readers would say was unfeasible if they were asked their opinion as to utility and safety without previous knowledge that hundreds of these boilers have been used for years with no disastrous results. I remember being in one of the large boiler shops of the Middle West when the specifications for one of these boilers came in and figures were asked regarding its construction. Our opinion at that time was that whoever knew no better than to design such a boiler, expecting it to work in safety, needed a guardian and that would be putting it mildly.

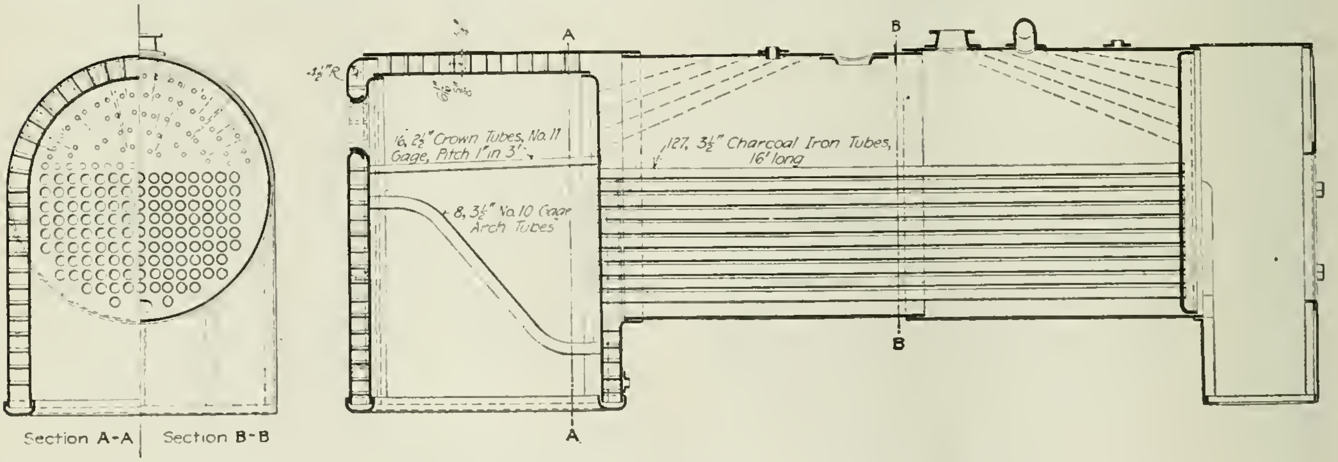


FIG. 2. SECTION THROUGH DRY CROWN-SHEET BOILER

An examination of Fig. 2 would at first suggest that the design is a contradiction of all known boiler rules in the deliberate use of a dry crown-sheet, one that is not covered by water; for it may be observed that the water-leg, a 6-in. space, is continued completely under the wagon top, and that the water level scarcely reaches within 18 in. of the top of the boiler as would be indicated by Fig. 2.

We are all forced to alter our preconceived opinions somewhat at times, and after finding this type of boiler in use and watching it under operation, I have gotten rid of a pre-established prejudice and dislike, as I have known them to be operating under severe conditions for about fifteen years.

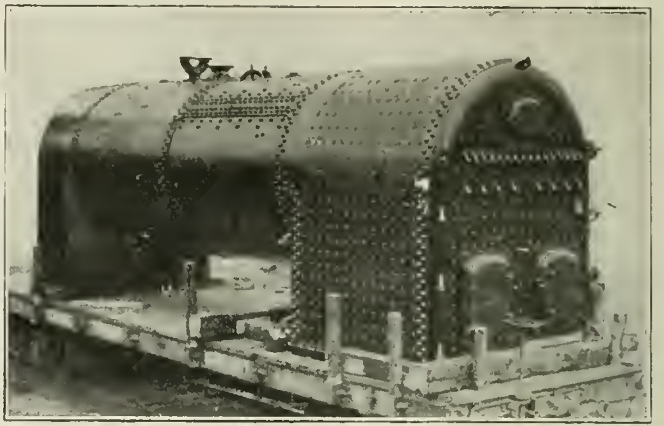


FIG. 1. EXTERIOR OF DRY CROWN-SHEET BOILER

Most of us can remember the popular fallacy and general belief not long since prevalent of red-hot crown-sheet, low water, turning on the feed and an explosion from sudden generation of steam. We used to believe that cold water on a red-hot crown-sheet would generate sufficient steam to cause an explosion, but experiments have proved the contrary and have shown that it was a difficult matter to bring about an explosion under such conditions.

In the boiler shown in Fig. 1, although it was not designed to be foolproof and even though the crown-sheet is at all times bare of water and entirely dry, such a thing as burning the crown-sheet has never occurred to my knowledge. Furthermore, this type of boiler is one that has the reputation of being impossible to burn, low water not affecting it until the water gets below the arch tube and exposes the upper portion thereof, at which time the tubes will blow out. This boiler was designed for 175 lb. pressure, a fairly high pressure for this type of boiler.

Supporting Effect of Boiler Heads

BY NEIL M. MACDONALD

Should the strength of the unsupported head be added to the strength of the stays to find the allowable pressure in a boiler? The author answers the question in the negative.

THE tendency of modern engineering practice is toward larger boiler units and high pressures. This tendency makes it imperative that serious consideration be given to the bracing and stay-bolting of the boiler surfaces. A number of engineers contend, no doubt without giving the subject proper consideration, that the strength of the braces or stay-bolts should be added to the strength of the sheet which they presumably support, and that the sum of these two values should be taken as the strength of that portion of the boiler. At first sight this theory may appear logical, but careful consideration clearly illustrates the fallacy of the contention.

There are four boiler surfaces which will be considered one by one, to indicate wherein the foregoing method of figuring is erroneous. The first case is the braced portions of the heads of a horizontal return-tubular boiler and particularly that portion above the tubes. Assume, by way of illustration, a 72-in. by 18-ft. horizontal-tubular boiler having a distance of 26 in. between the top of the tubes and the shell plate. The area to be braced in this case is the area of a segment inclosed by lines drawn 3 in. from the shell and 2 in. from the tubes, or an area of 936 sq.in.

First find the strength of the unbraced flat head. There is no authentic formula for figuring accurately the strength of an unbraced flat head, and what is known of the subject is based on theory combined with a few practical experiments. However, as absolutely accurate results are not essential for the purpose of this discussion, the strength of the unstayed head will be calculated in accordance with Nichols' formula, which is based on his experiments and is

$$P = \frac{T \times S \times C}{A \times F}$$

in which

P = Safe working pressure, in pounds per square inch;

T = Thickness of plate, in inches;

S = Tensile strength of plate, in pounds per square inch;

C = Constant = 10;

A = Area to be stayed, in square inches;

F = Factor of safety = 8.

Assuming that the boiler head is ½-in. thick and that the material has a tensile strength of 55,000 lb. per sq.in., and substituting these values in the formula,

$$P = \frac{\frac{1}{2} \times 55{,}000 \times 10}{936 \times 8} = 37 \textit{ lb. per sq.in. nearly}$$

The bursting pressure is, then, 37 × 8 = 296 lb. per sq.in.

Now, in accordance with the foregoing erroneous theory, if the boiler was to be designed for a safe working pressure of 125 lb. per sq.in., it would only be necessary to add bracing good for 125 — 37 = 88 lb., or the difference between the strength of the unbraced head and the strength required. Following this theory, if the factor of safety on the unbraced head was 8 and on the braces 6, the bursting pressure of the braced head would be 37 × 8 + 88 × 6 = 824 lb. per sq.in. This is absolutely wrong, and the attempt will be made to prove, by illustration, that the real bursting pressure of the head is only the value of the strongest portion, which in this case is the braces, and is 88 × 6 = 528 lb. per sq.in. The safe working pressure is the bursting pressure divided by the factor of safety, or 528 ÷ 6 = 88 lb. per square inch.

To illustrate the fallacy of the theory, assume a solid stone wall capable of withstanding a pull of 1000 lb., and a second solid stone wall directly oposite the first one, able to withstand any pull up to 296 lb. It is assumed that these walls are so constructed that if a pull of 296 lb. is applied to the stronger wall, it will not be affected, but if the same pull is applied to the weaker wall, it will collapse.

Now, join the two walls by a rope, fastened so that it cannot slip, and capable of standing any pull up to 528 lb. Apply a pressure between the two walls tending to push them apart and strain the rope. Let the pressure start at one pound and increase gradually, and then analyze the behavior of the two walls and the connecting rope. The pressure rises slowly until 296 lb. is reached, which is greater than the weaker wall can stand, and if it were not for the rope holding it up, the wall would collapse; but there is no perceptible change in conditions, as both walls still stand and the rope is still intact. When the pressure reaches 528 lb., which is the ultimate strength of the rope, the rope breaks, allowing the full load of 528 lb. to come on the weaker wall. As the latter can stand only 296 lb., both the rope and the wall must necessarily let go. It is therefore obvious that the addition of the strength of the weaker wall did not add to the strength of the rope, and the strength of the wall and rope combined was only that of the stronger member, or the strength of the rope.

Now substitute the assumed boiler for the walls and the rope. The stronger wall is equivalent to the shell of the boiler to which the pad ends of the diagonal braces are attached, the weaker wall is equivalent to the head of the boiler to be braced, and the rope is equivalent to the braces.

The boiler head is supposedly designed to burst at 824 lb. The unbraced head will burst at 296 lb., and the bracing has an ultimate value of 528 lb., and by adding the strength of the unbraced head to the strength of the braces, the result is a bursting pressure on the braced head of supposedly 824 lb. Following the same line of reasoning as was used with the stone walls and the rope, as soon as a pressure equal to the value of the braces is applied, the head will give way. That is to say, when a pressure of 296 lb. has been reached, the value of the unbraced head is gone, and when a pressure of 528 lb. has been reached, the braces give way, carrying the head with them. It therefore follows that the assumed boiler is designed to burst at 528 lb. and not 824 lb. as it was supposed to be. This is based on the strength of the braces, and dividing the bursting pressure of 528 lb. by the factor of safety of 6, it is found that the boiler is designed for a safe working pressure on the heads of 88 lb. and not 125 lb. To make the heads safe for 125 lb. working pressure, they would have to be braced for 125 lb. and the value of the unbraced head ignored.

The same argument applies to the stay-bolted furnace sheet of a vertical-tubular boiler, with a slight difference when the furnace sheet proper is stronger than the stay-bolts. In the latter case it is not permissible to figure the safe strength of the furnace and then add that of the stay-bolts and consider the sum as the desired working pressure. Assume, for instance, that the actual collapsing pressure of a cylindrical furnace is 625 lb. and that an actual collapsing pressure of 1075 lb. is desired and that stay-bolts to the value of 1075 — 625 = 450 lb. are installed to bring the actual collapsing strength of the furnace up to the desired pressure. Comparing this with the stone-wall illustration, the furnace is equivalent to the weaker wall and the stay-bolts are equivalent to the rope. When a pressure of 450 lb. is applied, there will be no perceptible change in conditions, as the walls can withstand that pressure; but when the load reaches 625 lb., the weaker wall starts to collapse, transferring the load to the rope, which is good for only 450 lb.; therefore, the wall and the rope give way. So it is obvious that the strength of the stay-bolts cannot be added to the strength of the furnace sheet and the sum considered as the strength of the stay-bolted furnace. If the example just given is reduced to safe working pressures by dividing each item by a factor of safety of, say, 6, the unstayed furnace will have a safe collapsing pressure of 104 lb. and the stay-bolts alone will be safe for 75 lb., making the stay-bolted furnace good for only 104 lb. If a safe working pressure of 200 lb. is desired, the furnace must either be strong enough in itself for 200 lb. or else the stay-bolts must be good for 200 lb. It is incorrect to add them together and call the combined value the safe working pressure.

The same argument applies to the stay-bolting of a cone top in a submerged vertical-tubular boiler and to the flat firebox sides of a locomotive-type boiler.

Summing up the entire subject, a braced or stay-bolted portion of a boiler is no stronger than its strongest part, and on no account should the strength of the braces or stay-bolts be added to the strength of the plate and their sum considered the strength of that portion of the boiler.

Some Notes on Turbine Bearings and Their Lubrication

COMPILED BY CHARLES H. BROMLEY

The data given in this article are from the author's loose-leaf notebook and have been gathered from many sources during recent years. Some engineers may desire them for their notebooks.

IT IS the consensus of opinion that the coefficient of friction slightly decreases with increasing speed. In high-speed bearings the coefficient is independent of the load.

Bearing Pressure—With slow-running bearings the pressure per square inch usually is not more than 70 to 80 lb., with white metal and forced lubrication. Bauer, Lascher & Swallow give 57 to 114 lb. per sq.in. for forced lubrication.

Temperature of the Oil—About 165 deg. F. should be considered the limit for turbine bearings, although constant temperature of 195 deg. F. may not give trouble, but the safety margin is cut down. When the oil reaches a temperature above 160 deg., it is likely that it will carbonize, therefore, 120 to 140 deg. is good practice; 250 deg. F. is the limit at which most oils have enough viscosity to be of any value in turbine lubrication.

Influence of Viscosity.—Pressure in bearings experimented on by Tower was 625 lb. due to oil being dragged in by the journal; that is, dragged in between the journal and the bearing. This teaches, of course, that the oil should be fed into the bearing at a point where the pressure is lowest.

Value of Viscosity—It is well to cite that in stern tubes of torpedo-boat destroyers, where water is the lubricant used, mean bearing pressure is limited to 20 to 25 lb. per sq.in. of projected area. Railway axles using grease go as high as 600 lb. per sq.in. of projected area.

Viscosity must be such that the oil film is carried completely around the journal without breaking down and without squeezing out of the bearing.

Stability of Oil Film—A remarkable demonstration of the stability of an oil film is shown by tests of the Westinghouse Co. (Pittsburgh) on segmental thrust blocks of a Kingsbury bearing, where with a mean surface speed of 54 ft. per sec. pressure could be (and was) increased to 10,000 lb. per sq.in. before failure occurred; but it was the white-metal facing of the bearings that flowed and not the oil film that broke down, as no serious heating of the oil took place.

Relative Position of Lubricated Surfaces—In high-speed lubrication the journal is never concentric with its bearings. This is the ideal condition, as the experiments of Osborne Reynolds and others have shown that opposing surfaces must never be parallel to each other for successful lubrication.

Specific Heat of Oil—In practice, the specific heat is usually taken as 0.31 and the specific gravity as 0.88. Battle's "Lubricating Engineers' Handbook," page 138, gives the specific heat of petroleum lubricating oil at 60 deg. as 0.4175.

The Coefficient of Friction—The coefficient of friction, or ratio of the resistance of the oil film to the load may vary, according to Stoney, from 0.0008 to 0.003, but he suggests 0.002 as suitable for usual cases where the unit pressure is about 500 lb. per sq.in.

Oil Consumption and Costs—Returns from a large number of users of Westinghouse turbines show that only about one-quarter gallon of oil is required for the bearings per kilowatt per year—"Steam Turbines," by L. G. French, p. 7. H. G. Scott in a paper read before the American Institute of Electrical Engineers, January, gave the lubrication charges per kilowatt-hour of reciprocating engines as 1.77c. and of the turbines as 0.35c. This was back in 1896, when turbines were of small capacity, comparatively.

Cooling Bearings with Water—At the plant of the Buffalo General Electric Co., Buffalo, N. Y., water is supplied from the boiler-water makeup evaporators, which are 60 ft. above the turbine floor and receive their supply from the hotwell pumps. From here the pipes are led to the turbine bearing, giving a head of 60 ft.; therefore, no extra pumps are used to handle the water which cools the turbine bearing.

Surface Speed—Land, 30 to 60 ft. per sec.; marine, 15 to 30 ft. per sec.

Ratio of Length to Diameter—Land, 2 to 3:1; marine 1:1 to 2:1.

Parsons Elastic Sleeve Bearings—For turbines with speeds of 3000 to 4000 r.p.m. Parsons uses an elastic sleeve bearing, consisting of concentric sleeves slipped endwise over the shaft. Instead of the top and bottom brasses, the concentric sleeves are used. The clearance between one sleeve and another varies from 0.002 to 0.006 in. The inner sleeve is really the bearing brass and is flanged at one end and has a ring nut at the other. The inner sleeve is thus fixed loosely in the bearing block; the other sleeves, usually two, are slipped on over the inner one, which has oil grooves and radial holes to let oil get to the other sleeve, which also has small holes in it to let the oil through. The bearing forms a hydraulic cushion which admirably stands vibration. This type of bearing should eliminate bearing trouble where chronic vibration of the machine causes a hot bearing, as may happen when severe vibration is caused by an unbalanced rotor. A similar bearing is used on Westinghouse turbines of speeds around 3600 r.p.m.

High-Speed Zoelly Machine—The high-speed Zoelly machines use a spherical bearing in which a sleeve fits over the journal, the sleeve being held in by segments resting upon spherical-headed screws.

Oil Consumption and Bearing Pressures—For high-speed bearings B. C. K. Balfrey, in a paper on "High Speed Bearings," Proceedings of the Rugby Engineering Society, Vol. 10, 1912-13, gives the practice of three English makers as:

Gal. per Sq.In. per Min.	Pressure Lb. per Sq.In.
0.05	45 to 60
0.05	5 to 10
0.01	....

Heat Loss at Turbine Bearings—The loss of heat in the bearings of well-lubricated turbines of large output is less than 1 per cent., reckoned on the total available heat.

Thrust-Bearing Clearances—Thrust bearings of the ring and collar types usually have clearance between rings and collars of from 0.002 to 0.003 inch.

Influence of Temperature on Chemical Reactions—Broadly, the higher the temperature the more rapid the chemical reaction between the constituents of the oil. At 120 deg. F., common in turbine work, chemical reactions go on, though slowly when pure mineral oil is used. The most common trouble is that caused by paraffin separating out of the oil in the form of a pasty, jelly-like substance adhering to the cooling coils of the oil cooler, greatly decreasing the rate of heat transmission through the coils. This trouble is most noticeable with oils of high viscosity, says the Westinghouse Co. An olefine-base oil avoids this trouble; but the cost is high. Russian oils are of olefine base.

Heat Transmission in Oil Coolers—The following data are from tests by M. Boella, of the Italian Corps of Naval Architects, and were given by him in an article in *Rivista Marittima*.

Explanation of types of oil coolers:

A: Cylindrical shell with two rows of U-tubes; water passing in series through tubes; oil surrounding tubes entering at bottom of shell, discharging at top; single pass, no baffles; gravity oil circulation.

B: Horizontal shell; straight tubes; water in single pass through tubes; oil surrounding tubes; three passes; counter-current.

C: Horizontal cylindrical shell; oil through helical coils, one coil inside the other (not one pipe inside another), oil inlet to inside coil returning through outside coil; water in one pass through shell.

D: Condenser type; straight horizontal tubes; oil, two passes; water, two passes; oil and water flow in same direction, that is, bottom to top.

E: Cylindrical vertical shell; short flattened tubes; oil through tubes in one pass, inlet at top, outlet at bottom; water, single pass, inlet bottom, outlet top.

Types of Oil Coolers	Weight, Lb.	Diameter, In.	Height or Length, In.	Space Taken Up, Cu.Ft.	Cooling Surface, Sq.Ft.	Weight per Sq.Ft.	Space Taken Up per Sq.Ft., Cu.Ft.	Coefficient of Transmission per Sq.Ft. per Degree Difference in Temperature B.t.u.
A	772	31.5	39.4	17.7	28.00	27.6	0.63	33 to 59
B	1,234	13.8	110.3	9.5	484.00	2.56	0.02	..
C	992	15.7	118.1	13.4	215.00	4.61	0.063	66 to 73
D	1,543	23.6	66.9	17.0	204.52	7.54	0.084	25 to 35
E	265	12.6	15.7	2.3	62.00	4.26	0.038	136 to 180

Note that the cooler E gives high heat transfer coefficient with small weight and volume.

In a paper, "Performance of Lubricating Oil Coolers," by M. C. Stuart, in the May 17 *Journal* of the American Society of Naval Engineers, some interesting results of tests were reported on three types of oil coolers, here designated A, B and C.

A: Plain tube; oil in shell in multipass arrangement; water through tubes in single pass.

B: Plain tubes, fitted with retarders; oil through the tubes in multipass arrangement; water in shell in multipass arrangement.

C: Special corrugated concentric tubes; oil between tubes in single pass; water in shell in single pass.

The coolers used were of practically the same weight and volume.

A summary of the tests follows:

Cooler	A	B	C
Heat transfer coefficient (based on unit surface) at equal capacities, B.t.u. per hr. per sq.ft. per deg. mean temperature difference	82.00	39.00	125.00
Relative heat transferred (based on unit volume) at equal capacities, B.t.u	1,000.00	450.00	450.00
Capacities, based on equal temperature drops, lb. oil per min	195.00	85.00	27.00
Oil-friction drop, based on equal capacities, lb. per sq.in. (pressure)	7.80	2.00	22.6
Weight per square foot of surface, lb	10.87	7.95	30.00
Volume per square foot of surface, cu.ft	0.49	0.53	0.15

These tests showed that the relative friction drops are in the same order as the relative heat-transfer factors and furthermore that the weights per square foot of cooling surface are in the order of the heat-transfer factors.

The summary strikingly shows that when considering the relative merits of oil coolers, all features of design should be taken into account.

Separating Water from Oil—The oil from the bearings may be heated for a considerable time to a temperature of 200 deg. F. without impairing the quality of the oil, when separating water from oil.

Testing Oil for Water—The following method is in use by some engineers of the United States Navy. Draw a small quantity of oil to be tested into an ordinary test tube; mix with the oil an equal quantity of gasoline and shake the contents of the test tube. The water will settle to the bottom. With a graduated tube the percentage of water may be determined, the quantity of oil and gasoline being known.

The Michell Thrust Bearing—The bearing surface is made up of adjustable segments, each pivoted to automatically produce a pressure oil film between the collar and bearing surface. The body of the bearing forms the oil well, and in large-sized bearings is water cooled. The coefficient of friction is about 0.0015 as against 0.03; the factor of safety at 300 lb. pressure per square inch, projected area is greater than multi-collar bearings give at 50 lb. per square inch. The friction is about one twenty-fifth that in multi-collar bearings.

The Michell Journal Bearing—This bearing for large sizes has 12 segments forming the bearing surface. Each segment is faced with white metal and rests in a spherical seat. The body of the bearing forms an oil well, the oil passing to the journal through holes, admitting oil between each segment at their seats. The following table gives the results of tests of experimental Michell journal bearing conducted by Cammell, Laird & Co., Birkenhead, England:

TEST OF EXPERIMENTAL MICHELL JOURNAL BEARING

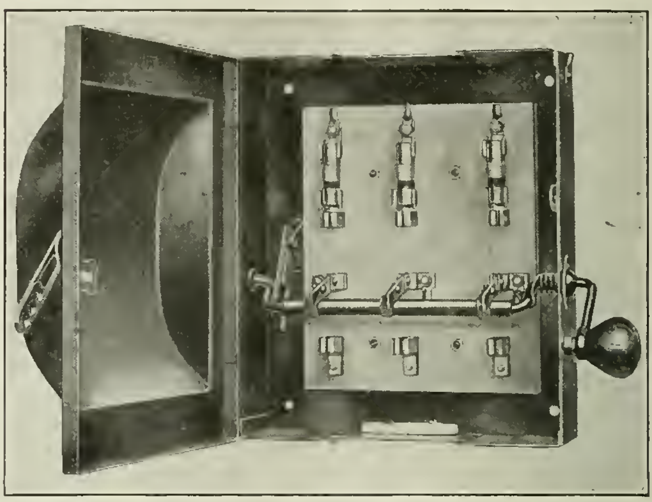
								Oil Supply				Friction		
Duration of Test, Min.	Total Load, Lb.	Bearing Pressure, Lb. per Sq.In.	Revs. per Min.	Surface Speed, Ft. per Min.	Amperes	Volts	Horsepower Input	Final Inlet Temp., Deg. F.	Final Outlet Temp., Deg. F.	Rise of Temp., Deg. F.	Flow of Oil, Lb. Min.	Horsepower from Heat to Oil	Coefficient of Friction	Actual Friction, Lb.
45		.	585	1,840	16 5	406	9 2	68	84	16	12 6	1 9	. . .	.
105	2,400	145	620	1,958	14.5	403	7 9	79	99	20	14 8	2 8	0.0099	47.5
105	3,600	220	615	1,930	16.0	395	8.6	84	101	17	14 3	2 3	0 0054	39.2
60	4,800	290	605	1,900	16.6	382	8.6	83	100	17	15 6	2.5	0.0045	43 7
40	6,000	370	615	1,930	16 9	395	9 1	84	102	18	17 6	3.0	0.0043	51.6
75	7,300	440	607	1,907	18 9	391	10 0	84	102	18	18 7	3.2	0.0038	55.4
45	8,500	520	605	1,900	19 0	395	10 2	83	99	16	19 0	2.9	0.0029	50 1
60	9,800	600	618	1,940	20 4	395	10 9	71	93	22	19 0	4 0	0.0034	67 6
90	11,700	700	611	1,920	21.0	391	11.1	76	100	24	19 7	4.5	0.0033	77.2
30	14,800	900	620	1,950	26.5	400	14 4	77	102	25	22 7	5 4	0.0031	91.7
30		.	1,315	4,130	23.0	390	12 2	76	95	19	23 0	4 1	. . . . .	
60	2,400	145	1,320	4,140	27 8	392	14 8	74	96	22	26.4	5.5	0.0091	43.7
45	5,500	330	1,320	4,140	29 8	390	15.8	77	104	27	25.2	6.4	0 0046	51.1
60	8,500	520	1,303	4,100	40 0	398	21 6	82	117	35	33 0	10 9	0 0051	87 5
60	11,700	700	1,324	4,140	50 0	382	26 0	76	111	35	37 3	12 2	0.0042	98.3
105	11,700	700	1,317	4,140	42 0	390	21 2	73	112	39	31 2	11 5	0 0039	91.2
30	14,800	900	1,320	4,140	45 5	400	24 7	76	117	41	33 0	12 7	0.0034	100.4

Westinghouse Thrust Bearings—The segmental thrust bearings have red-metal packing rings; the effective bearing surface is, roughly, 55 per cent. on the thrust or outer side and 45 per cent. on the inner side. The 45,000-kw. two-cylinder compound turbine at Providence, R. I., has effective bearing surface of 69 sq. in., thrust side, 54.5 sq.in., back. The maximum bearing speed at 1800 r.p.m. is 100 ft. per second.

Data on this subject are meager and widely scattered, and a really satisfactory compilation is yet to be presented.

Square D Motor-Starting Switches

The illustration shows a steel-inclosed starting switch made for three-phase motors of 5 hp. capacity or less. It was designed by the Square D Co., of Detroit, to afford protection against accidental contact with live parts, to protect the operator from being burned by the flash while operating the switch and to prevent tampering with circuits.



MOTOR-STARTING SWITCH WITH COVER OPEN

The switch is of the double-throw knife-blade type with the running side arranged for fuses. It is completely inclosed in a metal box provided with a hinged cover.

The switch is operated by a handle on the outside of the box, name-plates on the cover designating the position of the switch. Means are provided to lock the cover shut to prevent unauthorized persons from overfusing the switch or in any way tampering with the connections. A safety lock for the handle is also provided to prevent the careless closing of the switch when anyone is working on the line or the equipment controlled by the switch. Inside the cabinet a steel latch prevents throwing the switch from the off to the running position without its first being thrown into the starting position. The latch also makes necessary a quick change from starting to running position. The switch can be furnished with either straight-induction or star-delta connections. With the latter a separate main-line switch must be installed ahead of the starting switch in accordance with the regulations of the National Electrical Code.

Why Bill Reads "Power"

By Himself

The whistle had sounded, the day's work was done,
And engine and boiler had ended their run,
And fireman Bill, with the place spick and span,
Was waiting to hear from the blooming night man.
While watching and waiting, to kill a half-hour,
From out of the refuse he dug an old *Power*.

Then, seating himself in his rickety chair,
He studied the pages with painstaking care.
One article told how to pack a feed pump.
"That's rotten!" said Bill. "Gee! That fellow's a chump!"
But his brow quickly cleared, and he quit looking sour,
As he muttered, "By gum! I'll write something for *Power*."

Bill wrote out his letter—some job for a toiler—
As hard on religion as firing a boiler.
He told just how tight they should set up the glands,
And how to pack steam ends and not burn their hands.
"What's doing?" inquired his wife, with a glower.
"Oh, nothing," said Bill. "I'm just writing to *Power*."

Now, after the letter was well on its way,
Poor Bill recalled things he'd forgotten to say,
And after he'd waited in vain for reply,
Bill almost forgot it, as time scurried by.
But one night his wife, with her hands deep in flour,
Said, "Bill, there's a letter. I think it's from *Power*."

Bill tore off the end, and his hardened hands shook,
For what it contained made his wife stop and look—
Just a long yellow slip, very classy and nifty,
Telling someone to hand Bill the sum of two-fifty.
"Eureka!" yelled Bill. "That's as good as a dower,
For it gives me the chance for subscribing for *Power*."

Said Bill, "I'll invest it in reading, by heck!"
So back to New York went the long yellow check,
And when, at the end of a twelve-month or more,
Bill's wages were raised, Mrs. Bill wasn't sore.
"Good fortune," she said, "came to us in a shower
Not long after Bill started in to read *Power*."

Bill climbed some, for now he's the boss of the shift
And always on hand when the boys need a lift;
He knows when the engine is wasting her steam,
Can scrape in a bearing or calk a bad seam.
He's the friend of the men, and the Super's right bower,
But he isn't self-made—he's a man made by *Power*.

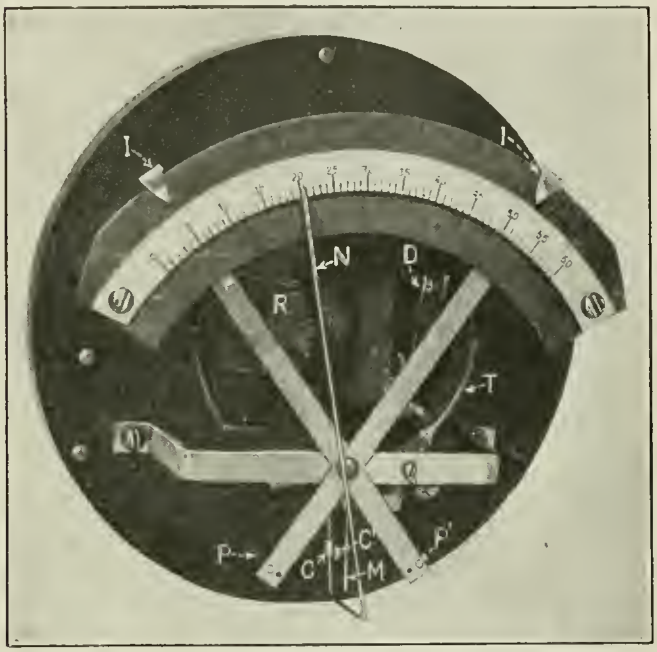
Pressure Governor for Gas and Liquid Systems

The General Electric Co. has developed a new pressure governor to control standard self-starters for motor-operated pumps and compressors for maintaining air, gases or liquids under pressure. The governor maintains a pressure between predetermined limits on any gas or liquid system that will not corrode the Bourdon tube. This governor can be used on any standard alternating- or direct-current circuit. It is rated for pressures of 80, 100, 160, 300, or 500 lb. and operates within settings of from 3 to 12 lb. between high and low pressures. Governors for higher pressures can be supplied if desired.

The governor consists of a Bourdon tube, an indicating needle, a graduated pressure scale, adjustable high- and low-pressure stops to determine the desired pressure range and a relay which actuates the contacts in the control circuit of the self-starter, all inclosed within a dustproof case, easily opened for inspection.

Action of the governor is dependent on the Bourdon tube, which should be connected to an independent discharge pipe from the pressure tank. The free end of the tube *T* in the figure is mechanically connected to the indicator needle *N*, moving it over the scale as changes of pressure affect the tube. After the settings for the pressure range have been made, the governor will automatically maintain pressure within those limits. The operation of the pressure governor is as follows:

Assuming that the pressure is at the low value, as indicated by the left-hand indicator *I*, then contact *C* on needle *N* completes the circuits through contact *C′* on movable arm *M*, which at the low-pressure point rests against stop *P′*. When this contact is made, the circuit is completed through the relay coil *R*, causing its armature to close. Attached to this armature is contact *D*, which upon closing, completes the control circuit to the self-starter, causing the motor to start. The armature is also attached to a spring which holds contact *C′* firmly against *C* until the contact is broken at *P*.



PRESSURE GOVERNOR WITH COVER REMOVED

As the pressure increases, the needle pointer moves to the right, but its lower part, to which contact *C* is attached, moves to the left and is followed by the movable arm *M*. When the high-pressure point is reached, the movable arm is prevented from traveling farther by stop *P* and the needle continues its course, breaking the circuit by separating contacts *C* and *C′*. The instant the circuit is broken, relay *R* is deënergized and its armature falls,. releasing the tension of the latter's spring, and because the movable arm *M* is counterweighted, it returns to stop post *P′*.

When the pressure has decreased to the minimum value contact *C* again completes the relay-coil circuit by engaging contact *C′* and the cycle of operation is repeated. The case is tapped and drilled at the bottom for the pressure-pipe and electrical-conduit connections.

Every dollar put into the Red Cross make not only for victory, but for everlasting peace between the great nations now fighting together in this war.

As It Is in Holland

By Y. Brouwers*

When the postman brings the paper on Saturday evening, the mistress eagerly scans it to see what is to be had from the grocer, the butcher, the milkman, etc., for we are rationed in every way. One of the most urgent questions at present is, "What shall we eat and drink and what shall we burn?" Our national mines do not supply what coal the country needs, so we depend upon importation from Germany and England. However, the Germans themselves are in want of coal because they cannot spare men enough for the mines, and this is also the case in England I suppose. Notwithstanding that, our Eastern neighbors are willing to furnish us with a limited quantity if we pay handsomely and provide the necessary facilities. So the last contract contains the conditions that we have to pay for each wagon load of about 20,000 lb. 450 guilders ($180) and have, moreover, to furnish for every wagon load a credit to Germany of a like amount. Before the war the price for the same quantity was about $40. The import from England is hampered by the want of ship capacity, and communication is dangerous on account of mines and submarines. Hence the greatest economy is necessary, for not only in the industries but also for private use coal is rationed. The industries that are most indispensable to our commonwealth, among them the factories that produce foodstuffs, receive a sufficiency. On the other hand, many factories have been forced to suspend operation of late owing to want of coal.

It is not to be wondered that many ways have been proposed and some adopted to diminish coal consumption. One of these was to limit railway traffic and not to heat the railway cars. It is only on very cold days that cars have been heated. It was proposed by an engineer in a paper at the confederation of dairy producers to replace all steam pumps in cheese and butter factories by belt-driven pumps, keeping the steam pumps in reserve, estimating that the relative steam consumption would only be about 1 to 8. He claimed that the saving would be about 6 million pounds of coal a year.

A similar case of economizing was discussed in our engineering journal *De Ingenieur* in regard to auxiliary engines on board ships. As a rule small condensing engines, consuming about 22 lb. of steam per indicated horsepower are used. One of the members of the Royal Institute of Engineers proposed to apply more economical engines; for instance, a small vertical steam engine of the uniflow type such as has been constructed by one of the professors at the Technical University at Delft, which consumes, when working condensing, only 7½ lb. of steam. Another engineer argues in a following number of *De Ingenieur* that, strange though it may seem, it is more economical to use a less economical noncondensing engine because the waste steam is used to heat the feed water and is almost always insufficient even for that purpose.

He calculates as follows, assuming that only the main engine and circulating pump engine are in operation: Assume that the circulating pump is driven by an engine using 45 lb. of steam per indicated horsepower. Steam consumption of the main engine, 3750 i.hp. × 12 lb. = 45,000 lb. per hour; circulating engine, 40 i.hp. × 45 lb. steam = 1800 lb. per hour; total boiler feed water = 46,800 lb. per hour; temperature of hotwell, 104 deg. F. Assuming that the exhaust steam from the circulating engine still contains 970.4 B.t.u. per lb. then it will give to the feed water 970.4 × 1800 = 1,746,720 ÷ 46,800 = 37.3 deg. F. rise in temperature of the total amount of the feed water. Assume that the circulating engine uses only 7½ lb. of steam, then 40 × 7.5 = 300 × 970.4 = 291,120 ÷ 45,300 = 6.4 deg. rise in the feed-water temperature. This difference must be made up from some other source, so that there is no real economy in using a highly efficient circulating-pump engine in this case. Every case should be calculated separately on its own merit.

To show the widespread interest in fuel and food conservation here, I may say that two subjects for prize competitions were published recently by some of the foremost men of our technical and commercial world, in which competitors are asked to propose methods for economy of heat force and food supply. The papers have not yet been published.

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*Rijks-Landbouwingenieur, Wageningen, Holland.

Reverse-Current Relays

A new form of reverse-current relay, Figs. 1 and 2, has been developed by the Automatic Reclosing Circuit-Breaker Co. These relays are of the circuit-opening type and are so designed that the relay will open either upon reversal of current or with zero current at abnormally low voltage. The relay is closed and held closed by a shunt-polarizing coil *P*. A high resistance is connected in series with this coil. To close the relay a push-button switch is provided which temporarily short-circuits the high resistance. The high resistance limits the current in the shunt winding to just sufficient value to hold the relay closed. A reversal of current or failure of voltage will thus cause the relay to open. These relays are designed for mounting on the rear of the circuit-breaker panel. The 1200- and 2000-amp. size, Fig. 1, has a magnetic yoke *Y*, which surrounds the upper stud of the breaker, while the 400- and 800-amp. size, Fig. 2, is provided with a series winding *W*, one terminal of which connects directly to the upper stud of the circuit-breaker. The other terminal of this winding connects to a stud *S*, through which connection to the external circuit is made.

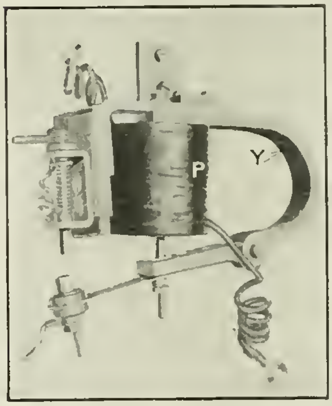


FIG. 1. RELAY, 1200 to 2000-AMP. SIZE

FIG. 2. RELAY, 400 to 800-AMP. SIZE

Editorials

This Time It Is Give, Not Lend

WITHIN less than a year the American people have responded to the call of their country three different times and have oversubscribed three of the largest loans ever floated in the history of the world, each time with an increased response as evidenced by the increase in the number of subscribers from about four million to the first loan to upward of twenty million in the third. The sale of War Savings Certificates is also meeting with a hearty response and by the end of the year will show that the American people are willing to back their Government to the last dollar. But all this money is only being loaned to the Government at a good rate of interest and will be paid back in full to each holder of these securities when they mature, and our enemies might have accused us of doing this simply because it was good financial policy had it not been for what the great American Red Cross has been doing on every battle front in the world, as briefly outlined on page 700 of last week's issue of *Power*.

In fact, when we entered the war part of the German propaganda in France was to create the impression that we were a nation of money grabbers, that we never did anything except for the money we could get out of it, that the vast sums we were investing in France for great military bases, railways and disembarkation ports were not for the interest of France but to use against that country after the war to further our own selfish interests. This propaganda might have succeeded, but the call was sent forth to the people of this country less than a year ago by the American Red Cross, not for a loan at a good rate of interest, but to give outright $100,000,000 to create a War Fund with which to finance the tremendous work of relief and reconstruction that was so vital to our Allies and ourselves in Europe, and that call was answered in a way that sent a message back to Europe that the American people had donated over $100,000,000 to the Red Cross War Fund, thus giving the lie to our enemies, the enemies of right and liberty, that we are a lot of wealth worshipers.

Before this war it was looked upon as the duty of the Red Cross to take care of the wounded, but conditions have changed and now it has become their work to provide everything that human beings need in a war-devastated country. This was very clearly shown in the previously mentioned report and is further emphasized by the following paragraphs taken from a Red Cross leaflet, "What Does the Red Cross Do?" by William Allen White, a copy of which can be secured by applying to any Red Cross Chapter:

"Over in France where French soldiers are coming back from the trenches on furlough, canteens have been erected by the Red Cross in order that the men might have lodging, food and bath, and a clean resting place. Such men return home clean and happy instead of wet and hungry. They come back from their homes to the trenches to fight, not in a sullen but in a happier frame of mind because of this Red Cross work. In France, too, the Red Cross supplies fuel and food and shelter to the soldier's families so that the men are prepared to stick—stick—and stick to the end, full of courage and ginger.

"Less than a week after the Italian breakdown the American Red Cross was in Italy with long lines of freight cars loaded with surgical supplies, food and clothing for civilians and distributing this aid to the hospitals and to the hundreds of thousands of refugees, men women and children, fleeing from the German invaders and making America felt for brotherhood in Northern Italy as no other country was ever able to make itself felt in the world before."

Since the first call the demands upon the Red Cross War Fund have been tremendous, the work accomplished staggers the imagination, but the first fund is nearing exhaustion, therefore the American people have again been asked to give $100,000,000 more, during the week May 20-27, to create a second War Fund so that the magnificent work that has been started may be continued. Let the answer to this appeal go echoing back to Europe from one hundred million loyal Americans that they have again cheerfully given over $100,000,000, to create a Second War Fund.

Give to your Red Cross until your heart says stop; it is "A great net of mercy drawn through an ocean of unspeakable pain."

Tube Failure in Water-Tube Boilers

TIME and experience have pretty well demonstrated that liability to complete disruption, with the destruction of property and loss of life that attends an old-fashioned boiler explosion, is much reduced in the water-tube boiler. The casualty statistics, however, show this type to be quite liable to local injury by rupture of the tubes, the bursting of a water tube being a much more frequent mishap than the collapse or failure otherwise of a fire tube. While most cases of bursting of water tubes undoubtedly result from overheating on account of oil or sediment preventing proper water contact, still there have been many such accidents that were apparently due to a breakdown of the strength and durability of the material under the stresses of long service. The latter cause may be wrongly ascribed for a tube failure on the strength of an absence of foreign matter from the surface of the tube, as revealed by an inspection following the explosion. The fact that no incrustation is found inside an exploded water tube is no indication that the rupture was not due to overheating. The shock at the instant of the explosion is pretty certain to jar the deposits loose, allowing the current of water and steam rushing at high velocity toward the opening to thoroughly wash them out.

When a tube failure results from overheating, the rupture is preceded by a softening and bulging of the overheated area and a consequent distention of the metal, so that when it finally rips open, the edges of the fissure are drawn down to a knife-edge. Of course a thin edge along the rip might also indicate a wasting away of the material by corrosion and abrasion; but if such be the case there will be corroborative signs that will be absent if the injury has resulted simply from overheating. One of these signs is that if the tube is measured roundabout from edge to edge of the rupture, the distance will be found to equal the normal circumference of the tube. If the failure has resulted from overheating, the preliminary stretching to which the metal was subjected will be shown by the measurement roundabout at the place of rupture being greater than the normal circumference.

A particularly insidious cause of injury to water tubes is the oil that gets into the boilers in plants where proper means are not used to separate the oil from the exhaust steam that goes to heat the feed water. A very small quantity of oil thus misplaced can do an immense amount of damage. It may also prove very elusive. It may spread out on the metal surface in a film so tenuous, or may combine so unobtrusively with the solid impurities to form sludgy deposits, as to escape even the practical eye and touch of the inspector. Overheating on account of oil usually extends over a larger area, and the resulting rupture is more violent in its effects than where the destructive agent comprises simply the ordinary scale-making ingredients, and these indications furnish the only guide in assigning the true cause of failure in many cases.

Scrupulous care should be exercised to keep oil out of steam boilers. Very often those responsible appear to be lacking in appreciation of the injury it can do, if one is to judge by the indifference manifested toward the oily scum that is to be seen on top of the water in many gage-glasses. When a grease line shows in the water glass, it is high time to do some industrious figuring on the problem of purifying the exhaust steam before it mingles with the feed water. Oil-extracting apparatus is to be had, which, if intelligently installed and cared for, will eliminate danger from this source.

But the tubes of a water-tube boiler may be free from scale and oily deposits, and still burning and bagging will develop by reason of the extremely hot fires commonly carried in large power stations. The bottom rows of tubes invariably suffer in such service, notwithstanding extreme vigilance to keep them clean. It is possible that the water coursing through these tubes is heated so rapidly that it cannot pass out quickly enough to carry away the globules of steam as fast as generated, with the result that they gather momentarily in pockets next the surface of the tube, thus excluding the water from contact with the metal. It is presumed, of course, that the accumulation of steam bubbles is of very short duration; but with the fierce heat of the furnace impinging directly upon the tubes with the concentrated intensity of a blow-torch, it requires but little time to soften the thin area of exposed metal to the bulging point, and a bag is the immediate result. Often a tube is found bagged along the sides. This seems to substantiate the theory of burning on account of steam pockets, since the natural precipitation of foreign particles in the water would evidently result in bags due to this source appearing along the bottom of the tube.

A variety of causes may contribute to the deterioration of water tubes. Of these the corrosive action of acids in the feed water internally and of sulphurous compounds externally are perhaps the most common. The fine fly ash that collects around the ends of the tubes and works in beneath the baffle tiles is also a prevalent source of decay. Removal of these deposits is an item that is generally neglected when the boiler is gone over at cleaning time. Great care will be observed to keep the insides of the tubes clear of corrosive agents, but little attention will be given to the outside. With some makers of water-tube boilers the water that is splashed around while washing out works in between the headers and through hollow stay-bolts, thus saturating the deposits of fine ash and initiating a rapid process of corrosion, perhaps utterly spoiling some of the tubes if the boiler stands idle for a considerable space of time. Instances have also been reported of baffled tubes having been worn dangerously thin by rubbing on the tiles due to the constant changing of form in the boiler.

Sometimes a water tube lets go on account of an imperfect weld. In such cases there can be no room for conjecture, the evidence of deficiency in a broken weld being so plain that the cause of the failure is never in doubt. There can be no absolute certainty about the security of a weld. Despite the utmost precaution in the manufacture of lap-welded tubes and rigid inspection of the product as it comes from the mill, defects in the welding will now and then crop out. Instances of imperfectly welded tubes continuing in service for months before bursting open have been reported.

The fluctuation of pressure and temperature in the ordinary working of a boiler, by producing a succession of molecular stresses that tend to crystallize the material, is also an active cause of deterioration, although its effects are never manifest to ordinary inspection. Loss of tenacity and ductility, and of the essential property of resilience or springiness is the inevitable penalty of age in a steam boiler. In water-tube boilers the tubes have practically the whole burden of service, since they comprise almost the entire heating surface of the structure; they fulfill, in fact, so far as absorption of heat is concerned, the same purpose as the more substantial furnace sheets of fire-tube boilers. The tubes should therefore be the objects of critical inspection. As the boiler ages, even though the tubes be kept free from oil and scale and show no visible signs of decay, it might still be the part of prudence to cut one out once in a while so as to determine by test just what the condition of the material may be.

The most unfortunate thing about a water-tube explosion is that it generally means death or painful injury by scalding to the fireman or stoker attendant, and perhaps to others who may be near-by; the damage to the boiler and setting in most cases is small and easily repaired. The menace to human life that is involved is certainly the outstanding reason why every precautionary measure available should be applied to minimize these accidents.

The most hopeful item of news bearing on the possibility of a coal shortage next winter is the announcement of an order by the Government, with deliveries promised through the summer, of 1025 locomotives and 100,000 freight cars.

Correspondence

A Talk to Firemen on Saving Coal

I read with interest the lecture by Mr. Bromley at the Baltimore City Club, as published in *Power* some time ago (Jan. 22 issue). The American Society of Mechanical Engineers deserves praise for bringing about such a meeting. More should be done in that direction.

"Employers Need Education" reads a subhead in the article. This is true, indeed. As every engineer knows, when he asks his employer for a new device, one that invariably is sure to save coal, he is usually told to wait, that labor and material are too high at present. The engineer usually concludes then something like this: "Very well, Mr. Employer, if you do not want to listen to me, you can go on wasting coal. I do not have to pay for it directly." But this attitude is as disagreeable to the engineer as to anyone else.

Here are some suggestions on coal saving that engineers may find applicable without the use of new apparatus.

When a plant of any size is started in the morning, generally engines, pumps, etc., are started some time before the working day begins; that is, before the load comes on. The engineer should have the machines warm, but start them as near the beginning of the working day as conditions permit. Do not have machinery running before it is needed. At noon be ready to shut down as soon as the whistle blows. In the evening perhaps some of the engines or other machines may be shut down before quitting time. Do not wait until you shut down all the other machines just to save a trip. Send the oiler or helper to do it if you are too busy. The heads of the different departments should coöperate with the engineer and notify him immediately when they can spare an engine; also they should not allow their men to waste steam.

The engineer should keep in close and constant touch with his fireman, should let him know when the heavy load is about to come on or be taken off. If the fireman is treated that way, he will no doubt like his engineer and take more interest in the work. During the time the plant is in full operation, the fireman should not be called to do work other than caring for the fires and the boilers. WILLIAM L. KEIL.

Philadelphia, Penn.

Setting the Clock Back Again

The editorial in the issue of Apr. 9 on daylight saving seems timely, and I hope the solution will put all sections of the country on a more equal basis with reference to the sun. The Central and Mountain Standard zones are too wide at present to give all parts of the zones an equal chance to get the most benefit from the available daylight. To illustrate, consider two strips of territory—the eastern and the western fourths of the Central zone. The recent change of the clock puts the western strip one and one-half hours ahead of the sun, which is excessive, as it will necessitate the use of light in the mornings till well toward summer and for a period in summer it will be bedtime by the clock while yet daylight, both of which factors tend to defeat the purpose of the law; while the eastern strip is merely advanced to the position formerly held by the western, and as far as daylight saving is concerned, the eastern strip is doing no different under war conditions than has normally been done in the western strip ever since standard time was adopted.

Another feature is this: Under the old way the daylight comes so close to 6 p.m. in the western strip that the peak before 6 p.m. is negligible, while in the eastern strip, which is one of the greatest coal-consuming sections of the country, they have had the extra burden of an enormous peak load for some time before 6 p.m. every day. I have often wondered why more of the cities in that section have not adopted local time to do away with the burden, but the reason probably is that habit has such a hold on men.

As to keeping the clock as at present the year round, it would put the eastern strips of the Central and Mountain zones in the positions formerly held by the western strips, or local time would be about half an hour ahead of the sun, which I consider almost the ideal. Perhaps 45 minutes ahead of the sun would be a little better as it puts the sun on the meridian almost exactly midway of the working day. It would do away with the greater part of the peak load before 6 p.m. in winter and in summer would give all the extra daylight needed. It would produce an increase of load in the morning, but not nearly as much as to offset the gain caused by the drop of the early evening load. If it is decreed that the clock shall not be put back, I hope that the Central and Mountain zones will be split into several, for unless that is done the inhabitants of this strip will be groping in the dark "of mornings" for three-fourths of the year.

Exeter, Neb. W. M. ALEXANDER.

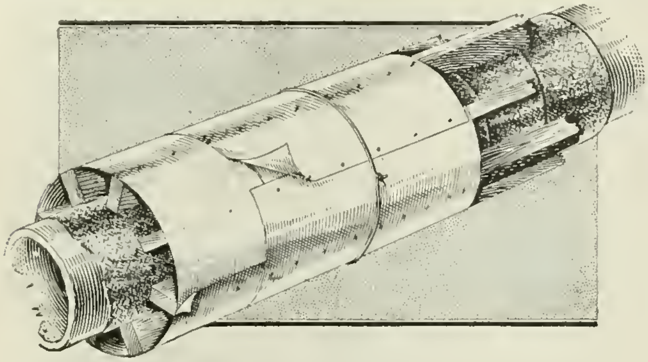
Burning Slack Containing Excessive Moisture

In my article in the issue of Apr. 2 on "Burning Slack Containing Excessive Moisture," an error in the printed figures has been brought to my notice, the stoker speed in our test being stated as averaging 2 ft. per min. This is obviously a mistake, and I find my original copy reads "No. 2 Stoker Speed," which is the record of the indicator connected to the stoker grate. In case this should not be clear, I recently checked the actual speed of this grate at the speed given, and find it moves 1 ft. in 5 min. The grate frontage is 7 ft., and the thickness of the fire 4 inches.

Calgary, Alta., Canada. JAMES F. MCCALL.

Easily Made Pipe Covering

The illustration shows how a fairly good pipe covering can be easily made. To lengths of building or tarred paper three or four feet long (the usual width of the roll) nail strips of wood equally spaced and about three inches short of the edges of the paper, as shown. This completes the outside of the covering. Wrap asbestos paper around the pipe to be covered and tie it on with stout twine, then put on the strips of wood and tarred paper and tie them on with a few turns of wire. This makes a fairly good insulator at a low cost. Care should be taken to see that the outside paper joints overlap at the sides and ends and that there are no holes, as the efficiency of the insulation depends to a large extent on the dead-air space. Painting the covering over occasionally with hot pitch will improve its quality and life.



COVERING APPLIED TO PIPE

JAMES E. NOBLE.

Portsmouth, Ont., Canada.

How Pat Saved a Barge by Sinking It

His name was Pat and his hair was as red as his wit was spontaneous. He was a shoveler on a coal barge on one of the steel company's routes up the Allegheny. The particular coal barge on which Pat was stationed was "docked" for the winter above the Sharpsburg bridge, and it was Pat's duty (and his pleasure be it said) to board the barge every morning and see if it was dry and, if not, to pump it out.

Pat was fulfilling his responsible duties one day while a carpenter was busy at work repairing the footboards of the barge, and all the while the water was rising in the river at the rate of about a foot every two hours. About noontime Pat said to the carpenter: "It is meself that's thinkin' that the wather is low enough to rise higher and if the ice comes down from up beyant, this old boat will be our coffin, begum."

The carpenter, looking upstream, saw a white streak coming around the point at Aspinwall and shouted to Pat to pull the barge to shore, knowing from experience that this white streak meant ice and that ice with a current meant—well, not death, but as near to it as he wanted to be. Pat tugged on the lines forward and the carpenter pulled on the lines astern, but with the current in the river about six miles per hour, the ice came down on the barge, tearing it from its moorings with Pat and the carpenter still on duty at their respective posts.

As Pat was forward at first and the carpenter astern downstream, Pat thought it his duty to be subordinate to his superior; but as the ice took the barge with Pat at the stern, as it were, he became captain and forthwith commanded the other to keep a sharp lookout for a jumping-off place. When they neared the P. R.R. bridge, the lookout yelled: "Pat, we are done; the water is so high that we can't go under the bridge, and the two of us and the barge will go to hell in ten minutes."

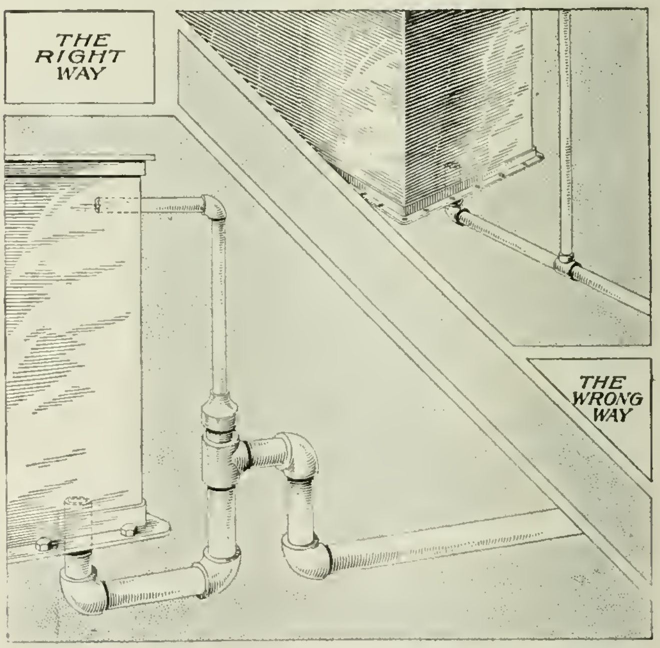
Pat, the captain, yelled: "Take your domn auger and bore some holes in her bottom to let the water in and get her low enough to go under the bridge; then plug the holes." It was done, with the result that Captain Pat and the carpenter were taken off the barge at East Liverpool and the barge was salvaged at Newport, Kentucky.

G. E. MICHAEL.

Pittsburgh, Penn.

Keeping Oil Out of Feed Pump

The same principle involved in the piping arrangement shown by T. A. Marshall in the issue of Apr. 30, page 630, that makes it impossible to entirely empty a receiving tank or heater by accident and get the oil and scum that is always found floating on the top of the water into the feed pump and boilers, may also be applied, as shown in the illustration, to open heaters, etc., in which there are trays and the like in the way of internal piping. The pump suction from the heater should be arranged somewhat as shown to form a seal, and a small vapor pipe connected from the tee at the top of the seal to the steam space of the heater or tank. The action is, of course, the same as that described by Mr. Marshall. It is not safe to allow the vapor pipe to be simply open to the atmosphere in case of a closed tank, because, in the event of even a slight pressure in the heater, all the water may be discharged from it before the pump gets air or vapor. Connecting a vapor pipe into the side of a tee, as I have seen tried, won't do either, for obvious reasons.



OUTSIDE PIPING TO KEEP SURFACE OIL FROM PUMP

New York City. J. LEWIS.

Fitting a New Piston Valve

My experience in putting a new piston valve in a Buckeye engine may be of value to some brother engineer, so I give it for what it is worth.

After pulling in the new valve-chest bushing, which necessitated the removal of the crank-end valve-chest head and stuffing-box, my assistant replaced the head, and upon attempting to insert the new valve I found it rather a snug fit; in fact, it would go only about halfway in. I discovered that the valve rod was binding on the top where it passed through the stuffing-box. The shoulder on the chest head, intended to fit the counterbore of the chest, was about one-eighth inch smaller than the bore, which allowed the head to drop down out of line; the slack of the studs in the holes also allow this. Loosening the stud nuts and raising the chest head slightly so the stuffing-box would be central with the valve-chest bore corrected the difficulty, and the valve entered properly. W. D. WAKEMAN.

Deposit, N. Y.

Single-Phase Motor Would Not Carry Its Load

Some time ago I had occasion to investigate trouble in a single-phase motor of the split-phase, clutch type that would not carry its load. It would start and increase in speed until the clutch began to grip, and at this speed it would remain until all the load was taken off, when it would come up to full speed. If the load was put on again, it would slow down until the clutch slipped. Considerable work was done on the clutch as the electrician thought the trouble was in this part of the equipment. However, when I investigated the matter, I found many of the rotor bars loose, and upon resoldering these, the motor ran as satisfactorily as when new. The reason for the motor slowing down is as follows:

The action in a single-phase motor is somewhat different from that of a polyphase machine. In the latter the revolving magnetic field is independent of the rotor's speed. A resistance in the rotor circuit will have the effect of changing the speed at which the maximum torque will take place, the maximum torque being of practically the same value regardless of whether it occurs at standstill or near full speed.

In the case of the single-phase motor the revolving field is dependent on the rotor's speed, being maximum at full speed and becoming simply a pulsating field as the rotor comes to rest. In this type a rotor resistance not only has the effect of reducing the speed at which the maximum torque will be developed, as in a polyphase machine, but also it reduces the amount of torque until at standstill the torque becomes zero.

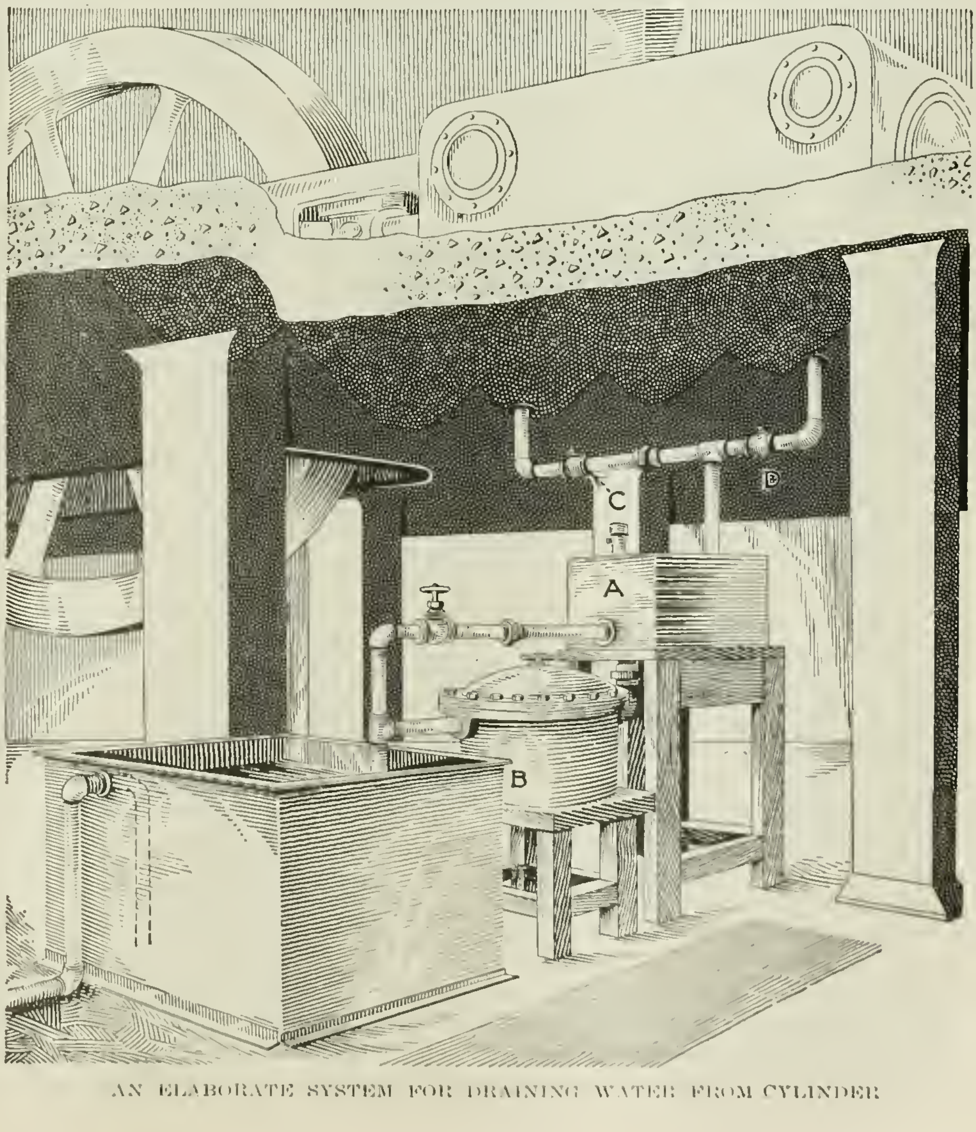
Adams, Mass. ALBERT CARPENTER.

Cylinder-Draining System

The illustration shows a rather elaborate cylinder-draining outfit that may be interesting. The globe valves on the drain lines above the floor are not shown; *C* and *D* are check valves, *A* is a cast-iron receiver and *B* is a trap.

Considerable water came over with the steam at times, but by leaving the draining valves above the floor open, the water got away all right. It was found that the cylinder oil soon closed up the trap discharge, so the outlet was drilled out to about twice its former diameter, and it did not choke up any more. The trap discharged into an open tank with a discharge overflow as shown, and most of the oil was skimmed from the top of the water in the tank and after being passed through a filter was used for oiling shafting, etc.

Portsmouth, Ont., Canada. JAMES E. NOBLE.



AN ELABORATE SYSTEM FOR DRAINING WATER FROM CYLINDER

Burning Slack Containing Excessive Moisture

The stoker setting described in J. F. McCall's article in the issue of Apr. 2, page 472, is by no means new, being generally similar to a standard Babcock & Wilcox Limited chain-grate stoker setting for low-volatile coals, which has been used for many years in England and Europe. In 1913 one of these B. & W. stokers was installed at the University of Alberta, Edmonton, which has proved very satisfactory in burning the Edmonton lignites, and a series of tests were being carried out by C. Robb, professor of mechanical engineering, when the war broke out and the work was held up. Some changes in the settings of the chain-grate stokers along the same lines have been made at the city power plants of Edmonton and Saskatoon by their city engineers.

While Mr. McCall's setting includes the essential center arch with an opening behind it, which is the best arrangement possible without more extensive changes to the standard bituminous-coal setting, still better results would probably be obtained by the regular B. & W. setting in which the back arch is set at a slope to obtain the maximum reflecting power, the grate inclined and a larger combustion space obtained by increasing the furnace height. The horizontal front arch is of little value, and as sub-bituminous and lignite coals do not take long to burn out, the length of the grate need not as a rule be over ten feet, the front of the stoker being set closer into the front of the boiler. This type of setting will prove satisfactory when burning the better grades of lignite. For lignites containing a high percentage of moisture, a special extension is employed at the front of the grate for partially drying the fuel before passing on to the chain grate proper.

In view of its present importance the question of the most satisfactory way to burn the Canadian lignites is engaging the general attention of engineers, and the Canadian government recently passed a special grant for an experimental plant in Saskatchewan. While some valuable investigations have been carried out by the United States Bureau of Mines, it would be of additional interest to hear from others who have had experience in burning lignite containing over 25 per cent. moisture under boilers. F. A. COMBE.

Montreal, Que., Canada.

Combustion in Boiler Breechings

I read with interest the experiences of Mr. Sonntag in regard to the gas burning in the breeching of boilers equipped with forced-draft apparatus, in the issue of Mar. 26, page 448, and having had experience with high-volatile coals and various kinds of furnaces, I think possibly the following may be of interest. I feel sure that Mr. Sonntag's conclusions are correct—that the gas burning in the breeching is the result of insufficient oxygen to support combustion, which causes the flame to reach out for more. A kerosene lamp will demonstrate this condition, as any slight reduction of air through the burner will cause the flame to lengthen.

It is generally recognized that successful forced-draft installation depends on a restricted and uniform air supply to the fire. Eliminating excess air is vital to good efficiency, so that the foregoing condition warrants a lot of consideration, as there is a possibility that the condition that did exist in this case could be made to produce remarkably good results if a few minor changes and experiments had been made. For such a condition I would suggest a few encircling tile directly over the bridge-walls to give the gas an incandescent surface to impinge on, creating a zone of much higher temperature than can be obtained otherwise, and then by firing alternate doors there is a chance for the fire to get sufficient free oxygen well mixed and ignited at this point, so that the gases will be consumed in the combustion chamber instead of in the breeching. A still better method is to construct arches of short spans, approximately four feet wide, over the bridge-walls, which, on account of being narrower than the boiler, will make a much better mixing medium.

I have records of tests on Heine boilers with properly arranged forced-draft grates and furnaces, using Southern Kansas coal of a very rich volatile content, where the temperature in the combustion chamber reached over 2000 deg. F. when carrying heavy loads, and the stack temperatures reached but a fraction over 600 deg., with the waste gases showing only a trace of carbon monoxide. I have also made exhaustive experiments at a reduction works in Colorado City, where Colorado lignite coal is burned with a forced-draft furnace especially designed for that fuel, in which preheated air is introduced between the furnace and the combustion chamber; and by controlling this air, the length of the flame on the hearth can be changed from 20 ft. to as high as 70 ft. The flame can be controlled in the same way under the boilers, which are similarly equipped in this plant. Forced draft is getting to be the favorite method of burning slack and high-volatile coals on account of the high boiler efficiencies maintained. My experience has taught me that it is much easier to add a little air at the proper place in a furnace under slight pressure than to fight the eternal excess that filters through boiler settings and fuel beds in poor condition caused by poorly designed grates. WILLIAM J. MANHIRE.

Kansas City, Mo.

Volumetric Efficiency of Air Compressors

The apparent volumetric efficiency of an air compressor is the apparent volume of free air drawn in divided by the piston displacement; the cylinder clearance is, of course, considered in the calculation or determination. This efficiency is usually about 96 to 97 per cent. with modern valves.

Paradoxical as it may seem there is a two-stage steam-driven air compressor at Newport, R. I., that shows a volumetric efficiency of 116.8 per cent. as shown in the records of tests on file in Washington. You don't believe it? Neither did I when it was first brought to my notice, but I believe it now. Here is the reason: The cold-air inlet is a long pipe extending to the river bank, and when suction starts in the compressor it sets in motion the long column of air in the inlet pipe, the momentum of which partly compresses the air in the low-pressure cylinder before the inlet valves are completely closed. Do you believe it now?

Pittsburgh, Penn. G. E. MICHAEL.

Inquiries of General Interest

Effect of Superheating on Valve Leakage—What effect has the use of superheated steam on the leakage of engine valves? W. R.

In all forms of valves the tendency to leakage is increased, as the higher temperature of the steam causes greater distortion of the parts and at the same time the steam is less dense.

Quick Rise of Compression Line of Indicator Diagram—What causes the quick rise in the compression line frequently observed in steam-engine indicator diagrams? W. R. S.

A quick rise of the compression line may be due to the compression steam taking up heat from the cylinder and also may be due to the addition of steam that has leaked past the inlet valve.

Expansion Tank for Hot-Water Heating—What size of expansion tank would be suitable for a hot-water heating system having about 750 sq.ft. of radiation? S. F.

Expansion tanks for hot-water systems containing 500 to 1000 sq.ft. of radiation should have a capacity of about 1 gal. per 40 ft. of radiation. For 750 ft. of radiation a tank of 20 to 25 gal. capacity would be sufficient.

Ratio of Expansion—What is meant by ratio of expansion in a simple engine and in a compound engine? J. L.

The ratio of expansion of the steam used in a simple engine is the quotient derived by dividing the final volume of steam found in the cylinder by the initial volume. By initial volume is meant the volume of steam admitted to the cylinder up to the point of cutoff plus the clearance volume, and by final volume is meant the volume of the cylinder, plus the clearance volume. In a compound, triple or any other form of stage-expansion engine, just as in a simple engine, the total ratio of expansion is the ratio of the final volume of steam found in the last cylinder to the initial volume in the first cylinder.

Dry Pipe Preferable to Steam Dome—Why is a dry pipe for a horizontal return-tubular boiler preferable to a steam dome? S. P.

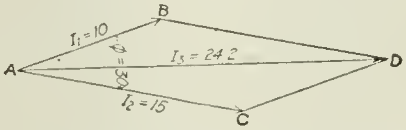
A steam dome takes up headroom, affords a large surface for loss of heat and the construction impairs the safety of the shell. The strength of the riveting and staying of a dome to the shell is uncertain, as it depends on the holding power of rivet heads, and the unequal expansion of the dome flanging and boiler shell is likely to cause leakage that cannot be stopped by calking. None of these disadvantages is present from use of a dry pipe, and when it is properly designed and placed within a boiler, mechanical separation of water that is entrained in the steam may be obtained as effectually as by use of a dome of ordinary dimensions.

Changing Direct-Current Motor's Voltage—What changes are necessary to be made in the windings of a 4-pole 240 volt compound-wound motor, running 1350 r.p.m., to operate on 115 volts and run at one-half its original speed, or 675 r.p.m.? T. A. M.

The only changes necessary are in the shunt-field windings. The shunt-field coils must be arranged in two groups of two coils in series in each and the two groups connected in parallel. To obtain the same amount of compounding as when the machine was operating on 240 volts it will not be necessary to make any change in the series-field windings. The machine will take the same current at full load on 115 volts as it did on 240 volts and develops one-half the number of horsepower. On account of 115 volts being slightly less than one-half of 240, or 120 volts, the speed on the new connection will be slightly less than one-half that on the higher voltage. The ventilation will not be quite so good on the lower speed, therefore the full-load temperature may be somewhat higher at the low speed.

Value of Two Alternating Currents—An alternating current of 10 amperes is out of phase by 30 deg. with a second current of 15 amperes. What is the resultant value of the two currents? H. F. S.

The resultant of two or more alternating currents in a circuit is always equal to their vectorial sum. The angle between the two currents in this case is 30 deg., hence the angle ϕ, between AB and AC representing the two currents in the figure, is made 30 deg., and by completing the parallelogram the resultant AD is obtained, which represents to scale what an ammeter would read when the two currents were flowing through it. This resultant may be calculated by the formula,



$$I_3 = \sqrt{I_1^2 + I_2^2 + 2I_1I_2 \cos\phi}$$
$$= \sqrt{10^2 + 15^2 + (2 \times 10 \times 15 \times 0.866)} = 24.2 \textit{ amperes}$$

Determining Advantage of Speeding Up Engine—How is it determined whether there would be an advantage from speeding up a Corliss engine with the present load? W. V. B.

As the advantage would depend on the superior economy from shorter cutoff combined with increased piston speed, the first step would be to determine the mean effective pressure necessary and from that to determine the new point of cutoff and the relative steam economy at the proposed speed. For the same load, the m.e.p. to be realized with different speeds is inversely as the speeds, and the required m.e.p. would be found by multiplying the present m.e.p. by the present speed and dividing the product by the proposed speed. Adding the m.e.p. to the average absolute back pressure gives the average absolute forward pressure and this divided by the absolute initial pressure will be the average forward pressure to be realized per pound of the initial.

Inspection of a table of mean pressure per pound of initial with different clearances and points of cutoff (such as given on page 115 of Low's "Steam Engine Indicator") will show the point of cutoff required. The relative amount of steam admitted with the present point of cutoff and number of strokes per minute can be compared with that required by the new point of cutoff and proposed number of strokes per minute. Such a comparison can only be approximate, however, as in the different cases there is likely to be different variation of the actual from the theoretical diagrams made by the engine. A closer estimate of relative economy could be made from comparison of actual diagrams obtained with the present speed for the average load and with the engine loaded only sufficiently for obtaining the m.e.p. that will be required by the proposed speed. If the proposed increase of speed is within limits of safety and certainty of operation of the engine, feed-water tests of economy of steam required per horsepower per hour for the present average m.e.p. and for a load that requires approximately the proposed m.e.p. at the present speed would give results near enough for all practical purposes to be regarded as identical with relative results of tests made at the actual speeds.

[Correspondents sending in inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Washington & Idaho Water Power Co. Valuation

In the hearings being conducted by the public-service commissions of Washington and Idaho at Spokane relative to the value of the Washington & Idaho Water Power Co., R. H. Thomson, former city engineer of Seattle, gave the properties a substantial boost in value.

Called as an expert on power-site values, he has given two months since the adjournment of the hearing in February to a study of the company's power sites, water-storage system, power plants and their relative costs as compared with other plants similarly situated. The total value of the company's properties is given as $26,000,000.

Engineer Thomson found that the power development of the Washington Water Power Co. was installed at a much less cost than that usually estimated, and for that reason he placed a valuation on the company's power plants, overflow rights and impounding systems of approximately $5,000,000 more than its book costs show. He called this the "value of opportunity," which he held entitled the company to a valuation which it would expect to ask were it about to sell its property to an outside purchaser. Should the joint commission accept the views of Thomson, it will mean an addition of 20 per cent. to the value of the company's property as given in former testimony and will entitle the company to increase its rates.

The Washington Water Power valuation hearing is being held preliminary to rate making by the public-service commissions of Washington and Idaho. The appraisal by the engineers of the Washington and Idaho commissions has been in progress more than three years. The greater part of the testimony of the engineers for the two states was taken in February, at which time R. H. Thomson was retained for a further inquiry as to power-site values by the Washington commission, and the City of Spokane retained Otto A. Weille, former city engineer, for testimony in behalf of the city. J. C. Ralston, former city engineer, appeared as an additional expert for the Washington Water Power Co., making three engineers representing the company, the others being Carl F. Uhden, chief engineer for the company, and Henry L. Gray. J. B. Ingersoll, former chief electrical engineer for the Inland Empire system, attended the hearings in consultation with counsel for the city.

For the Washington commission are appearing E. F. Blaine, chairman; F. I. Spinning, and Harry Lewis. The members of the Idaho commission in attendance are John W. Graham, chairman; George E. Erb and L. A. Freehafer. Hans Cleland, assistant attorney general, appears as counsel for the state, and J. P. Pope, assistant attorney general of Idaho, is counsel for the commission of that state. Frank T. Post is counsel for the Washington Water Power Co., and Mayor C. M. Fassett, J. M. Geraghty, corporation counsel, and A. M. Winston, assistant corporation counsel, appear for the city. D. F. McCurrach, acting chief engineer, and J. S. Simpson, former chief accountant, appear as technical experts for the Washington Commission. W. G. Swensden, chief engineer for the Idaho commission, is in attendance.

R. H. Thomson, the first witness called, said that power sites installed under similar conditions as those that obtained with the Washington Water Power Co. cost $225 per hp. The great Montana plants, the closest competitors of the Washington Water Power Co., he said, cost $215 per hp. He was surprised at the comparatively low cost of horsepower development shown in the invoice costs of the Washington Water Power Co., which is lower than the average costs over the country. He said that this difference is due to the advantageous location of the company's four plants on the Spokane River, with common impounding of water-storage facilities in Cœur d'Alene Lake. The company appears to have exercised prudence and close supervision in the building of its plants, as disclosed by its book costs. He claimed that the company in determining the value of its property is entitled to the difference in what its development has cost per horsepower as compared with what similar developments have cost elsewhere. Allowing ordinary conditions of growth and a favorable field in so far as competition is concerned, he would place this value of opportunity at $4,931,251.

Engineer Thomson produced the cost of power development per horsepower for the plants of the Washington Water Power Co., together with the credit due each plant compared with the going costs of such development for other companies:

Plant	Cost per Hp.	Hp. Development	Credit Due
Post Falls....	$168	5,930	$278,710
*Spokane..........	151	26,700	1,708,000
Long Lake Plant........	147	42,918	2,918,220
Little Falls Plant..............	120	18,130	1,722,350

* Estimated on basis of proposed new $3,000,000 plant.

He stated that this makes a total excess value of $6,628,080 over and above what might be styled invoice value of water rights and sites, including lands for impounding purposes, belonging to the Washington Water Power Co. This sum plus the invoice value will be at par at such time as the market demands of the territory will consume the normal output of the plant. Figuring on the basis of ten years being required for the territory to absorb the full output of the company, $4,931,251 would be a conservative figure as to the excess value.

Engineer McCurrach, for the Washington Commission, presented a supplemental report, bringing the appraisal of the Washington Water Power Co., to December, 1916, as compared to June 30, 1915, the date covered in his first report. This subsequent appraisal is based on additions actually made to the properties since June 30, 1915, as shown by the books of the company. Prices are based on the five-year average from 1910 to 1915. Following are the figures:

WASHINGTON PROPERTIES

	June 30, 1915	December, 1916
Railway system.................	$5,502,422 00	$5,593,214 00
Light and power system..............	13,505,694 00	13,834,977 00
Nonoperating property................	893,855.00	893,785.00
Totals.........................	$19,901,971.00	$20,321,976.00
Land railway....................	447,004.00	438,453 00
Land-light and power.................	1,114,904 00	1,114,232.00
Totals.........................	$1,561,908.00	$1,552,685.00

IDAHO PROPERTIES

Light and power systems...............	$2,326,669 00	$2,478,890.00
Nonoperating property...............	42,586.00	42,586.00
Totals....................	$2,369,255.00	$2,521,476 00
Land-light and power...............	123,560.00	143,203.00
Grand totals Washington and Idaho...	$23,956,694 00	$24,519,340 00

Another table of appraised values was presented by Engineer McCurrach, prepared at the request of F. P. Post, attorney for the power company, based on prices prevailing from 1912 to 1916, a period in which materials and labor cost more. These figures showed:

Washington totals	$23,490,484 00
Idaho totals.......................	2,839,626.00
Grand total	$26,330,110.00
Increase over regular appraisal figures.......	1,810,770 00

The appraisal of Engineer McCurrach on the railway property of the company to December, 1916, on the 1910-15 basis shows:

Spokane Street Railway	$4,732,521.00
Interurban System.....................	860,693 00
Lands—Spokane Railway........................	250,761 00
Lands—Interurban	178,692 00
Total..	$6,022,667.00

A calculation of what he thought was a fair system of annual depreciation allowances to be made on the property of the Washington Water Power Co. was presented by Mr. McCurrach, showing:

	Per Cent.	Amount
Spokane Street Railway	3 99	$191,185.00
Interurban railway	3 85	32,613.00
Light and power, Washington.	3 51	480,862.00
Light and power, Idaho	3 49	86,067.00
Total annual depreciation	3 71	$790,727.00

Remember, oil is lazy and very unobliging; it will never accommodate you by working to the center of a bearing, but will always work from the center out.—*Marine Engineering.*

Fuel Conservation by Off-Peak Rates for Isolated Plants

The testimony presented at the resumed hearing before the Public Service Commission for the First District of New York, on May 13, was of a character intended to establish the superiority of the isolated plant over the central station under certain conditions of operation and to bring out the idea that fuel can be saved to a community by permitting isolated plants to purchase current from public-service plants during the nonheating season and generate their own electricity during the heating season.

The plant of Saks & Co., Broadway and 34th St., furnishes light and heat to a seven-story building, as well as steam for operating elevator pumps. For about a year after the building was opened, in 1902, the plant was run to furnish light, heat and power. From December, 1903, to November, 1914, the plant discontinued the generation of electricity and purchased the necessary current for lighting from the Edison company. At the end of this period, however, electric generation in the plant was resumed.

A comparison of the costs of operation in 1913 and 1915 is interesting. In 1913 the purchased current cost $21,000 and the cost of operation of the plant to supply steam for heating and for running the elevator pumps was $17,000, making a total of $38,000. In 1915, with the plant supplying light, heat and power, the total cost of operation was $28,850, representing a saving of $9150 over the expense of operation in 1913.

During the heating season, the exhaust steam from the elevator pumps is sufficient to supply practically two-thirds of the heating, the remainder being made up by live steam. In the nonheating season, there is no way of utilizing the exhaust steam, and consequently it goes to waste. If a summer rate for current could be obtained, equal to or less than the cost of production in the plant, the plant could be shut down in the nonheating period with a resultant saving to the community of about 360 tons of coal. Approximately 180,000 kw.-hr. is needed during the nonheating season, and the generation of this current by the central station instead of the isolated plant could be done on at least 4 lb. of coal less per kilowatt-hour, amounting to a saving of 720,000 lb., or 360 tons. During the heating season, however, the central station would have no such advantage over the isolated plant, as the latter would use its exhaust for heating.

The plant of Bonwit Teller & Co., Fifth Avenue and 38th St., supplies steam for the operation of engines driving electric generators, for running refrigerating machinery and for heating. Comparison of the cost of generating current in this plant, as taken from the plant records, and buying it from the Edison company shows that the former is about half as large as the latter. The reason is that no exhaust steam is wasted, in the heating season, as it can all be used in supplying heat to the seven-story building in which the plant is situated.

The shutting down of the electric-generating part of the plant would have little value as a coal-saving scheme. About 14 tons a day is required for heating, and if current for lighting is generated, the coal consumption is only about 17 tons a day. The number of kilowatt-hours generated, however, is much greater than the central station could produce with the 3 tons of coal representing the increase of coal consumption, because the isolated plant obtains the current as a byproduct of the heating system.

The Columbia Trust Co., 60 Broadway, installed a private electric plant in 1915. Before that time current had been purchased from the Edison company, and an isolated steam plant had furnished the heating and run the elevators. The result is that the electric plant has saved enough to pay for the cost of installation and all interest charges. The saving for the year ending Oct. 15, 1916, was $10,171 and for the year ending Oct. 15, 1917, was $11,396. These savings were calculated on the basis of the Edison rate for current before the electric plant was installed. For example, in the year ending Oct. 15, 1916, the electric current used would have cost $19,494 at the Edison rate. The heating would have cost $7938 more, making a total expense of $27,432. The actual operating expense for that year was $17,261, so the amount saved was $10,171.

Percival R. Moses, who has had a wide experience in designing private plants for buildings, appeared in behalf of the isolated plant. He advocated coöperation of the public-service utility and the isolated plant as the solution of the coal-conservation problem. His plan would be to shut down the private plants during the nonheating season, when they have no use for exhaust steam and could therefore operate only wastefully, and to establish a low rate whereby they could purchase current for lighting during this period from the public-service plants.

The views expressed by Mr. Moses are given at considerable length in an article by him in the Mar. 26, 1918, issue of *Power*. He said in his testimony that the Chicago Edison Co. has established rates for off-peak service to isolated plants during the nonheating season, as follows: 3c. per kw.-hr. for the first 25,000 kw.-hr.; 1.3c. per kw.-hr. for the next 25,000 kw.-hr.; 1.1c. per kw.-hr. for the next 70,000 kw.-hr., and 0.9c. per kw.-hr. for all in excess of the last figure. It was his impression that the City of Milwaukee had a similar off-peak rate.

It will be remembered, in this connection, that at a preceding hearing John W. Lieb, of the New York Edison Co., made the statement that under the conditions existing in New York City there was no such thing as off-peak service, because a sudden demand might arise to tax the entire capacity of a station.

Mr. Moses was asked whether he could account for the paradoxical statement that in some plants less coal was burned for heating and generating current than for heating alone. He said that where live steam was used for heating it was quite probable that too high a temperature was remedied by opening windows; whereas, in a plant using exhaust steam for heating, the supply available is only that which comes through engines and pumps, at a fairly uniform rate, and therefore there is likely to be less waste of heat because of excessively high temperatures.

The hearing was adjourned until June 10, 1918.

Record Coal Production

A week's record production of bituminous coal is indicated by reports received by the United States Fuel Administration covering the week ended Apr. 27. During that week the total output is estimated by the United States Geological Survey at 11,803,000 net tons, an increase of 6.1 per cent. over the preceding week. The average production per working day was 1,946,000 net tons compared to 1,840,000 net tons the previous week and 1,680,000 net tons during April, 1917.

The output for the month of April, 1918, is estimated at 36,478,000 net tons, an increase of 10 per cent. over April, 1917. Production for the four months ended April, 1918, is estimated at 181,992,000 net tons, an increase over 5,000,000 net tons, or about 3 per cent. over the same four months of 1917. The week ended Apr. 27 recorded not only the highest rate of production for the past 12 months, but was the third successive week of rising production. The reports to the U. S. Geological Survey showed a gradual improvement in car service conditions at the mines during the week ending Apr. 20. Loss of production due to car shortage throughout the country was reported as 16.2 per cent. as against 18.1 per cent. for the preceding weeks. Loss due to labor shortage was 4.8 per cent. as against 2.6 per cent. during the preceding weeks.

There is quite a loss due to "no market" all through the Middle West, the loss running from 5.8 per cent. for the Rocky Mountain States to 30.7 per cent. for mines in Iowa.

During the week ended May 4 bituminous output declined slightly after three successive weeks of rising production, the total production being estimated at 11,559,000 net tons, a decrease of 2 per cent. from the week previous.

The continuous rotary motion of the turbine is ideal for certain drives, but the crank is still the ideal drive for an air compressor, as it gives the mechanical advantage of power application just when it is needed.—*Marine Engineering.*

Changes in Coal-Zoning Plan

Under an order modifying the zone system issued by the Fuel Administration, bituminous coal originating on the Broad Top Mountain railroads and their short-line connections, in the States of Pennsylvania, West Virginia and Maryland, when routed via the Pennsylvania R.R., is embargoed from Baltimore and Washington markets.

To meet this situation the Fuel Administration will arrange for the essential supply to the points designated from mines on the Baltimore & Ohio, the Western Maryland and their connections, which lines afford a much more direct route to these points. As a consequence a vast amount of time and mileage will be saved to the Pennsylvania lines, thus assuring an increased movement of coal to points in eastern Pennsylvania, New Jersey and New England.

Consumers of the classifications named in Preference List No. 1, of the priority board, will receive coal in preference to any other individual or class of consumers.

Under the modified order, which became effective on Apr. 20, producers in the sections named will be prohibited from selling, shipping or distributing coal to dealers and consumers at Washington and Baltimore and at all stations on the Baltimore & Sparrows Point R.R. when routed via the Pennsylvania.

The order forbids the shipment of bituminous coal over the railroads named for railroad delivery or transshipments to vessels in Baltimore, at President Street, Highlandtown, Jackson's Wharf, Calvert, Bolton, Frederick Road and Gwynns Run station; and points of delivery between any two of such stations; all stations and points of delivery on the Baltimore division of the Pennsylvania R.R. from Loudon Park, Md., to Catonsville, Md., inclusive, and Arbutus, Md., to Washington, D. C., and Rosslyn, Va., including Popes Creek branch, running from Bowie, Md., to Popes Creek, Md., inclusive.

Consumers located on the Pennsylvania and Baltimore & Sparrows Point railroads will continue to receive their coal at their regular points of delivery, the coal moving via the Baltimore & Ohio and Western Maryland being delivered to the Pennsylvania at junctions near destinations.

Navy Steam Engineering School

The United States Navy Department has perfected plans for the enrollment and training of considerable numbers of engineering officers. A school for this training known as the United States Navy Steam Engineering School, has been established at the Stevens Institute of Technology, Hoboken, N. J., under the guidance of Dean F. L. Pryor as Civilian Director.

The course consists of five months' training divided as follows: One month of military training at the Naval Training Camp, Pelham Bay Park, New York; one month at the U. S. Navy Steam Engineering School; two months' practical training on board ships and in repair shops in the vicinity of New York; one month finishing course at the U. S. Navy Steam Engineering School.

The school is open to men between 21 and 30, who are physically qualified, of thorough ability and officer-like character, and who have completed the engineering course at any recognized technical school.

This school presents particularly desirable opportunities to the young technical man, both in affording him a proper outlet for his trained facilities during the war and in rounding out his college work with a practical course and school experience which will be of value to any engineer.

The service that a graduate from the school will perform will be that of an engineer-officer in the auxiliary service of the Navy. A graduate of the school will be commissioned an ensign in the Naval Reserve Force.

Information has been sent to all registered technical schools and should be on file at the President's office. For any additional details application can be made to the Civilian Director, U. S. Navy Engineering School, Stevens Institute, Hoboken, N. J.

Any men, graduates or undergraduates, who are registered in the draft can enroll with the proper enrolling officer by securing from the draft board a letter of release, which in all probability can be obtained for this purpose, provided the men are not included in the current draft quota.

Special provision has been made for the continuance of the school with proper material by a Navy regulation which permits undergraduates of the freshman, sophomore and junior classes in recognized engineering schools to enroll in the Navy with a rating seaman second class and continue their courses at the institutions where they have matriculated. Such men will be called into active service after their graduation and can at that time, if they are physically qualified to pass an officer's physical examination, enroll for the course at the United States Navy Steam Engineering School.

Trained Engineers for Naval Service

The Bureau of Navigation, Navy Department, is desirous of securing trained engineers for general service in the Navy in steam and electrical engineering and radio duties.

Applicants will, if accepted, be enrolled as ensigns in the Naval Reserve Force and will be sent to the reserve officers' school at Annapolis for a special course of about four months, after which those who finish this course successfully will be placed in further training ashore or afloat, and then become available for regular sea or shore duty as the exigencies of the service may demand.

Applicants for this general service should have the following qualifications: A degree in mechanical, electrical or mining engineering, conferred by a college of recognized standing; at least two and one-half years' practical engineering experience subsequent to graduation (exclusive of time spent as sales agent); not over thirty-five years of age; physically strong and sound in health.

The American Institute of Electrical Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, Naval Consulting Board and National Research Council have each been requested to submit a list of fifty names equally proportioned among personnel trained in steam-engineering duties, electrical-engineering duties and radio duties; but the exact engineering duties to be performed in general service by each applicant will be decided after completion of the training under Naval supervision.

It is probable that from among the applicants selected, a class will be formed at the Naval Academy about the middle of June. Each applicant should without delay forward to the Engineering Council, which is acting for the five organizations named, a résumé of his education and engineering experience, together with a small photograph, if practicable, and such letters of recommendation as it may be possible to submit, addressed to 29 West 39th St., New York City.

Government Wants Business Diplomats

The Government is looking for big-caliber men with foreign trade experience to serve as commercial attachés for the Bureau of Foreign and Domestic Commerce, Department of Commerce, and announces that appointees will be accredited to American embassies or legations abroad and will be expected to meet in a creditable manner the most important Government officials and business men in such countries and make trade reports. A rigid examination will be held on June 6, and those interested are urged to write at once to the Bureau of Foreign and Domestic Commerce, Washington, for further details.

The salary of the Commercial Attachés ranges from $4000 upward, and there are transportation and other allowances. The Department of Commerce is also planning to appoint trade commissioners to Europe, South Africa and the Far East in the near future.

Many engineers forget, or never knew, that in a nonreversing engine only one side of the crankpin gets any wear. Think this statement over, and you will find it true.—*Marine Engineering.*

Maximum Production with Minimum Waste

The United States Fuel Administration has announced the appointment of Thomas R. Brown, of Pittsburgh, as administrative engineer for the Pittsburgh district, and C. P. Billings as special staff assistant. These appointments were made as a preliminary step toward putting into operation a general plan for fuel conservation in power plants.

This plan is the result of conferences with the Federal Fuel Administrators and their committees for the group of states which together consume about 70 per cent. of all the coal used in the United States, exclusive of railroads. The plan has received the indorsement of the fuel administrators of all these states, as well as the approval of the United States Bureau of Mines and a committee representing the Engineering Council of the four national engineering societies.

The slogan of the campaign is "Maximum production with minimum waste." In other words, the object is to operate all industries at full capacity, but at the same time to make a pound of fuel perform its maximum service in power, light and heat.

In laying the foundations for the organization it has been anticipated that this work should become a permanent service of the Government.

Ten to twenty per cent.—that is, from 25 to 50 million tons of coal per year—can be saved by the correct operation of steam power plants, using their present equipment, in the industries, in office buildings, hotels, apartment houses, etc.

It is considered most important that all existing fuel-conservation committees, committees of chambers of commerce and national defense, manufacturers' associations, and other bodies be continued in full force, and that the work of such organizations be consolidated with the national program, which comprises certain fundamentals as follows:

Fundamentals of the Program

Personal inspection of every power plant in the country.

Classification and rating of every power plant, based on the thoroughness with which the owner of the plant conforms to recommendations.

Responsibility of rating the plants will fall upon an engineer in each district, the rating to be based on reports of inspectors, who will not express opinions, but will collect definite information. The State Fuel Administrator, in his judgment, may entirely or partially shut off the consumption of coal to any needlessly wasteful plant in his territory.

Inspectors are to be furnished from one or more of the following sources: Inspectors of the steam-boiler insurance companies; state factory inspectors; engineering students from technical colleges; volunteers.

The ratings will be based on recorded answers to questions, each of which will be given a value depending upon its relative importance to the other questions. Depending on the efficiency of methods in use in any plant, it may be rated in Class 1, 2, 3 or 4.

The ratings will be based on existing equipment. The difficulty, delay and expense involved in the installation at this time of improved power equipment is fully recognized, but experience has proved that 10 to 20 per cent. of fuel now used in power plants can be saved by improvements in operation alone.

In advance of the first inspection a questionnaire will be sent to every power plant in each district, with notice to the owner that within 60 or 90 days his plant will be inspected personally and the questionnaire will be checked up by the inspector upon his visit. This action will tend to prepare the minds of plant owners for what will follow. It will operate to induce proper care in furnishing information and will also tend to produce a desire to improve their plants, if necessary, so that they may be rated in a high class by the time the inspector calls.

It is recommended that a board of competent engineers be attached to the conservation committee in each state; also a corps of lecturers to arouse public interest and disseminate engineering information.

The Fuel Administration has prepared a 50-minute film of moving pictures showing good and bad operation in the steam-boiler plant, methods of testing boilers, fuels, etc. These pictures will be available for each state in connection with its educational propaganda.

The administration is also preparing a series of official bulletins on engineering phases of steam and fuel economies. Some of these are now ready for printing. They will include: Boiler and Furnace Testing; Flue Gas Analysis; Saving Steam in Heating Systems; Boiler-Room Accounting Systems; Saving Steam and Fuel in Industrial Plants; Burning Fine Sizes of Anthracite; Boiler Water Treatment; Oil Burning; Stoker Operation.

In addition to this service a list of competent engineers has been prepared in Washington for each state and is available for use of each local administration. As the work develops, still further constructive assistance is contemplated for helping owners to bring their plants up to a high plane of economic operation.

Opposing Hun Force with Engineering Intelligence

Preparations by American engineers for leadership in the coming industrial development of Russia are being urged by the Russian Society of Engineers of Chicago. This organization was formed to help introduce modern achievements of American engineering into Russia and to develop friendly relations between the two countries. These aims are of special importance at the present time, as Russia is beginning to emerge from its chaotic conditions and to show increased resistance to the German invaders. To strengthen this resistance means to keep the vast natural resources of Russia from falling into the hands of Germany. This as well as the great prospective market into which Russia will ultimately develop should interest the American business man and especially the engineer who is the modern industrial pioneer. To promote this work a series of lectures by Russian and American engineers on the industrial needs of Russia and the mutual benefits to be derived by commercial intercourse is being arranged for all Chicago engineers by the society.

With a spirit of coöperation in this international patriotic endeavor the Western Society of Engineers is in accord, and the first meeting will be held May 22 in its rooms. W. J. H. Strong, Strong Engineering Co., will talk on "Industrial Developments in America as Compared With Those in Russia," and W. W. DeBerard on "Engineering Publicity." The Young Men's Committee of the latter society has already begun to study international subjects intensively, having spent two nights on the "Situation in Colombia, South America," and one on "Russia."

It is certain that the American engineer's horizon will not be to the boundaries of the United States hereafter, and studies of foreign development problems must be undertaken if the engineer is to keep in the foreground of obvious opportunities.

Control Over Power Companies

Upholding an order of the New York Public Service Commission, Second District, restraining the Oneonta Light and Power Co. from continuing to operate within certain territorial limits in Otsego County, N. Y., the Appellate Division of the New York Supreme Court holds that where an electric-power company's charter makes its right to exercise its powers within the limits of a town, village or city conditional upon obtaining the consent of the municipal authorities, there is no right to do business within such limits in the absence of such consent, although the owners of private property to be served consent to the stringing of poles, wires, etc., across their property. It is further decided in the same case that the fact that an electric-power company may acquire a private right-of-way for its transmission lines does not defeat supervisory control of the construction work by the Public Service Commission. (167 New York Supplement, 486.)

Frederick Remsen Hutton

IT IS with deep regret that we announce the death of Frederick Remsen Hutton, well-known engineer, educator, and distinguished member of the American Society of Mechanical Engineers, at his home, New York City, Tuesday, May 14. Death was due to heart trouble.

Professor Hutton was born in New York City, May 28, 1853; he died in his sixty-fifth year. After preparation in a private school, he entered Columbia University, receiving the degree of A. B. in 1873. After graduation he entered the School of Mines and was given its degree in 1876. Later he became an instructor, and was assistant to the late Professor Trowbridge, entering the faculty as adjunct professor in 1881 and professor in 1890. Professor Hutton served as head of the department of mechanical engineering until his resignation in July, 1907, when he was elected professor emeritus. From 1899 to 1905 he was Dean of the Schools of Engineering.

In 1911 he served as consulting engineer to the Department of Water, Gas and Electricity, New York City, and from 1905 to 1911 was vice chairman of the Museum of Safety. He was consulting engineer to the Automobile Club of America and chairman of its Technical Committee since 1912, in which capacity he supervised the important testing work conducted by the club in its laboratory.

It is as a member of the American Society of Mechanical Engineers that Professor Hutton was most widely known. He was made president of that society as the culmination of twenty-four years of service as its secretary. He had the honor of presiding at the first meeting of engineers in the splendid auditorium of the Engineering Societies Building in 1907. He represented the American Society of Mechanical Engineers at the formal ceremonial days of the dedication of the new building, a noteworthy event in the annals of American engineering society history. It was in 1883 that Professor Hutton became secretary of the A. S. M. E., three years after its organization. The offices were then at 17 Cortlandt St., and more than once in those early days he paid the office rent out of his own pocket.

FREDERICK REMSEN HUTTON

Professor Hutton was of great influence in giving international recognition to the society. He was connected with arrangements of the European trip in 1889, one of the noteworthy events in the society's history. He was a member of the Conference and Building Committee of the United Engineering Society which planned the present Engineering Societies Building at 29 West 39th St.; he also was one of the Board of Trustees holding the corporation for the United Engineering Society, 29 West 39th St., New York City.

Professor Hutton contributed much to scientific literature. His most important books are: "The Mechanical Engineering of Power Plants," "Heat and Heat Engines" and "The Gas Engine." The first is used as a textbook in some of the technical institutions of Japan. He contributed considerable to encyclopedias, dictionaries and the technical press. His speech at Washington before the American Uniform Boiler Code Congress early last year struck a new note in industrial-governmental relationship. Although an individualist by theory and preference, he recognized that the growing complexity of the social fabric would sooner or later compel significant changes in the relation of individuals, corporations and the state. At this congress he pointed out that a boiler explosion was a community loss, and not alone a loss to the purchaser, builder and insurance company.

He supplemented this speech with an article published in *Power* for June 5, 1917, p. 774, and in this he asked the significant question: "—— is there any logical pausing stage before the community demands economy and efficiency in the use of increasingly precious fuel in the generation and distribution of power, with a view to lowering the cost to the community of such commodities as call for power in their production?"

To quote further from this article: "First, every machine (and a power-house boiler and engine and generator are in this class) should be functioning continuously if possible, to earn the interest on its cost and pay the proper share of overhead charges. Second, an accident that involves the machine or disables its operator, or both machine and operator, breaks into this continuity of earning and involves losses. These losses fall into several groups: First, the cost of repair; second, the losses of idleness; third, the costs of compensation for bodily injuries, or of insurance against this cost; fourth, the costs in wasted stock and defective work, due to teaching a new operator, also in the slow and inferior production of the worker as yet inexpert; and fifth, the costs of the slackened speed of all workers in the department while the memory of it is fresh in the minds of those who witnessed the accident. There are, furthermore, indirect losses from the accident, which reach the community only through the heavy losses borne in the narrow circle affected when its wage-earner is disabled."

Among the societies and clubs to which Professor Hutton belonged are the Engineers' Club, New York, and the New York State Society of Cincinnati.

Final Figures for Rainbow Division

Final figures for the Rainbow Division given out by the Advisory Trades Committee of the Liberty Loan Committee, May 11, showed that the total subscriptions for all the 86 business and professional organizations comprising this division was $564,767,950. The grand total for the Second Loan was $409,367,150.

At the beginning of the Third Loan, an allotment of $450,000,000, one-half the total for the entire Second Federal Reserve District, was given the Rainbow Division. During the first two weeks of the campaign it looked as if the Division was falling behind the schedule laid out by the Central Committee. Emergency meetings were held and an intensified plan of action was begun.

One week after this, on Apr. 27, the total for the Second Loan was passed and on May 3 the figure aimed for, $450,000,000, was also passed.

Seventy committees reached and passed their total for the Second Loan. Of these the one that made the greatest percentage increase was the Electrical Committee. Its total for the Second Loan was $809,000 and for the Third, $9,457,000. This committee was awarded an Industrial Bull's-eye Honor Flag containing 21 stars, each star indicating an increase of 50 per cent. over the preceding total.

Standing out as one of the best things in the entire campaign was the splendid support of the workers. Not only did the employees buy in greater amounts and in larger numbers than in the two preceding loans, but the labor unions gave their fullest support and also bought more bonds than ever before.

How well the men and women workers supported the Third Loan can be seen by the fact that fully 5000 Industrial Honor Flags were awarded to firms where 60 per cent. and more of their employees bought the third issue of bonds. Nearly 1500 of these were 100 per cent. flags, meaning that every worker in each factory, firm and company bought a bond. It is expected that the total of 100 per cent. flag winners may reach and pass the 2000 mark when all the applications have been received and verified.

Personals

Frederick Ray, consulting engineer, announces the removal of his office from 95 Liberty St. to the Mills Building, 15 Broad St., New York City.

Cyrus Garnsey, Jr., has been appointed assistant fuel administrator. He will be in general charge of the administrative work of the Fuel Administration.

J. M. Riordan, until recently sales engineer of the Grant Lees Gear Co. of Cleveland, and formerly representing the Fellows Gear Shaper Co., of Springfield, Vt., in the Central States, is now connected with the sales organization of the Cleveland Milling Machine Co., 18,511 Euclid Ave., Cleveland, Ohio.

John A. Stevens and associated engineers, of Lowell, Mass., were presented the medal by the National Association of Cotton Manufacturers, at the Hotel Biltmore, New York, on May 3, for their paper on "The Evolution of the Steam Turbine in the Textile Industry," presented at the annual meeting of the association which was held in Boston, Apr. 25-26, 1917.

Engineering Affairs

The International Railway Fuel Association will hold its tenth annual convention at the Hotel Sherman, Chicago, May 23-24. Representatives of the United States Railroad Administration and the United States Fuel Administration will take a large part in the activities.

The New York Chapter of the American Association of Engineers will hold its annual election of officers at the Hotel McAlpin on May 22, at 8 p.m. G. A. Harris, chief engineer of the American Steel Export Co. will deliver an address on "The Opportunities for the American Engineer in the Export Field."

The Society for Electrical Development, Inc., held its annual meeting on Tuesday, May 14, at the offices of the society in New York. James R. Strong presided. The general manager read his annual report, reviewing the work of the society during the past year and suggesting activities for the coming year. At the Board of Directors' meeting which followed the annual meeting, it was decided to continue the work of the society for another year upon the present basis and to conduct a "Convenience Outlet" campaign as suggested by the general manager. An appropriation was made to carry on the campaign along national lines, similar to the "Wire Your Home" and "America's Electrical Christmas" campaigns. The officers elected for the ensuing year were: Henry L. Doherty, reëlected president; Joseph E. Montague, vice president and as a member of the executive committee; Gerard Swope, chairman of the executive committee; James M. Wakeman, reappointed general manager; James Smleton, Jr., secretary and treasurer.

Miscellaneous News

A High-Pressure Steam Pipe exploded in the testing room of the Sturtevant Blower Works at Hyde Park, Mass., on May 9, killing one man and injuring three others. The men were testing a turbine engine, forcing steam into it through a pipe 2½ in. in diameter, which broke, one section of it going through the wall of the building.

Business Items

The Brown Instrument Co., of Philadelphia, will open a new office at 2086 Railway Exchange Building, St. Louis, June 1, in charge of Paul H. Berggreen.

The Lehigh Foundry Co. and the Lehigh Car, Wheel and Axle Works, of Fullerton, Penn., have been merged into one organization to be known as the Fuller-Lehigh Co., with office and works at Fullerton. The properties of the two companies are adjoining and have been under the same management for a number of years. The change therefore is one of name only, the executive personnel remaining the same. J. W. Fuller is president.

The Joseph Dixon Crucible Co. at its annual and regular meetings on Apr. 15 elected the following directors and officers: Directors: George T. Smith, George E. Long, William G. Bumsted, Edward L. Young, J. H. Schermerhorn, Harry Dailey, Robert N. Jennings. Officers: George T. Smith, president, George E. Long, vice president, J. H. Schermerhorn, vice president, Harry Dailey, secretary, William Koester, treasurer, Albert Norris, assistant secretary and assistant treasurer. The American Graphite Co., Inc., is a subsidiary of the Joseph Dixon Crucible Co. and on the same day elected the following officers: George T. Smith, president, George E. Long, vice president, J. H. Schermerhorn, treasurer, Harry Dailey, secretary. The directorate is the same as that of the Joseph Dixon Crucible Co.

NEW CONSTRUCTION

Proposed Work

N. H., Manchester—The Manchester Traction Light and Power Co. is receiving bids for the erection of a 25 x 45 ft. addition to its power house. F. W. Gray, Elm St., Arch. Noted May 14.

Mass., Boston—The Board of Education will receive bids until May 24 for the installation of a heating system in 2 schools. About $10,000.

Mass., Canton—The Springdale Finishing Co., Pine St., will build a 2 story, 45 x 50 ft. reinforced concrete, steel and brick power house. Estimated cost, $25,000. Noted Apr. 30.

Mass., Dedham—The Cochrane Manufacturing Co., 56 Barrett Ave., Malden, will soon receive bids for the erection of a power house, transmission line and dam here. E. Worthington, Engr.

N. Y., Buffalo—The Buffalo Cereal Co., Chamber of Commerce, is having plans prepared for the erection of a 40 x 40 ft. power house in connection with its new plant.

N. Y., Buffalo—The Lamoka Electric Water Power Corporation has been given a franchise by the State, permitting it to use the waters of Little and Lamoka Lakes to generate electric power.

N. Y., New York—The B. L. M. Bates Corporation, Hotel Belmont, is in the market for boilers and superheaters. Estimated cost between $66,000 and $70,000. Warren & Wetmore, 16 East 37th St., Arch.

N. Y., New York—The United Electric Light and Power Co., 130 East 15th St., has purchased a site and plans to build an electric power station. J. G. Swallow, Supt.

N. Y., Olean—The Olean Electric Light and Power Co. plans to purchase additional equipment. F. G. Tennant, Gen. Supt.

N. Y., Schenectady—The American Locomotive Co., North Jay St., is having plans prepared for the erection of a 120 x 175 ft. addition to its boiler house.

N. Y., Syracuse—The Syracuse Lighting Co. is having plans prepared for the erection of an electric lighting plant on South Warren St.

N. J., Bayonne—The Elco Works, Ave. A and North St., plans to build a new power plant and install equipment including 2 direct connected engines, 400 hp. each; direct current generators, 250 kw., 25 volts with four 250 hp. boilers, etc.

N. J., Mays Landing—The Bethlehem Loading Co. will build a power plant near the South River in connection with its plant. C. J. Sittinger, Power Engr.

N. J., Ogdensburg—The New Jersey Zinc Co. plans to build a 1 story power house here. Estimated cost, $15,000. A. Lee, 55 Wall St., New York City, Purchasing Agent.

N. J., South Plainfield—The Spicer Manufacturing Co. has plans under consideration for the erection of a new power house in connection with its plant.

Penn., Bethlehem—The Bethlehem Electric Co. plans to issue $50,000 bonds; the proceeds will be used to build additions and make improvements.

Penn., Elwood City—The Pennsylvania Power Co. has purchased a 5 mile site on the water front in the Turkey Hill section, and plans to build a dam. L. B. Round, Supt.

Penn., Philadelphia—J. Bromley & Sons has awarded the contract for the erection of additions and improvements to its boiler plant at Front and Dauphin St., to G. W. Stewart & Co., 2123 Germantown Ave.

Penn., Philadelphia—City will soon award the contract for improvements to its power plant. W. H. Wilson, Director of Public Safety.

Penn., Pittsburgh—The Pittsburgh Modern Laundry Co. is having plans prepared for the erection of a new power plant in connection with its proposed plant. Estimated cost, $60,000. P. W. Irwin, Renshaws Bldg., Arch.

Penn., Wescoesville—The Commissioners of Lehigh County are considering the erection of a boiler plant. T. Moyer, 824 Hamilton St., Allentown, Arch.

N. C., Gibsonville—The Gibsonville Milling Co. plans to build an electric power system from here to Summers Mill.

N. C., Gliden—R. O. Blanchard is in the market for electrical and water power machinery.

La., Ville Platte—The Town will receive bids until June 4, for the erection of an addition to its electric lighting plant and line. Estimated cost, $5000. Work will include the installation of a 35 kw. alternator, setting 1 motor driven pump, switchboard, series lighting transformer and regulator, moving and repairing 1 Mietz and 1 Weiss engine and General Electric generator. Address A. C. Jones, Opelousas, La.

Tenn., Rutherford—City voted to issue $10,000 bonds for the installation of an electric lighting plant.

Ohio, Cincinnati—The Union Gas and Electric Co. plans to install a third generating unit.

Ohio, Marion—The Delaware and Marion Ry. Co. has geen granted a franchise by Marion Co. Commissioners, to erect a 10-mile transmission line from here to Caledonia.

Ohio, Youngstown—The Hydraulic Gas Power Co. has increased its capital stock from $200,000 to $300,000; the proceeds will be used to build additions to its plant.

Ill., Chicago—C. A. Brown, c/o C. E. Frazier, 30 North Darhorn St., is in the market for a low pressure steam heating plant for its truck body factory on 35th and Shields Sts.

..**Ill., Chicago**—The Chicago United Theaters Incorporated, c/o W. W. Alschuler, Arch., 111 West Washington St., plans to install a low pressure steam plant in its 2 story, 136 x 150 ft. theater on 63rd and Union Sts.

Wis., Milwaukee—City is in the market for one 125 brake hp. alternate current motor and one 20 in. centrifugal pump. Estimated cost, $2000.

Minn., Caledonia—The Root River Power and Light Co., Preston, plans to extend its electric system from here to Houston. A. H. Hanning, Preston, Mgr.

Kan., Baxter Springs—E. D. Nix, L. D. Knight and C. M. Mitchell, mine owners, plan to install equipment in their zinc mine. The installation includes engines, boilers, etc. C. M. Mitchell, Supt.

Kan., Wichita—The St. Francis Hospital is having plans prepared by E. Forsblom, Arch., 403 Winne Bldg., for the erection of a 2 story, 49 x 68 ft. power house and laundry. Estimated cost, $20,000.

Mont., Scoby—School District No. 1 will receive bids about June 15, for the installation of a heating plant here. Estimated cost, $15,000.

Mo., Seneca—The Oklamo Mining Co. plans to install engines, boilers, etc., in its lead mine. C. B. Bettis, Joplin, Pres. C. T. Jobes, Supt.

Ark., Lamar—The Peoples Service Co., 312 Barnes Bldg., Muskogee, Okla., has secured a franchise to establish an electric lighting plant here.

Tex., Del Rio—City plans to install an electric lighting plant.

Okla., Jennings—City voted to issue $25,000 bonds for the installation of an electric lighting plant. Noted May 14.

Okla., Miami—City plans to build a power and water plant. Estimated cost, $250,000. Bids are now being received for the new equipment for same.

N. M., Portales—City plans an election soon to vote on $20,000 bonds for the erection of an electric light and power plant. W. H. Braley, Clerk.

Ariz., Nogales—The Arizona Gas and Electric Co. has petitioned the State Corporation Commission for authority to issue $100,000 bonds; the proceeds will be used for the installation of an additional generating unit, etc.

Ore., Klamath—The Pacific Gas and Electric Co., 445 Sutter St., San Francisco, Calif., the Northern California Power Co. and the California Oregon Power Co. plan to build a 300 mi. transmission line from the Klamath River plant of the California Oregon Power Co. to San Francisco bay district. This work and many other improvements will cost about $1,000,000.

Ont., Bridgeburg—The Board of Education plans to install a heating system in the Phipp Street school. An appropriation for $10,000 is before the aldermanic board for same.

Sask., Regina—A. Beach, City Clerk, is in the market for electrical equipment for lighting. About $200,000 will be expended.

CONTRACTS AWARDED

R. I., Pawtucket—F. W. Taylor, 438 Main St., has awarded the contract for the erection of a 1 story, 65 x 80 ft. boiler house in the rear of Oak Hall Bldg., to J. W. Bishop Co., Butler Ex.; 4 new boilers will be installed.

N. Y., Albion—The Western House of Refuge has awarded the contract for the erection of an addition to its boiler plant, to H. C. Belson, Albion.

N. Y., Brooklyn—The Arabol Manufacturing Co., 100 William St., New York City, has awarded the contract for the erection of an addition to its boiler plant, to J. H. Deeves & Bro., 103 Park Ave., New York City. Noted Mar. 19.

N. Y., Brooklyn—The Brooklyn Gas Co., 176 Remsen St., has awarded the contract for the erection of a 30 x 40 ft. addition to its boiler plant, to J. H. Deeves & Bro., 103 Park Ave., New York City.

N. Y., Brooklyn—The Flatbush Gas Co., Clarkson St. and Kingston Ave., has awarded the contract for a 1 story, 30 x 40 addition to its boiler house, to J. H. Deeves & Bro., 103 Park Ave., New York City.

N. Y., New York—The Interborough Rapid Transit Co., 120 Bway., is building a transformer station on East 57th St. Estimated cost, $45,000.

Penn., Philadelphia—The Germantown Steam Heating Co., has awarded the contract for alterations and additions to its power house on Pelham Rd. and Hortter St., to W. O. Springer, 349 West Hortter St.

Penn., Philadelphia—The Philadelphia and Reading R.R., Reading Terminal, has awarded the contract for the erection of a 1 story, 44 x 78 ft., brick, concrete and steel power house at Tulip and Somerset St., to Pringle Borthwick, 8018 Germantown Ave. Estimated cost, $30,000. Noted Nov. 27.

Md., Baltimore—Roberts Bros., Wolfe and Preston St., has awarded the contract for the erection of a cannery, to P. J. Cushen, 117 St. Paul St. Estimated cost, $13,065. The work includes the construction of a boiler house, warehouse, etc.

Ohio, Akron—The Wellman Seaver Morgan Co., 260 Kenmore Blvd., has awarded the contract for the erection of a power house, to the G. A. Fuller Co. Estimated cost, $30,000.

Ohio, Columbus—The U. S. Government has warded the contract for the erection of the Columbus Quartermaster Interior Depot, to Hunkin Conkey Co., 321 Cuyahoga Bldg., Cleveland. The work includes the erection of an electric light and power plant, etc.

Ill., Chicago—P. J. Hursen, 4446 West Madison St., has awarded the contract for the erection of an undertaking establishment to McCarty Bros., 10 South La Salle St. A new steam heating plant will be installed.

Ill., Chicago—The Illinois Central R.R. has awarded the contract for the erection of a new electric power plant at 98th St. and Cottage Grove Ave., to J. E. Nelson & Sons, 118 La Salle St. Estimated cost, $60,000.

Neb., Falls City—City let contract building 1 story, 50 x 110 ft. power house, to Bohrer Bros., Falls City. Noted Feb. 8.

Que., Drummondville—The Southern Canada Power Co., on St. Francis River, has awarded the contract for the erection of a power house and dam, to Morrow & Beatty, Ltd., Peterboro. Work includes the erection of an 80-mile transmission line.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.00	$4.35	$3.90
Barley	2.15	1.50	2.40	1.75
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.65-3.00	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed	2.15-2.50	2.15-2.35	2.15-2.35

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cababa	2.40	2.65	2.15

Government figures.

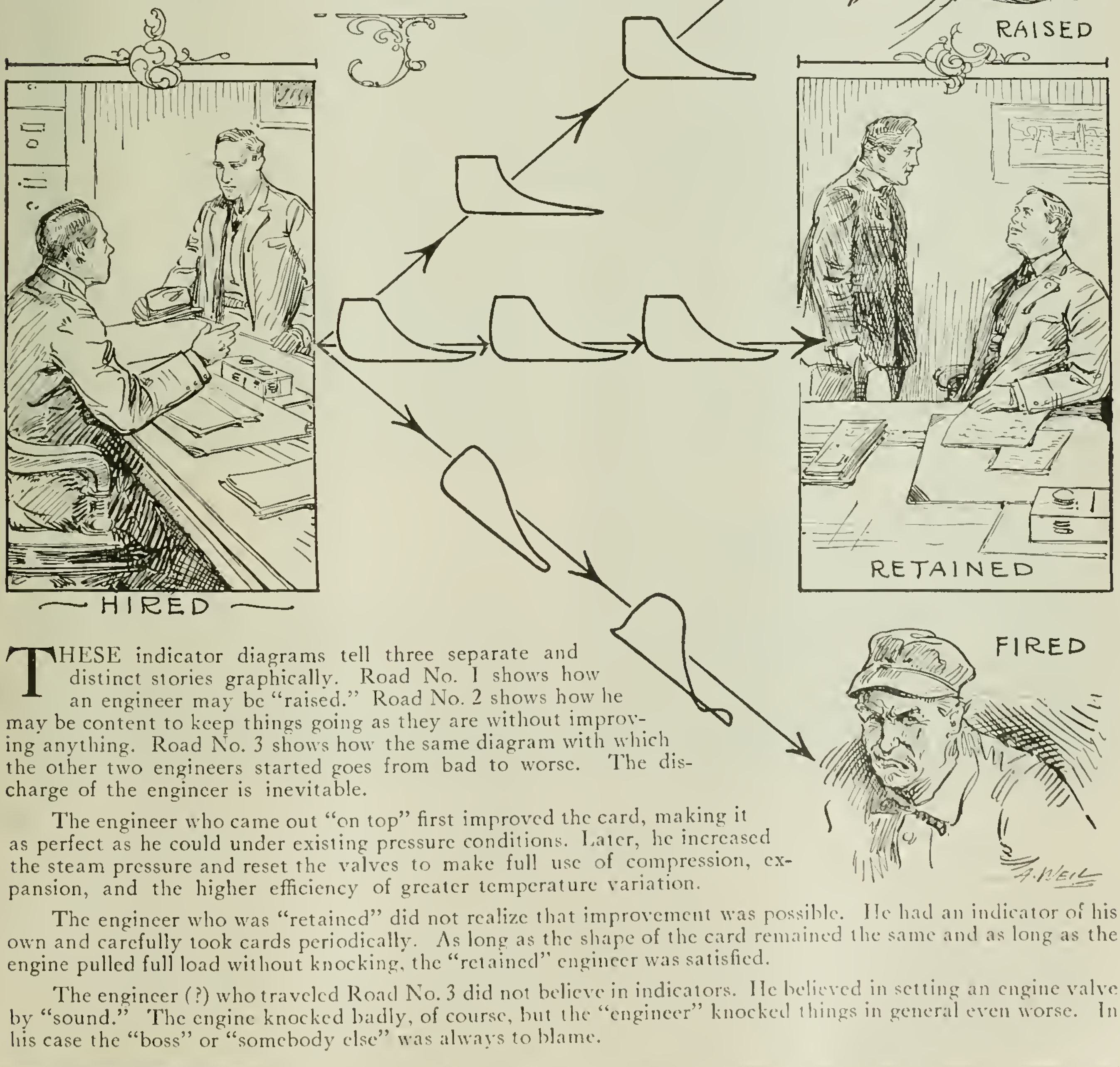
Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, MAY 28, 1918 No. 22

Three Roads

By N. G. NEAR



THESE indicator diagrams tell three separate and distinct stories graphically. Road No. 1 shows how an engineer may be "raised." Road No. 2 shows how he may be content to keep things going as they are without improving anything. Road No. 3 shows how the same diagram with which the other two engineers started goes from bad to worse. The discharge of the engineer is inevitable.

The engineer who came out "on top" first improved the card, making it as perfect as he could under existing pressure conditions. Later, he increased the steam pressure and reset the valves to make full use of compression, expansion, and the higher efficiency of greater temperature variation.

The engineer who was "retained" did not realize that improvement was possible. He had an indicator of his own and carefully took cards periodically. As long as the shape of the card remained the same and as long as the engine pulled full load without knocking, the "retained" engineer was satisfied.

The engineer (?) who traveled Road No. 3 did not believe in indicators. He believed in setting an engine valve by "sound." The engine knocked badly, of course, but the "engineer" knocked things in general even worse. In his case the "boss" or "somebody else" was always to blame.

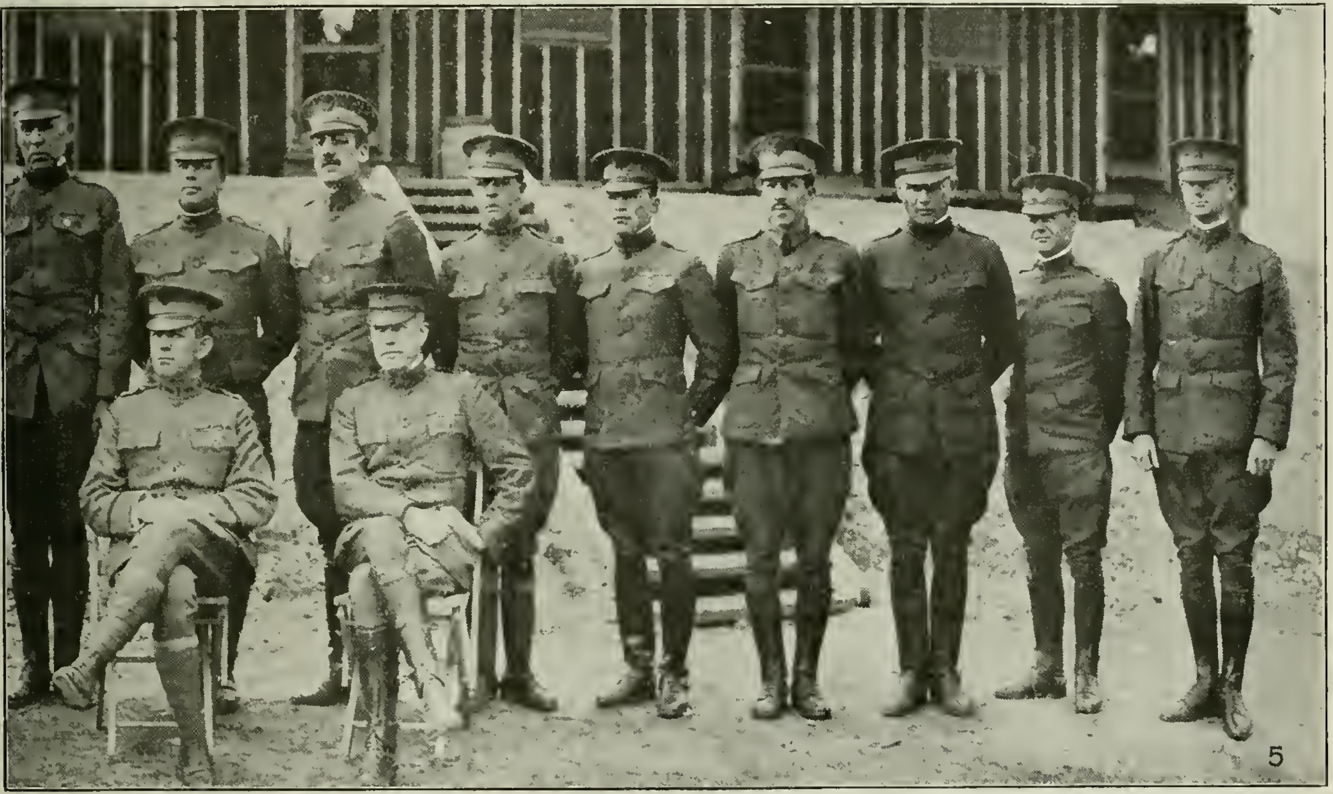
Meeting of the American Society of Mechanical

PERSONS AND PLACES OF INTEREST TO THOSE ATTENDING THE SPRING

Fig. 1—Boynton Hall (Administration), Polytechnic Institute; sessions will be held here. Fig. 2—Worcester Trade School. Fig. 5—Major General Hodges (third officer seated) and Staff, Camp Deven, Ayer, Mass.; the camp will be visited Fig. 8 New Boiler House, The Norton Co. Fig. 9—General View of Part of the

WORCESTER is the home of two past presidents of the society, namely, Charles H. Morgan and Dr. Ira N. Hollis. The city owes its place as a manufacturing center to the several buildings where power was furnished to tenants who eventually built factories for themselves in the city as their business grew. Some of these old buildings are still standing, and from one of them the other day an old Corliss engine, built in 1852, was removed. The Worcester Polytechnic Institute was started with the assistance of John Boynton, who made his money as a peddler and who contributed liberally to the fund that built old Boynton Hall. The lock system of the Panama Canal is said to be patterned after the locks in connection

Engineers, Worcester, Mass., June 4, 5, 6 and 7



MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Fig. 3—Electrical Laboratory, Worcester Polytechnic Institute. Fig. 4—Mechanical Engineering Laboratory, Polytechnic Institute. Fig. 6—Bancroft Hotel where those attending will register. Fig. 7—New Plant, Worcester Electric Light Co. Works of the Norton Co. which will be visited by those attending.

with Clinton Dam, near Worcester, which those attending the meeting will visit. Worcester has high- and low-pressure water systems, both of the gravity type; high-pressure, 150 lb., low pressure 85 lb. Camp Deven is but twenty-six miles from Worcester and is one of the large army cantonments. Worcester's population is 200,000, and 3,000,000 people are within fifty miles.

The Fuel Session, scheduled for Thursday, June 6, promises to be a most interesting one; it was arranged for by the Fuel Conservation Committee of the Engineering Council. A. A. Potter, Dean of the Engineering Schools, University of Kansas, will read a paper on "An Investigation of the Fuel Problem in the

(*Continued on page 762*)

Figuring Furnace-Grate Area

Various more or less confusing ideas are held by engineers and stoker manufacturers regarding the figuring of grate area. Every manufacturer has some rule based upon his experience with his particular equipment. This article sets forth the rules followed by a number of manufacturers as to what is considered active grate and as to whether actual or projected grate area is used in figuring the grate area of their stokers.

If a boiler containing 5000 sq.ft. of heating surface were to be installed, how much grate area would you put in the furnace and how would the grate area of the various types of stokers manufactured be figured? In the general run of power plants the ratio of grate area to the boiler-heating surface averages about 1 to 56. This ratio is as low as 1 to 48 and as high as 1 to 69 in individual cases. One power plant now in operation is so overstokered that the ratio is about 1 to 27. From the prevailing custom it would appear that a boiler plant is designed for so many square feet of heating surface per boiler horsepower (usually 10 sq.ft.) and that the grate area is put in, not in accordance with any standard usage, but to conform to whatever ratio the designer may favor.

However, assuming that one square foot of grate area is allowed for each 50 sq.ft. of boiler-heating surface, how is the area of the grate to be figured?

The view of one stoker manufacturer is that most of them seem to hold to some rule based upon their experience with their particular equipment, and it would seem that for any particular make of stoker whatever the manufacturer considers as grate surface should be considered as the grate area of the stoker in engineering problems. The manufacturer's rules for stoker area apply to the amount of coal that can be burned per square foot of grate surface per hour with varying conditions of draft, and these rates of burning are commonly used in proportioning a stoker for the load conditions to be met.

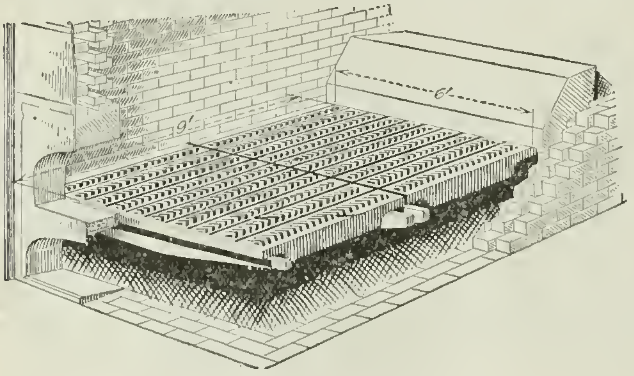


FIG. 1. ORDINARY HAND-FIRED FURNACE

Taking the double inclined type of stoker, if the manufacturer makes a practice of estimating 30 lb. of coal per square foot of projected area of the grate surface, and assuming that the data on this basis are the most reliable source of information that can be obtained, therefore on figuring up stoker sizes where the manufacturer's datum of 30 lb. of coal is used, the stoker should be rated or considered on its projected area. Under these conditions where but one stoker is considered, it appears that it makes no great difference what is considered as grate area so long as the same area is used as when computing the pounds of coal burned per square foot of grate surface per hour.

Another feature of the question of grate surface is the comparison of, say, 100 sq.ft. of, say, a single inclined gravity fuel stoker with, for instance, 100 sq.ft. of chain-grate area. There would be an extreme difference in the nature of the fuel bed of the two stokers and in the difference in air spaces, and for these reasons there cannot be any just comparison as to the performance of a square foot of grate surface per hour of one of these stokers with a square foot of the other type. One chain-grate stoker manufacturer states that under similar conditions his stoker can burn twice as much bituminous coal per square foot of area as can be burned with either a single or double inclined stoker, and this regardless of how the grate area is computed.

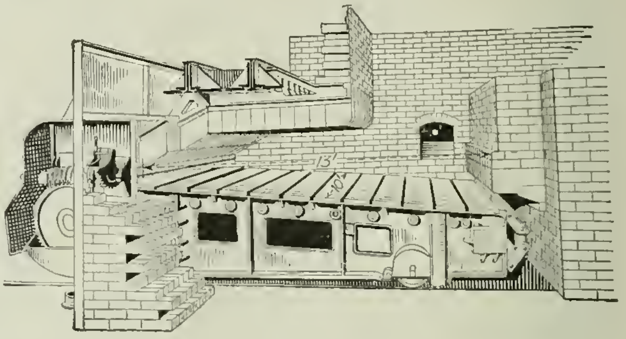


FIG. 2. INCLINED CHAIN-GRATE STOKER

This statement emphasizes what has been said—that the important thing is the performance that can be secured with a unit of grate area. This is emphasized by a consideration of the underfeed stoker which is rated on the performance of the retorts of specified dimensions.

Figuring the grate area of a chain-grate stoker is the same as calculating that for an ordinary horizontal hand-fired grate; that is, the width times the length, as shown in Fig. 1, the width of the grate being 6 ft. and the length 9 ft. The grate area would therefore be 6 × 9 = 54 sq.ft. Although the dead-plate is within the furnace walls, it is not figured as grate area.

In the case of the chain-grate stoker the normal length of the grate is figured, the normal length being the distance from the inside of the stoker feed gate to the front side of the bridge-wall or water-box when so equipped, or to the flexible bridge-wall of other design. The normal length of the grate times the width between the furnace walls at the fire line equals the grate area. Thus if the grate is 13 ft. long between the feed gate and the water-back and the width of the grate is 10 ft., the grate area would be 10 × 13 = 130 sq.ft. Some chain-grate stokers are placed level and others are on an incline, as shown in Fig. 2, the pitch being approximately ¾ in. to the foot. Thus a grate 10 ft. long would be 7.5 in. lower at the rear end than at the front. The difference in length due to the inclined grate over one set level is so small that no difference is made in calculating the area.

The type of stoker having both flat and inclined surfaces presents another phase in area calculation. Both are figured as active grate area, the actual area being considered. For instance, in Fig. 3, assume that the flat grate is 4 x 6 ft. and each of the inclined is 2 x 6 ft., then the total area of the grates would be (4 × 6) + (6 × 2 × 2) = 48 sq.ft. This method of figuring is in accordance with the assumption that active grate area, whether flat or inclined, is that part that is provided with air available for burning fuel.

Considering the front inclined type of stoker, Fig. 4. the total grate surface with the approximate dimensions is 8 x 10 ft. This is all grate surface between the front wall and the vertical portion of the bridge-wall including the dump plate. The effective grate surface includes the full width of the grate, which is 8 ft., and the distance from the top grate bar to the bottom grate bar measured on the inclined plane or the length 9 ft. or 8 × 9 = 72 sq.ft. In the type of stoker shown the area of the dump plate is not considered as effective grate surface, which is as it should be.

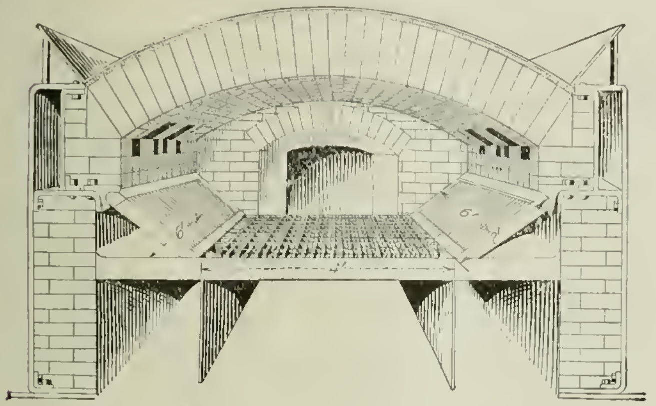


FIG. 3. COMBINED FLAT AND INCLINED GRATE

One would suppose that the method of figuring a front gravity-feed stoker would be the same as with a gravity side feed. However, the substance of what a manufacturer of the latter type says is to the effect that in stating the grate surface either the projected or the actual grate surface is specified. To figure the former the actual flat area is taken the same as with a flat grate. In figuring the actual area the length of the grate from the feed opening to the lower end of the grate is taken and this is multiplied by the depth of the furnace. This company uses one method about as frequently as the other. In drawing up specifications engineers usually specify either actual or projected area and the manufacturers specify accordingly. The actual area is approximately 25 per cent. greater in the side gravity-feed stoker than the projected area. Fig. 5 shows the type of stoker and the difference between the method of calculating the area. With the figures given the projected area would be 11.5 × 10 = 115 sq.ft. and the actual area would be 10 × 7 × 2 = 140 sq.ft., a difference of 25 sq.ft., or 22 per cent. greater actual than the projected area. The clinker-grinding portion of the stoker should not be included in the actual grate area.

In considering the underfeed stoker, Fig. 6, a difference of opinion seems to exist. One type makes use of dump plates, and these are included as projected area which is used in figuring this type of grate, as the slant of the grates at either side of the feeding trough is but slight.

A similar type of stoker does not take into consideration the grate area of the furnace as related to the coal-burning capacity. Each underfeed stoker is usually figured on the coal-burning capacity of the retort and the tuyere area, and this has nothing to do with the grate area. Furnace width, however, is taken into consideration in connection with the kind of coal burned, as if the fuel is high in refuse a greater furnace width is desired. The coal-burning capacity of an underfeed-stoker retort is dependent upon the quality of the coal and the percentage of refuse. The relation of fixed carbon and volatile matter is also important. In underfeed stokers, combustion is due to the tuyere area itself and not to any auxiliary grate area or to any combustion that may take place on any dumping plates. The underfeed principle involves the distillation of the gases at the point below the incandescent bed of fire and not on top of the grates or dump plates. Where these are resorted to increase the coal-burning capacity, the stoker system becomes a combination of underfeeding and overfeeding as the combustion on the grates and dump plates is the same as on any other system of overfeed fires.

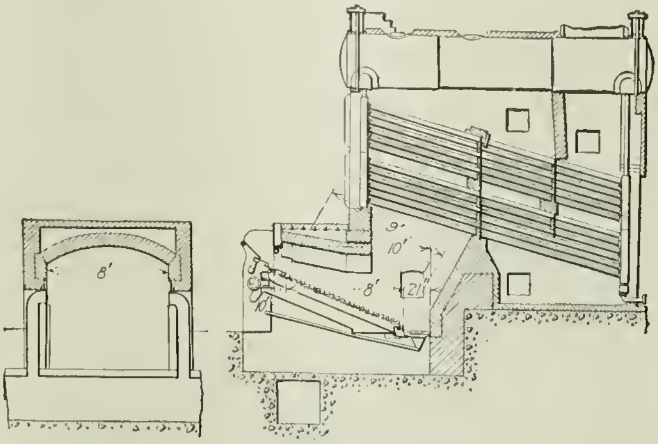


FIG. 4. FRONT GRAVITY-FEED INCLINED STOKER

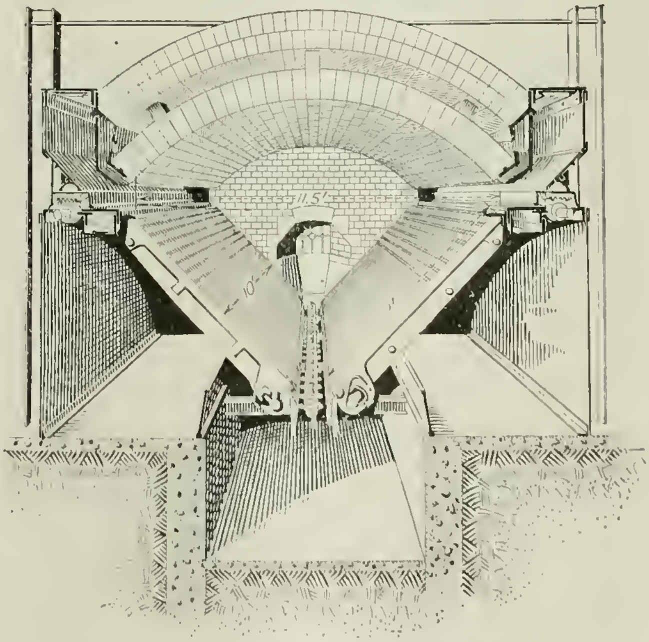


FIG. 5. SIDE GRAVITY-FEED STOKER

An inclination of the tuyere line does not affect the coal-burning capacity, and therefore there is nothing but the actual area of the air space of the tuyere to be taken into consideration. When using an underfeed stoker, any lack of furnace area due to a narrow furnace can be compensated for by securing increased room for combustion by elevating the boilers. From this it is evident that the area has nothing to do with the coal-burning capacity of an underfeed stoker.

Considering the front-feed inclined type of underfeed stoker, Fig. 7, the part of the stoker that supports the fuel and delivers air under pressure for the burning of coal should be considered as grate area; and as has already been stated, grate surface is a somewhat meaningless term and one that is misleading when used in connection with this type of stoker.

One manufacturer states that ordinarily when specifying grate area, it refers to the projected area of the stoker on a horizontal plane and includes the entire area bounded by the brick walls. Of course every portion of this area is available for the burning of some combustible. However, in his own practice for the purpose of design quite a different area is used. For instance, an imaginary line is established above the air openings which it is assumed represents the surface that is reached by the air discharged from the tuyeres and grate openings. This line establishes an imaginary active grate surface, and the projected area of this grate surface is what is termed active grate surface.

Grate surface actually means but little, as the important factor is the admission and distribution of air, and the method of determining grate area as outlined in the foregoing seems to be fairly consistent in so far as the type of stoker with which it is used goes. The imaginary surface is approximately 13 in. from the air openings and on a line with them and makes each retort of the stoker practically 13¾ sq.ft. projected area.

One builder of this type of stoker uses a double-leaf dump, of which there are two types. In one design the rear leaf of the dump is not supplied with air under pressure, and the grate area should stop at the end of the forward dump; the rear dump is not considered as grate surface. The other type has a rear dump designed to supply air under pressure from a main air duct, and since this dump can be covered with fuel, the manufacturers consider it active grate surface. Where crushing rolls are used for removing ash from the furnace, they should not be included as active grate surface.

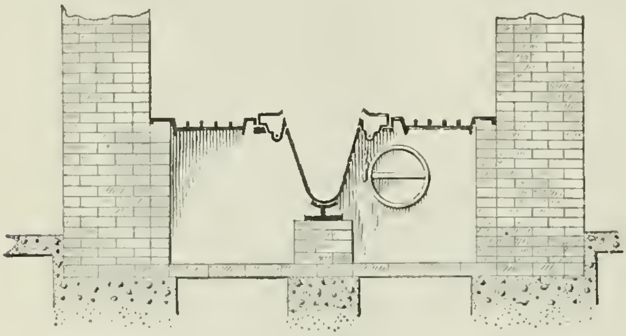


FIG. 6. ONE TYPE OF UNDERFEED STOKER

One manufacturer, when making a statement as to the grate area of the front gravity fuel underfeed stoker, always specifies whether the projected or the actual area is given because there is no standard method of determining the grate surface and the figures may be misleading unless it is specified whether actual projected area is being considered.

Another manufacturer of the last type of stoker under consideration holds views contrary to the other, as regards considering the dump plate as grate area. In this instance the usual practice in figuring the square feet of grate surface is to use the projected area of the stoker including the dump, as it is claimed that the combustion actually takes place from the front wall clear back to the bridge-wall. The reason for including the dump as grate area is because the path of least resistance for the air through the fuel bed is generally toward the bridge-wall, and even if there is no definite air supply at the rear end of the stoker, there is still ample air coming through from the fuel bed above to maintain active combustion. For this reason the makers of this stoker claim that it is legitimate to include the dump as grate area when figuring the grate surface of the underfeed stoker.

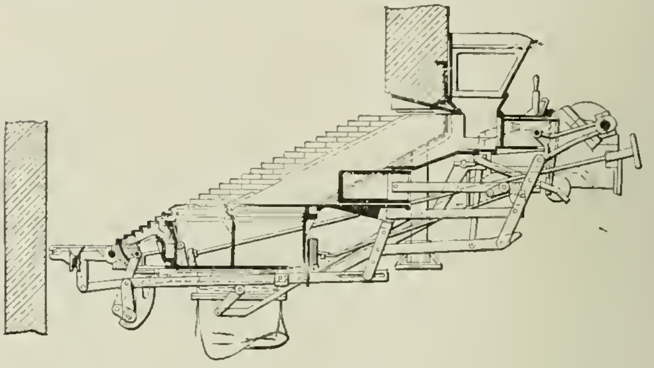


FIG. 7. FRONT-FEED INCLINED UNDERFEED STOKER

In considering the underfeed type of stoker, the volume of coal in the retort below the end of the tuyeres, the throat under the front of the plungers and the total volume of coal, which includes that in the retorts, and the thickness of the fire over the surface of the stoker, are of importance. The fuel total volume thickness averages about 1 ft., an average ranging from 18 to 24 in. at the thickest part of the fuel bed to 6 or 8 in. at the lower end and dump plate. The most satisfactory comparison of an underfeed stoker is to get the ratio between the retort volume and the total volume, or between the retort volume and the grate surface.

Boiler Capacity Depends

The active heating surface in a boiler will evaporate from 3 to 6 lb. of water from and at 212 deg. F. per square foot per hour, and 34.5 lb. of water per hour "from and at" is the standard rate of evaporation per boiler horsepower; therefore anywhere from 5½ to 12 sq.ft. of heating surface is required per boiler horsepower. This great variation in evaporative capacity is not necessarily inherent in type, design or installation. A boiler capable of the best performance may under unfavorable conditions be doing no better than the poorest. Neglect of the heating surface, inside and outside, is one of the most frequent causes of reduction in capacity.

The dollar that you contribute to the Red Cross Fund may save the life of one of our boys in France.

"Resisto" Furnace Paint and Putty

One of the certainties of boiler-room practice is that the fire-brick lining of the furnace will burn out sooner or later, depending upon the intensity of the fire. Renewing the lining is expensive, to say nothing of the loss of the boiler while the work is being done. The need for a furnace material that will withstand the high temperatures now maintained is well known, and although there has been a great advancement in the construction of such material, there still remains much to be desired.

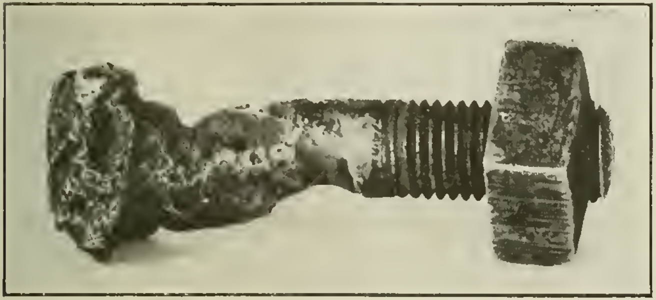


FIG. 1. PART OF BOLT NOT COVERED WITH THE PUTTY FUSED AND BURNED

Although there are several fire-resisting compounds on the market, one known as Dunbar's "Resisto," and manufactured by Wm. Clifford & Sons Co., 358 Union Ave., Elizabeth, N. J., seems to have the necessary qualifications for protecting firebrick, fire tile and iron from the effect of high temperatures. This fire-resisting compound comes in the form of a paint and a putty, and when used on furnace brick requires no drying out before starting the fires after the application.

Not only can this material be used for laying up new furnace brickwork in which ordinary fireclay is commonly used, but the putty is adaptable for pointing up old brickwork and for covering such metal as might be exposed to the furnace heat.

FIG. 2. BRICK THAT HAS BEEN PAINTED AND EXPOSED TO HIGH TEMPERATURE

In laying up new firebrick, they can be either dipped in the material or "buttered" in the usual manner. It is necessary, however, that they be clean, dry and free from grease or oil. After the work has been completed, it is coated with the paint and the furnace is then ready for use. When the brickwork is exposed to exceptionally high temperature, two coats of paint are advisable. When pointing up old brickwork the old joints must be cleaned out not less than one-half inch, given a coat of paint and then filled with enough putty to make a smooth surface.

Some idea of the heat-resisting properties of this compound and paint can be gathered from the illustrations. In Fig. 1 is shown what is left of a common wrought-iron bolt. The nut and threads were covered with a $\frac{3}{8}$-in. thickness of putty and the whole put in a blacksmith's forge and brought to a white heat. The part of the bolt not covered was fused and burned as shown. As the melting point of wrought iron is about 2550 deg. F., it shows that the bolt was subjected to a greater heat than obtains in the average boiler furnace under average conditions.

FIG. 3. BALL OF PUTTY AFTER BEING IN TEST FURNACE

The action of the paint may be seen in Fig. 2, which shows a piece of brick taken from a furnace bridgewall after four days' exposure to a temperature of about 2500 deg. F. The brick was given a coat of "Resisto" paint, which, when subjected to heat, vitrifies and forms a glazed surface, as shown by its slag-like appearance. Although the brick is in two pieces, the joints cannot be easily distinguished, thus showing that the furnace brickwork joints are protected against rapid deterioration.

Another example of the heat-resisting properties of "Resisto" is shown in Fig. 3, which is a photograph of a 2-in. diameter ball of putty that has been subjected to about 3000 deg. temperature in a test furnace. The test had to be discontinued before any effects detrimental to the putty could be noticed, as the furnace began to melt.

It would appear that where this material is used for furnace construction, it will strengthen the brickwork considerably, which, together with its heat-resisting properties, should obviate the necessity of rebuilding the furnace brickwork at such frequent intervals as has been the common practice.

Boiler Settings*

BY CHARLES H. BROMLEY

Associate Editor of "Power"

One of a number of articles on boiler settings for various stokers under the many different boilers adapted to high-volatile coals.

IT WOULD be well, at the beginning of these articles, to broadly consider boiler settings or, better, combustion volume, that one's perspective may be broadened, if need be. So much has been written on this subject that most engineers are convinced of the need of large combustion volume. But these articles are intended primarily to convince those who are not convinced, either because they are unfamiliar with the subject or because they are plainly obstinate. There are more of these people than most of us have allowed ourselves to believe there are. The secondary purpose is to present the most modern practice of setting boilers as related to improving combustion.

At least until very recently no really scientific thought was given to the relationship that should exist between combustion volume, kind of coal, combustion rate and excess air. In fact, few gave but the most superficial consideration to the subject. An example of this is illuminating: Within the month the writer asked two engineers what combustion volume per square foot of active grate surface they allowed in their boilers, volatile content of coal considered. One of these engineers is distinguished for his boiler work; the other has conspicuously contributed to power-station design and operation. The former did not know; the latter had "never looked at it that way." He sets his boilers as high as he can and lets it go at that. Obviously, this is working in the dark. Contrast this unscientific method with the elaborate research made to develop greatest efficiencies in turbine nozzles and ship propellers. Yet in the boiler the action is, for the most part, chemical and highly complex, while in both of the other cases it is mechanical. The first scientific attempt to determine the most suitable ratios of combustion

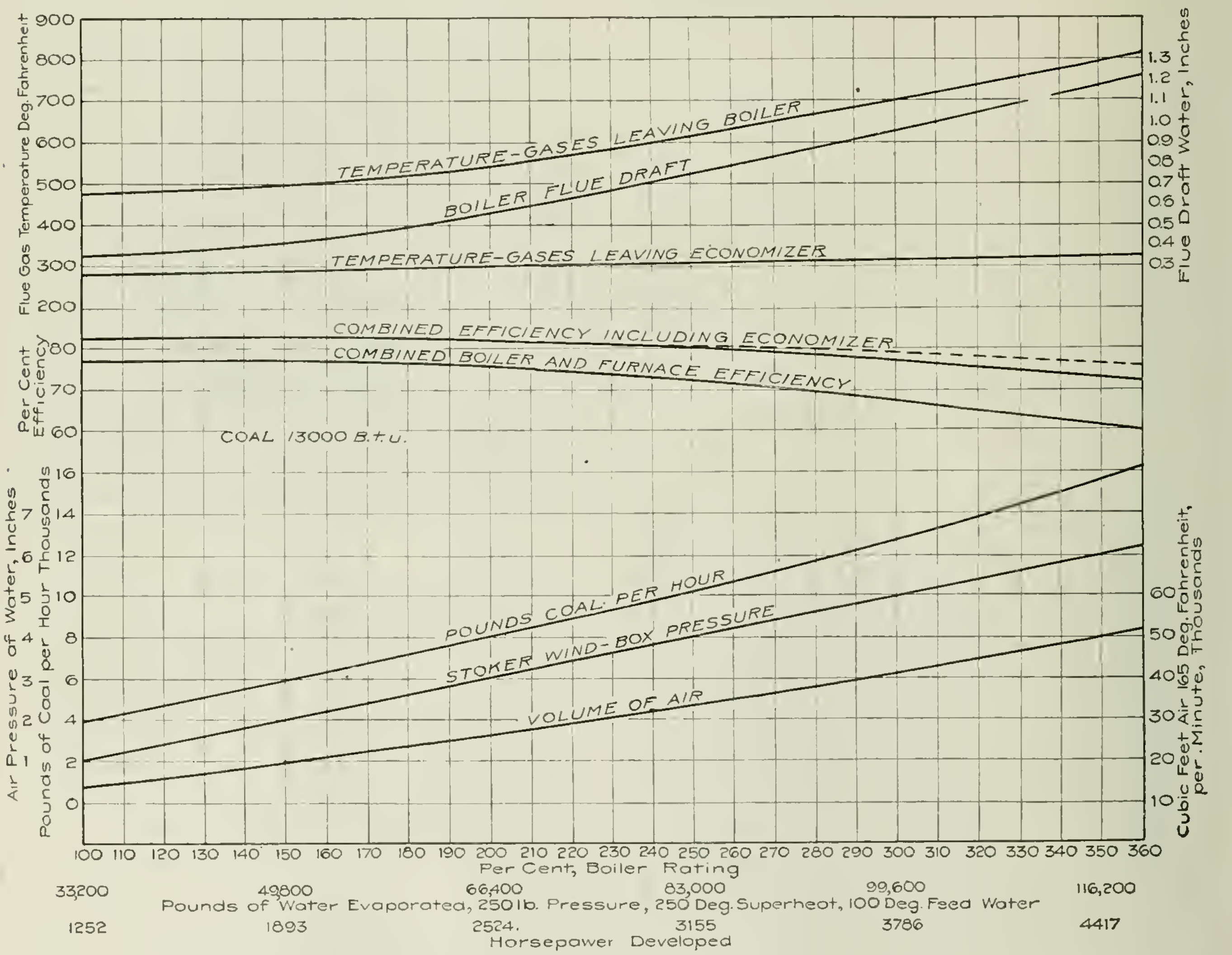


FIG. 1. PERFORMANCE CURVES, 13-RETORT UNDERFEED (WESTINGHOUSE) STOKER

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*For previous articles of this series see the following issues of "Power": "Zone System for the Distribution of Bituminous Coal," May 14, 1918. "Coals of the United States," May 21, 1918.

volume and combustion rate for particular coals that I know of were the experiments by Kreisinger, Augustine and Ovitz for the Bureau of Mines, reported in Bulletin No. 135, recently distributed. [This bulletin was reviewed by the writer in *Power* for Apr. 23, 1918.] E. H. Peabody, in that excellent paper, "Oil Fuel," presented before the International Engineering Congress, San Francisco, September, 1915, has three interesting paragraphs on the subject of furnace volume and combustion rate, on pages 103 and 104. But as to ratios or their equivalents, he merely points out that some relation exists between the heat liberated and the combustion volume, but is not specific as to these ratios.

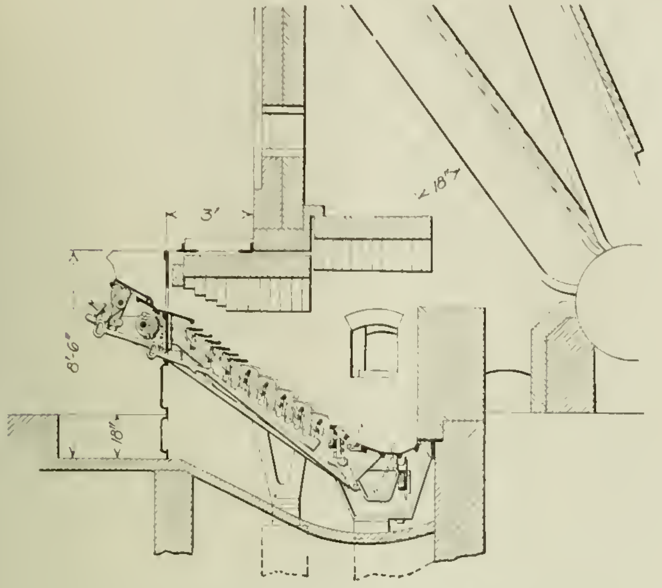


FIG. 2. SECONDARY ARCH ASSISTS IN MIXING AIR AND COMBUSTIBLE GASES

Tables I and II are from Bureau of Mines Bulletin 135; both are unusually interesting in combustion-volume studies.

TABLE I. CHEMICAL CHARACTERISTICS OF THREE COALS TESTED

	Pocahontas Coal	Pittsburgh Coal	Illinois Coal
1. Volatile matter in moisture and ash-free coal, per cent ...	18.05	34.77	46.52
2. Fixed carbon in moisture and ash-free coal, per cent	81.95	65.23	53.48
3. Carbon in moisture and ash-free coal, per cent ..	90.50	85.7	79.7
4. Volatile carbon in moisture and ash-free coal, per cent ..	8.55	20.47	26.22
5 Available hydrogen in moisture and ash-free coal, per cent .	3.96	4.70	3.96
6 Ratio of volatile carbon to available hydrogen, per cent . . .	2.16	4.35	6.[illegible]
7 Oxygen in moisture and ash-free coal, per cent .	3.32	5.59	10.93
8. Nitrogen in moisture and ash-free coal, per cent	1.19	1.73	1.70
9 Moisture accompanying 100 per cent. of moisture and ash-free coal, per cent.	2.53	2.88	22.07
10 Volatile matter times ratio of volatile carbon to available hydrogen (product of items 1 and 6)	39.00	151.00	307.00
11 Ratio of oxygen to total carbon, in moisture and ash-free coal... ..	0.0367	0.0652	0.137
12 Total moisture in furnace per lb. of coal reduced to moisture and ash-free basis, lb ..	0.409	0.501	0.70

That furnace volume alone will not necessarily give the most efficient combustion commercially is widely known. Complete mixture of air with the combustible gases is the all-important factor. This is shown by Bone's surface-combustion experiments; it is shown in the gas engine, and to a lesser degree in the underfeed stoker with its thick fuel bed. Above a limit of temperature, say 1200 to 1800 deg. F., mixture of air and combustible gases exerts a far greater influence upon the efficiency of combustion than temperature and furnace volume. In fact, furnace volume is merely an expedient to insure good mixture by lengthening the time of contact of gases and air.

If immediately above the fuel bed of an underfeed stoker there were placed a zone of high heat-resisting refractory material, broken in pieces and not so dense as to offer objectionable resistance to gas flow and protected against too rapid burning away by means of resting on water tubes integral with the boiler—in other words, using the stoker as a gas producer and passing the gas through an incandescent zone—it would likely be found that furnace volume could be materially decreased below present requirements with high-volatile coal and high combustion rates. Provision for further air admission and distribution between the fuel bed and refractory zone would of course be necessary; but it would be merely the presence of air that would be necessary, the broken refractory zone would insure good mixing because of the character of its porosity—and this zone would of course be very hot.

TABLE II. COMBUSTION SPACE REQUIRED FOR POCAHONTAS, PITTSBURGH AND ILLINOIS COALS

Completeness of Combustion, per Cent. Undeveloped Heat 1	Rate of Combustion Lb. per Sq Ft. of Grate per Hour 2	Excess of Air, per Cent 3	—Cubic Feet of Combustion Space per Sq.Ft. Grate— Pocahontas 4	Pittsburgh 5	Illinois 6
5	50	50	2.7	2.9	4.3
3	50	50	3.2	3.7	5.3
2	50	50	3.6	4.4	6.3
1	50	50	4.0	5.6	8.9
0.5	50	50	4.8	6.8	11.9
5	25	50	2.0	2.2	3.5
3	25	50	2.3	2.7	4.35
2	25	50	2.7	3.1	5.1
1	25	50	3.4	4.0	6.2
0.5	25	50	4.0	5.0	7.1

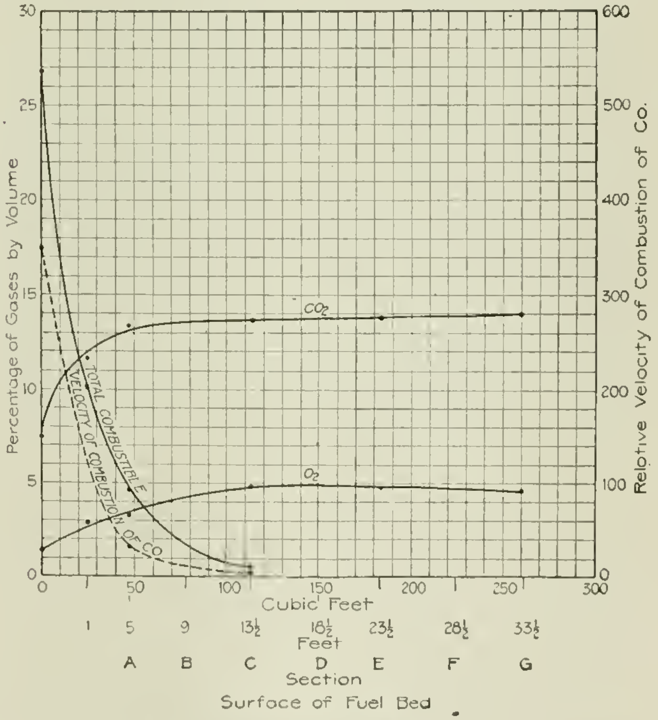


FIG. 3. NOTE INFLUENCE OF COMBUSTION VOLUME ON COMPLETENESS OF COMBUSTION

Most of us have regarded heat as the all-essential factor in combustion. Even now, unless we stop to check our thought, we regard the sole function of furnace arches as heat-radiating or reflecting surfaces.

We likely will soon universally see that except for short coking arches, the really important thing they do is to roll or scrub the gases and air and promote an intimate mixture of them *in the presence of high temperature.*

There is no question that this is the fact. Everyday boiler-room experience confirms it. Why is it that the underfeed stoker gets its efficient performance with no arches at all? Because the character of the fuel bed and air-admission areas insures a thorough mixing of air and gases within the fuel bed and in the presence of high temperature. With no arches whatever, an underfeed stoker will give an almost flat combined boiler-efficiency curve between 100 and 300 per cent. rating, and with economizers one can say, without being charitable, that it is flat. See Fig. 1.

SECONDARY ARCHES SOMETIMES SUPERFLUOUS

Secondary arches are usually at a considerable height above the fuel bed. Here they merely reflect heat and do not contribute appreciably to mixing the air and gases. They are sometimes superfluous, and when far removed from the fire in an ordinary boiler setting, are probably wholly superfluous. This is borne out by the gradual abandonment of the secondary arches on Stirling boilers of the usual class. Here the secondary arch is far from the fire and cannot exert an appreciable influence upon the fuel bed because of its distance from it, and does no good whatever in coking the coal, unless the grate is run too fast, because of the curtain wall between the coking and secondary arches.

That we too generally overlook the mixing function of arches is brought out by a statement to me by Mr. Stowe of the Laclede-Christy Clay Products Co., who, in discussing secondary arches in Stirling boilers, says that they have had no little difficulty in getting away from the secondary arch, customers insisting on their use until made thoroughly familiar with performance without them. And yet we chide marine engineers because they are slaves to precedent and custom!

A secondary arch may, however, in some settings, be useful for mixing the air and gases, provided the bridge-wall is continued high enough to form a narrow passage between the end of the bridge, wall and the end of the secondary arch, as in Fig. 2.

CHICAGO HAND-FIRED FURNACES

The excellent work of the Chicago Smoke Inspection Department under Monnett gave a memorable impetus to intelligent combustion under boilers. Though Monnett, Vial and Misostow, all of the Chicago department, did not aim to determine what ratios of furnace volumes and combustion rates were most suitable, they early found that smokelessness and economy were greatly improved by their attempts to obtain intimate mixture of air and gases in a high-temperature zone. Witness the hand-fired boiler settings developed while Monnett was chief of the Chicago Smoke Department. In all of these the chief function of the arches is that of mixing air and gases.

The curves, Fig. 3, show the effect of furnace volume upon efficiency of combustion. They are from Bureau of Mines Bulletin 135, already referred to. The stoker used was the Murphy set in a special furnace of 5 ft. square section beyond the stoker and 43 ft. 4 in. long. The coal burned was Pittsburgh screenings, and the combustion rate was 35.6 lb. coal per hour. Notice that at 13½ ft., average length of travel from the surface of the fuel bed, there is little combustible gas left. The usual boiler settings do not begin to approach the ideal as nearly as this one, and the combustion rates at peak loads are usually much higher than in these tests. In modern boiler settings for underfeed stokers, the space directly above the fuel bed is about 10 ft. wide and a mean of about 8 ft., for a 500-hp. B. & W. type boiler set with the bottom of the front header 12 ft. from the floor. The space is clear, unobstructed, with no wing walls, arches or other objects to give a rolling, mixing or scrubbing action to air and gases. It is likely that the results for the same length of gas travel at the same combustion rate would be much less favorable for this later setting than they were in the special setting used by the Bureau of Mines. It should be remembered however, that narrow gas passages without arches or wing walls conduce to gas and air stratification at too high combustion rates and high gas velocities.

The value of combustion volume is widely appreciated, however, as shown by the progress made in setting boilers high above the floor line. Eight feet was the highest a few years ago; those who had set boilers (B. & W. type) this high, went to 10 and 12 ft. on later installations. Today 12 ft. is common, and one finds 13 and 14 ft. in the very latest installations.

In the articles that are to follow, the latest and best boiler settings for the various boilers will be shown. All chief dimensions will be given. These settings are well suited to the high-volatile coals of the Middle West and, successfully burning these, they will burn any high-volatile coal obtainable on this continent. The next article will treat of settings for chain-grate stokers.

Spring Meeting of the A. S. M. E.

(*Continued from page 755*)

Middle West." In the topical discussion during this session some unusually interesting papers are expected. Other papers to be presented include: "Foundry Cost and Accounting System," by W. W. Bird; "The Public Interest as the Bedrock of Professional Practice," by Morris L. Cooke; "Moisture Reabsorption of Air-Dried Douglas Fir and Hard Pine, etc.," by Irving H. Cowdrey; "A High Speed Air and Gas Washer," by Lieut. J. L. Alden; "Investigation of the Uses of Steam in the Canning Industry," by J. C. Smallwood. On Thursday forenoon at the general session will be given the following papers: "Efficiency of Gear Drives," by C. M. Allen and F. W. Roys; "Self-Adjusting Spring-Thrust Bearing," by H. G. Reist; "Air Propulsion," by Morgan Brooks; "The Elastic Indentation of Steel Balls Under Pressure," by C. A. Briggs, W. C. Chapin and H. G. Heil; "Electric Heating of Molds," by Harold E. White; "Stresses in Machines When Starting or Stopping," by F. Hymans. Wednesday afternoon tea will be served at the Tatnuck Country Club, and on Thursday dinner will be served at the Worcester Country Club, followed by a lecture by Dr. S. I. Bailey on "Harvard's Contribution to Astronomy."

Co-operation of Public-Service and Isolated Plants

By Harold L. Alt

A rather original solution of the difficulty between the central station and the isolated plant was presented by Mr. Evans in the Apr. 23 issue of *Power*, and all credit is due him for a unique suggestion which no one else has thus far conceived. In fact, the proposition seemed so unusually good that an endeavor to check his figures was made; but here difficulties arose. To clear up the matter, I append the figures I have obtained, in the hope that Mr. Evans will point out the reasons for the discrepancies.

The heating season is usually considered as extending from Oct. 15 to Apr. 15, a period of 180 days, or, in other cases, 200 heating days. Allow 210 days for the sake of liberality, or 30 weeks. From this must be deducted 30 Sundays and the holidays of Thanksgiving, Christmas, New Year and Election Day, or 34 days in all, leaving 176 actual working days. Heating, of course, must be provided on all days.

Assuming a working day of 9 hours and a heating day of 18 hours, there must be $176 \times 9 = 1584$ hours requiring power and $210 \times 18 = 3780$ hours requiring heating, so that there will be $3780 - 1584 = 2196$ hours of heating without power. Mr. Evans, however, claims a total of 5832 hours, of which 2050 require power and 3782 require heat without power. Where does the larger amount come from?

The industrial plant assumed by him contained 1000 hp. in high-pressure boilers for heating in zero weather. This 1000 hp. apparently means developed boiler horsepower, which is roughly $1000 \times 32 = 32{,}000$ lb. of high-pressure steam produced per hour in zero weather only. At other times the amount is proportionately less, depending on the outside temperature.

Mr. Evans claims 34,000 lb., but it is not clear where he gets the larger amount, as one boiler horsepower is 33,479 B.t.u. At 150 lb. gage, with feed water at 200 deg. F., the heat required to produce 1 lb. of steam is $1195 - (200 - 32) = 1027$ B.t.u., and $33{,}479 \div 1027 = 32.6$ pounds.

As the average temperature for the heating season is 35 deg. F., or half the maximum temperature difference, the amount of steam developed for heating per year will be $3780 \times 32{,}000 \div 2 = 60{,}480{,}000$ pounds.

If the heating water from the combined converter-condenser is supplied to the buildings at 180 deg. F., with a maximum drop of 10 deg. in the transmission lines, it must leave the converter-condenser at $180 + 10 = 190$ deg. F. As it would hardly be practicable in a surface condenser to have the water approach the steam temperature within 10 deg., the maximum exhaust temperature on the coldest days will be $190 + 10 = 200$ deg. F., which corresponds to a vacuum of 6 in. of mercury. As the limit of vacuum practicable for regular work is about 28 in., it follows that the exhaust from the turbine would fluctuate between 6 in. of vacuum on the coldest days and 28 in. on the mildest days, or an average of 17 in. for the heating season.

No superheat is considered, as it is not mentioned. A large turbo-generator operates on from 15 to 18 lb. of steam per kilowatt-hour, with steam at 190 lb. gage, 125 deg. F. of superheat and a vacuum of 28 in. A decrease of 1 in. of vacuum increases the steam consumption about 3.5 per cent., and a decrease of 10 deg. of superheat increases the steam consumption 1 per cent. With 17 in. vacuum as an average, the reduction of vacuum is $28 - 17 = 11$ in., which would increase the steam consumption $11 \times 3.5 = 38.5$ per cent. The lack of superheat would increase it $125 \div 10 = 12.5$ per cent. So the total increase of steam consumption would be 51 per cent., or 1.51 times as great.

Under the conditions assumed, the minimum steam consumption would be $15 \times 1.51 = 22.65$ lb. per kw.-hr. and the maximum would be $18 \times 1.51 = 27.18$ lb. per kw.-hr., giving an average of approximately 25 lb. per kw.-hr. As the turbine must run under all sorts of fractional loads, the rate would probably be at least 30 lb. per kw.-hr., especially with steam at 150 lb. or less, instead of the 190 lb. on which the foregoing figures are based.

With a production of 60,480,000 lb. of steam in a season, it would be possible to develop $60{,}480{,}000 \div 30 = 2{,}016{,}000$ kw.-hr. As the maximum steam production on a zero day is 32,000 lb. per hour, and the turbo-generator takes about 30 lb. per kw.-hr., the size of unit required to utilize all the steam will be $32{,}000 \div 30 = 1066$ kw., or about 1000 kw., as suggested by Mr. Evans.

In the normal power plant, about 15 per cent. of the power produced is required for the operation of the plant accessories—forced draft, boiler feed, vacuum pumps, stoker engines, etc. In this case probably another 10 per cent. will be required to drive the circulating pumps for hot-water heating, which are usually of the centrifugal type and have a low efficiency.

A loss of $15 + 10 = 25$ per cent. of the total power generated would leave 75 per cent. available, or $2{,}016{,}000 \times 0.75 = 1{,}512{,}000$ kw.-hr. At Mr. Evans' figure of 1c. per kw.-hr. this would amount to $15,120 per season, as compared with his figure of $46,656. At $100 per kilowatt, the 1000-kw. plant would cost $100,000 and the interest and depreciation at 10 per cent. would be $10,000. At $0.0033 per kw.-hr. the supplies and other expenses would be 1,512,000 × $0.0033 = $4990. The total cost of running the plant would then be $14,990 a year, and the saving "to be divided as mutually agreed" would be $15,120 — $14,990 = $130 per year.

Mr. Evans has an item of $7125 which further subtracts from the value of the current produced and he explains this charge as "extra coal over heating requirements at $5 a ton." This is equivalent to charging up $7125 ÷ $5 = 1425 tons of additional coal. If (according to his figures) it takes 34,000 lb. of steam per hour in zero weather and he heats for a total period of 5832 hours, then his yearly steam consumption for heat must be $(34{,}000 \div 2) \times 5832 = 99{,}144{,}000$ lb. At 8 lb. of steam per pound of coal, this is equivalent to 12,393,000 lb. of coal, or about 6196 tons, burned to provide heat.

To run the 1000-kw. turbo-generator at full load at all times during the heating season would require approximately a steam production equal to the maximum heating requirement at all times, or just about twice the heating coal, which is 6196 tons, based on his figures. Therefore, the purpose of the additional 1425 tons is not clear, as it does not represent a sufficient quantity of coal to run the turbine on full load for 5832 hours.

Now as to the fuel consumption. All power is being purchased from the central station, where it is generated at 2 lb. of coal per kilowatt-hour, according to Mr. Evans' supposition. If the 1000-kw. machine requires 30 lb. of steam per kilowatt-hour and the evaporation is 8 lb. of steam per pound of coal, then each kilowatt-hour produced by the machine means 30 ÷ 8 = 3.75 lb. of coal. Accordingly, every hour the 1000-kw. machine is run on steam not generated for heating purposes, there is an increased fuel consumption of (3.75 — 2) ÷ 2 = 0.875, or 87.5 per cent.

This proves that the turbine in order to economize fuel consumption must be run on the steam that would otherwise be generated for heating only and must be run so as to utilize this steam alone and at such times and at such load as this quantity of steam makes it possible to carry.

The foregoing figures are not quite fair, however, as the central station uses about 2.9 lb. per kw.-hr. and probably loses 10 per cent. in transmission to the building, so that the actual figure for the central station will be 2.9 ÷ 0.90 = 3.22 lb. as compared with 3.75 for the isolated plant. The isolated plant would then be in excess of the central station by (3.75 — 3.22) ÷ 3.22 = 0.164, or 16.4 per cent.

Operation and Maintenance of Elevators—Arrangement of Cables

BY R. H. WHITEHEAD

Different schemes of roping up the winding-drum type of elevator machine, for both overhead and basement installations, are described. The limitations of these installations are also pointed out.

THE standard-elevator installations, Figs. 1 and 2, have two ropes from the winding drum to the car and two from the winding drum to the drum counterweight. Each of these pairs of ropes lead off from diametrically opposite sides of the drum, as shown at *A* and *B*, Fig. 1. *A* is the car-hoisting cables and *B* the drum-counterweight cables. The vibrating-sheave shaft and one bearing pedestal have been cut away to show the way the cables come down to the drum.

The grooving in the drum is generally arranged so that both sets of ropes use the same grooves; that is, when the car is traveling up the hoistway, the car-hoisting ropes wind on the drum and occupy the grooves that are vacated by the drum-counterweight cables, simultaneously unwinding off the drum, and vice versa for the downward travel of the car. This arrangement enables the drum to care for almost twice the rise that would be possible otherwise, since the rise of this type of elevator is limited by the amount of rope that can be wound on the drum.

For a standard installation where the elevator machine is located below, as in Fig. 1, the drum is generally continuously and spirally double-grooved in one direction and this double grooving may be either right-hand or left-hand. It is important that the angle at which the ropes lead off the drum be kept very small. This angle is denoted by *A* in Fig. 3. As shown in the figure, the angle is made minimum by locating the machine so that the cables, as they wind on and unwind off the drum, will be vertical when the car and counterweight are in mid-position in the hoistway.

When the car is at the top of the hoistway, the maximum amount of car-hoisting rope is wound on the drum, but allowance is always made on the drum for winding additional rope in case the car travels beyond the top landing. As the car descends, the hoisting ropes unwind, until finally, when the car is at the bottom of the hoistway, there remain, as a safety feature, about two complete turns on the drum to take care of any condition where the car might happen to run below the bottom landing. The drum-counterweight ropes lead off from the opposite side of the drum, as shown in Fig. 1, and are fastened to the extreme left of the drum, as at *R*.

When the car is at the top of the hoistway, the drum counterweight is at the bottom, consequently there are only a few turns of drum-counterweight rope on the drum for this position. As the car descends, the car-counterweight ropes are wound on the drum a few turns after the grooving has been vacated by the unwinding of the car-hoisting ropes. For low-rise machines, however, one half of the drum may be used exclusively for the car-hoisting ropes, and the other half for the drum-counterweight ropes.

The different methods of roping up the counterweights are also shown in Figs. 1 and 2. In Fig. 1, with the machine located in the basement, the drum-counterweight cables come down between the car-counterweight cables, pass through the center of this counterweight and are fastened to the center of the drum counterweight at *E*. For the overhead machine the drum-counterweight ropes come down, one on each side of the car-counterweight ropes, pass down through the car counterweight near its ends and are fastened to the drum counterweight at *E* and *E*.

In Fig. 7 a view is shown looking down the hoistway from above when the counterweights are located at right angles to the machine. The location of the overhead sheaves is shown and the general outline of the machine below. The length of the drum in a basement installation cannot be greater than the width of the hoistway, consequently, as the amount of rope that can be wound on the drum depends on the length of the

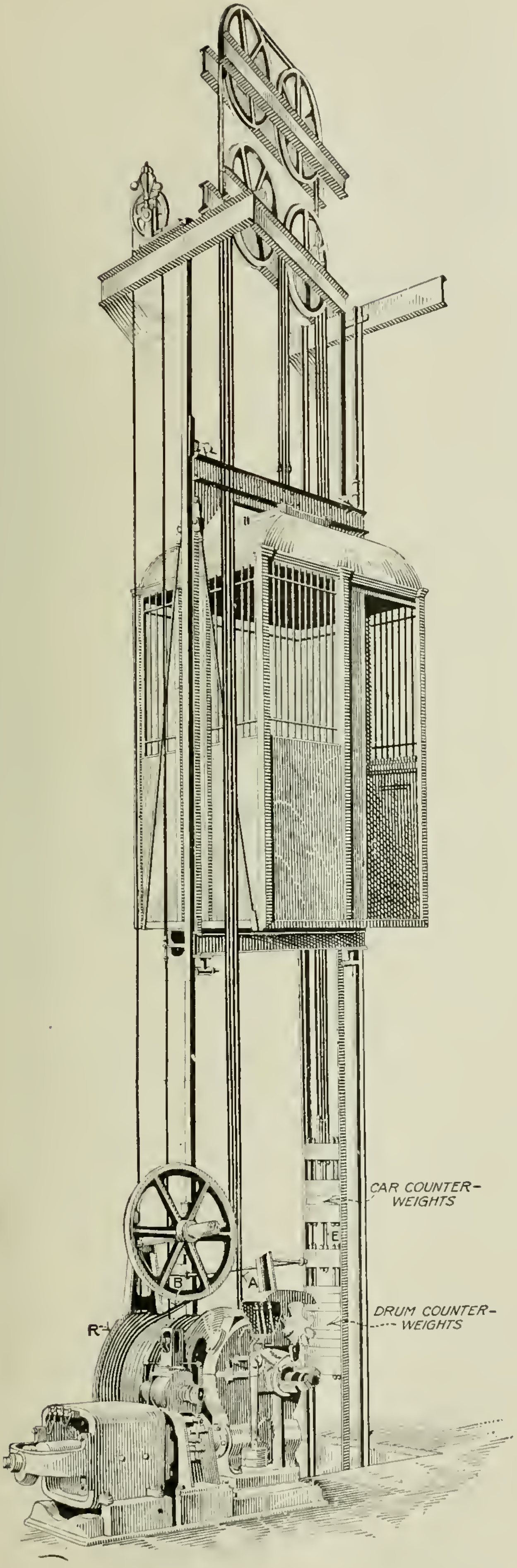


FIG. 1. BASEMENT INSTALLATION OF WINDING-DRUM TYPE ELEVATOR MACHINE

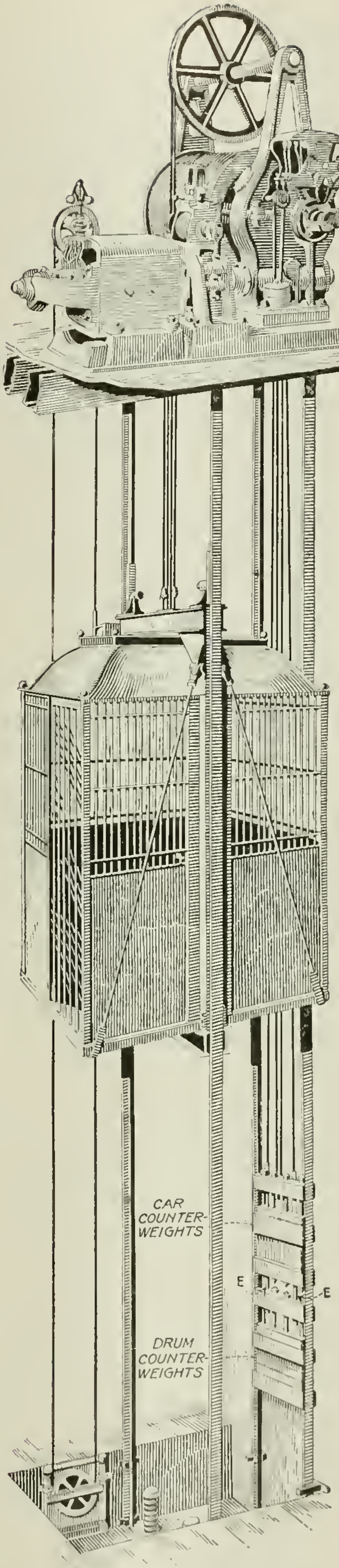


FIG. 2 OVERHEAD INSTALLATION OF WINDING-DRUM TYPE ELEVATOR MACHINE

latter, the possible rise of the car is limited by this factor. The diameter of the drum of such a machine is limited by consideration of elevator speed and space conditions.

When the elevator is overhead, as in Fig. 2, the grooving becomes a different proposition. Fig. 4 shows the rope lead when a continuously double-grooved drum machine, normally used on a lower floor or in the basement, is placed overhead. When the car is near the top of the hoistway, the length of car-hoisting ropes from the drum to the car may be only three or four feet. Therefore, for this position of the car, in order to have a good lead on the ropes, the latter must come down vertically from the drum to the car. As the car descends, the ropes lead off from the car crosshead at an increasing angle to the vertical, as at *A*. Where the distance is greater than about 35 ft., this arrangement causes an undesirable side thrust on the car, and friction between the car shoes and the guide rails.

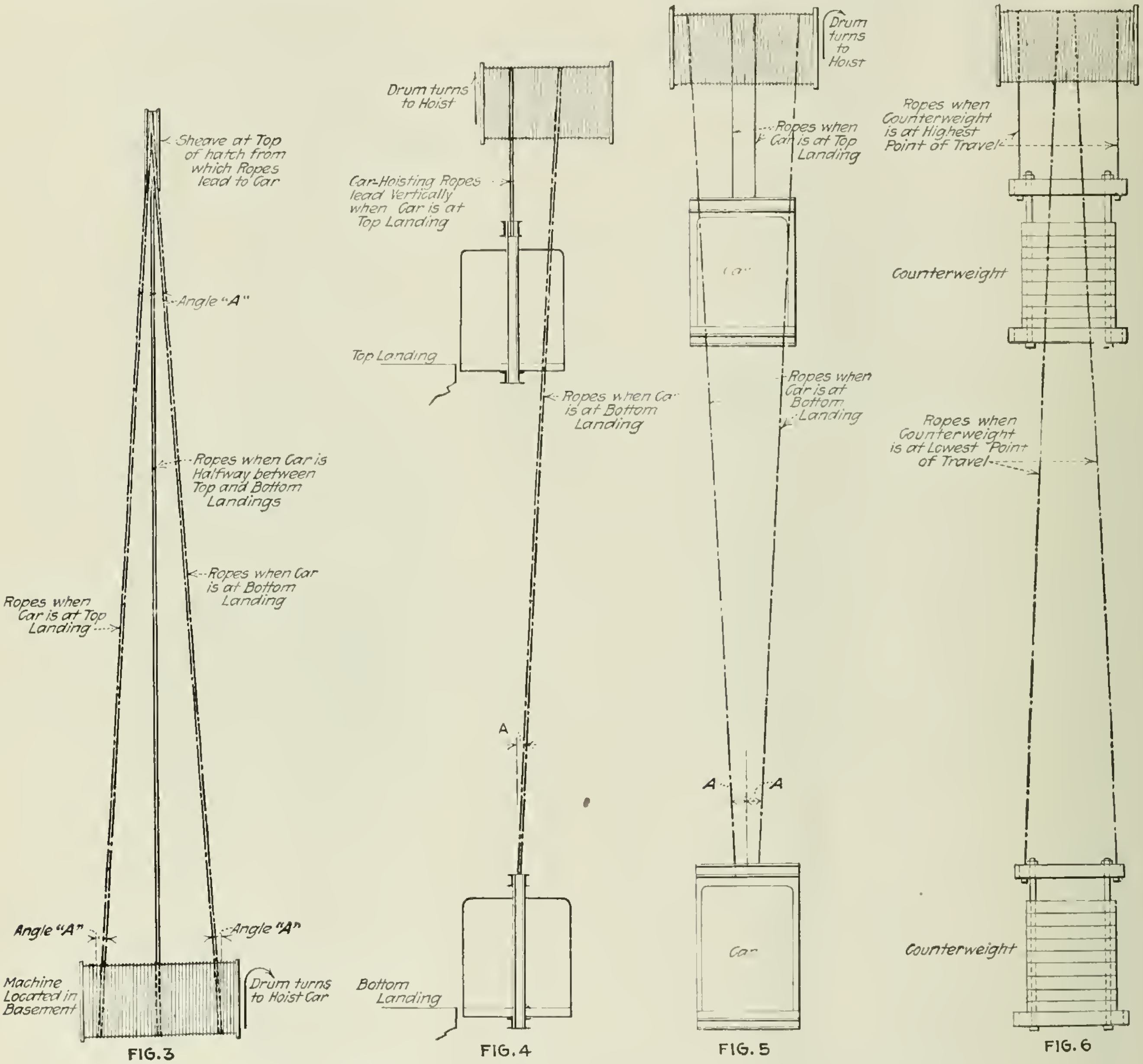


FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 3 TO 6. DIFFERENT ARRANGEMENTS OF CABLES FOR ELEVATOR MACHINES

To avoid this disadvantage for high rises, a single spiral groove is used on the drum. One half of the drum is spirally grooved right-hand and the other left-hand, as shown in Fig. 5. With this arrangement the side thrust on the car caused by one of the ropes is offset by that of the other. In Fig. 5, when the car is at the top of the hoistway, the lead of the hoisting rope must be as shown—that is, from a position near the center of the drum—and as the car descends, the two car-hoisting ropes travel in opposite directions along the face of the drum toward the flanges. The ropes are fastened to the opposite ends of the drum's face. This arrangement gives the best rope lead for all conditions. Both drum-counterweight ropes are fastened at the center of the drum's face.

When the car is at the top of the hoistway, there are three or four turns of the drum-counterweight rope wound on each set of grooving between the car-hoisting ropes; the latter, for this position, are fully wound up on the drum. As the car descends and the car-hoisting ropes unwind, the drum-counterweight ropes occupy the vacated grooving on the drum as it revolves. This permits of the maximum economy of drum surface, and thus with an overhead machine it is possible to have the same rise as with a machine located below.

Fig. 6 shows how the proper lead of drum-counterweight rope is maintained. The width of the counterweight is approximately the same as the length of the drum, so that when the counterweight is near the top of the hoistway, the counterweight ropes will lead vertically from the face of the drum to the counterweight, and each of the ropes is at the same time about a maximum distance from its central position along the face of the drum. The ropes are therefore attached to the counterweights at points spaced apart equal to the maximum distance they are separated on the drum, when the counterweights are at the top of the hoistway. For high rises wide counterweights are required, but for all rises the proper proportion of width to the length of the counterweight must be maintained to avoid a condition that would cause them to jam, similar to that effect which sometimes occurs on opening a bureau drawer.

With an overhead machine the drum diameter is limited by the distance from the center of the car to the center of the counterweight. This is shown in Figs. 8 and 9. If the machine does not span this distance, as in Fig 8, then a pair of detached vibrator sheaves must be used for the drum-counterweight ropes which move along a shaft parallel with the drum. If the drum does span the distance from the center of the car to the center of the counterweight, as in Fig. 9, no vibrator sheaves are needed for the drum-counterweight ropes. Such an installation is also shown in Fig. 2.

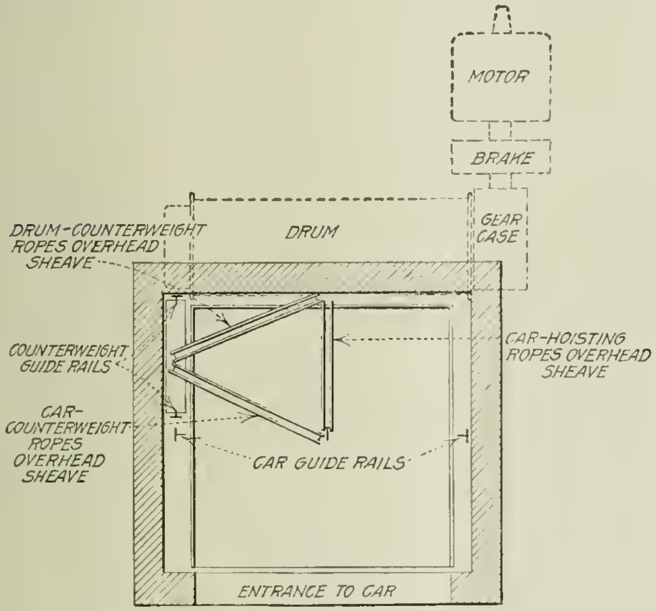


FIG. 7. LOCATION OF OVERHEAD SHEAVES WHEN MACHINE IS PLACED AT RIGHT ANGLES TO COUNTERWEIGHTS

There are some cases with machines of either the overhead or basement type, where four car-hoisting ropes are required. With a basement-type machine it is not practical to groove the drum continuously with quadruple grooving, so that the ropes can travel side by side, owing to the large pitch of grooving that would be required. Consequently, when four ropes are required with machines of either type, the machine is grooved as in Figs. 5 and 6, excepting instead of single grooves, double grooves are used, and a pair of hoisting ropes is used on each end of the drum instead of a single rope as shown. The drum-counterweight ropes are cared for in a similar manner to that shown in Fig. 6.

The winding-drum machine, as explained, has certain definite limitations and cannot on this account be used for the high rises met with in our modern high buildings. Its use is generally limited to about a 15-story building although, as explained, this depends on the particular characteristics of the installation. The next article will deal with the operation of traction-type elevator machines, which have practically no limitations as far as the length of the rise is concerned.

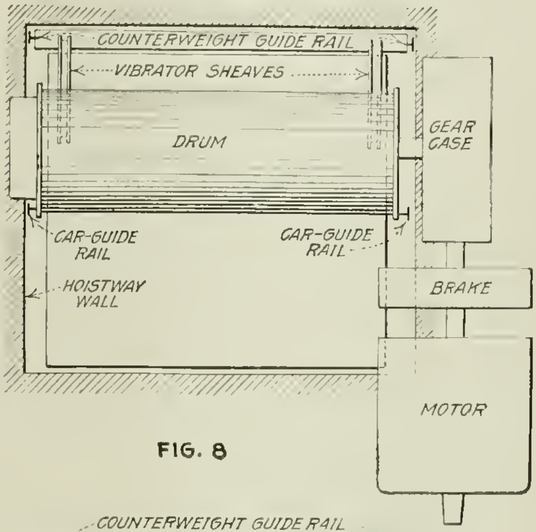


FIG. 8

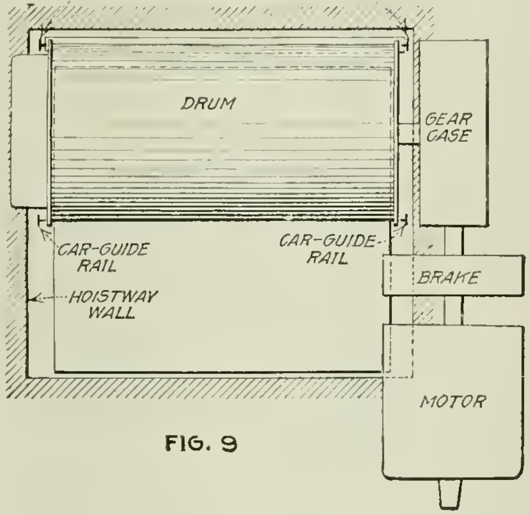


FIG. 9

FIGS. 8 AND 9. LAYOUTS OF OVERHEAD MACHINES

Something About the Steam Loop

A few nights after the Saturday afternoon chat Willis had with Williams at the Stahley plant, he dropped in again, as he was on his way home for supper, to have another talk about the action of the steam loop. Williams was washing up when Willis breezed into the engine room with the remark, "I got here just in time to keep you on the job a little longer than the law demands. I guess you don't mind, do you?"

"Not so as you would notice it, seeing it's you. What's on your mind tonight?" replied Williams.

"Well, last Saturday afternoon we had a little confab about pumps, and you was cussin' 'em up hill and down and wished that some fellow would get up something that would handle hot water without any moving parts. I told you that I would give you a few pointers about the steam loop, and here I am to carry out my part of the contract."

"All right, go to it. Better take a chair and be as sociable as you can while I get into my street togs. I can listen just as well as not while I am changing."

"All right, here goes. A steam loop is a device for returning condensation from steam pipes, separators, radiators and other parts of a steam plant to a boiler, when there is not an excessive pressure between the boiler and the different parts of the system. To do that, water has to be carried from some part of the system of less pressure than is carried in the boiler and delivered to the boiler where there is a higher pressure than is carried in the piping system of the plant."

"Why the drop in pressure? If you turn steam into a pipe line, you will get the same pressure all along its length, won't you?"

"Not so as you would notice it," replied Willis. "If you don't believe it, you put a gage on the steam pipe next to your engine and you will find that there is a few pounds less pressure there than at the boiler; this is due to the length of the pipe and the number of fittings, the velocity of the steam flow and the amount of condensation that takes place. Now to get the water of condensation back to the boilers, it is generally necessary to overcome the drop in pressure and also the weight of the water or hydraulic head if you want to be technical, so to speak. The beauty of a steam loop is that it will handle water with pretty near no attention, and all of the work done by it is due to the condensation of steam in the apparatus."

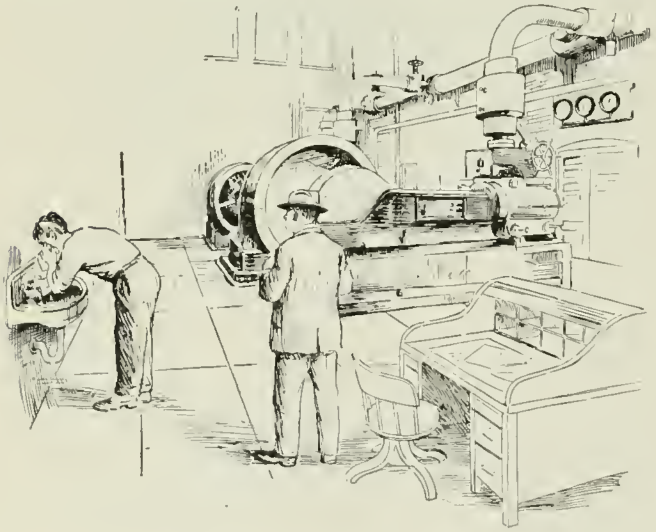


FIG. 1. "I GOT HERE JUST IN TIME TO KEEP YOU ON THE JOB A LITTLE LONGER"

"That may all be; but how is the thing made?" asked Williams.

"It is simple in construction and consists of but three parts—two vertical pipes and one horizontal. Perhaps I had better make a sketch so as to make the matter plain." (See Fig. 2.) "The pipes I will mark *A*, *B* and *C*. The vertical pipe *A* is called the drop leg, the connecting pipe *C* the horizontal and the pipe *B* the riser, the last being connected to the steam separator *D* of the engine."

"That's a funny arrangement," said Williams as he examined the sketch. "What does it do?"

"Just what I have been telling you. It will take the vapor that collects in the separator just as fast as it accumulates and return it to the boiler, and it won't allow a lot of water to collect in the separator before it begins to operate. Now to have the system work as it should, it is necessary to have the pipes proportioned right. Added to that, the vertical pipes should be covered with some insulating material, but the horizontal pipe *C* should be left bare. Under ordinary conditions the pipe *C* will act as a condenser and the loop *E* prevents the water from running back into the riser *B*."

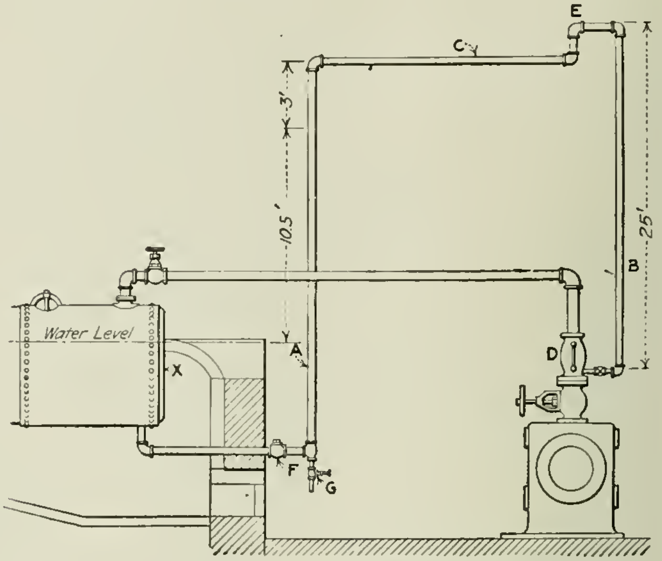


FIG. 2. LAYOUT OF A STEAM-LOOP SYSTEM

"I don't believe the thing will work," Williams exclaimed after examining the sketch once more; "that is, I don't believe it will the way you have got it drawn. Where is the steam coming from to be condensed in the horizontal pipe *C*? You haven't made any connection to the steam space of the boiler."

"Well, I declare, that was careless of me, wasn't it?" replied Willis. "Of course, if that pipe is going to act as a condenser it has got to have steam to condense and, as you say, it can't come from the boiler because there ain't no steam connection and it can't come from the blowoff connection because there is water in it up to the water level in the boiler, and a check valve prevents it from going higher. I swan, I don't see how I came to make that mistake, but perhaps there is another way for that pipe to get steam for condensing purposes," and Willis indulged in a slight grin as he continued:

"The condensation and entrained water in the separator are in the form of a moist vapor, with a low specific gravity, which rises to the condenser *C* and is turned into water. This will go on as long as there is vapor, and when the water running into the drop leg *A* reaches a height sufficient to overcome the pressure on the check valve *F*, it will run into the boiler. The weight of a cubic foot of water depends on its temperature. At 60-lb. gage pressure the temperature would be about 307 deg., using round numbers, and at, say, 110-lb. pressure it would be about 344 deg. The weight of a cubic foot of water at the corresponding temperatures would be about 57 and 56 lb., respectively. Now, a column of water 1 in. square and 1 ft. high weighs, at your pressure of 110 lb., which equals 344 deg. temperature, $56 \div 144 = 0.388$ lb. That being a fact, the height of the column of water in the pipe *A* with, say, a 4-lb. difference in pressure between the boilers and the engine would be $4 \div 0.388 = 10.3$ ft."

"All right, I will take your word for it, so go to it."

"If the water in the pipe *A* is to run into the boiler, you can see that the height of the water must be enough to overbalance the difference in pressure, as well as what friction there may be. In order to do this the pipe *A* has got to be about 30 per cent. higher than the height of the column of water that we found was necessary to balance the difference in pressure due to the drop between the boiler and the engine, or 10.3 ft. Then $10.3 \times 0.30 = 3.09$ ft., which, added to the height of the water necessary to overbalance the difference in pressure, will be $10.3 + 3.09 = 13.39$ ft., or 13.5 ft., the height of the pipe *A* above the water level in the boiler. The head of water tending to force the check valve *F* open is equal to the height of the pipe *A*, less the height necessary to balance the difference in pressure. You get this by multiplying by 0.388, the weight of a column of water 1 in. square and 1 ft. high, as we have already found. Then $13.5 - 10.3 \times 0.388 = 1.24$ lb."

"Does it make any difference where the pipe *A* enters the boiler; that is, below the water level?"

"If you will stop to think a moment, you will see that it does not. In the sketch the water enters through the blowoff pipe. It could have entered the boiler at the point, say, *X*, just as well, as it does not affect the working of the system."

"I don't see why it won't make a difference, because the column of water is higher with the lower connection than with the higher one."

"Well, well, it does look as if that were so, don't it, from the standpoint of the water in the pipe *A*? But ,on the other hand, with either a lower or higher connection, the height of the horizontal pipe *C* above the water level in the boiler will be the same, because its height is always measured from the water level in the boiler.

"Don't you see that the total difference in pressure is balanced by the height of water column in the drop leg and as the horizontal pipe is a condenser the vapor is drawn into it when it condenses and runs down into the drop leg? Then, just as soon as the column of water reaches a height sufficient to overcome the balance, the check valve opens and the water flows into the boiler, and that is about all there is to it."

"That sounds easy. I wonder that there are not more of them working in steam plants."

"Now you come to mention it, there are a lot of them operating in power plants. They take up so little room that a fellow don't see them when he goes through a plant where they are. One thing that should be remembered is to have the check valve *F* of large area, because if there is much difference in area between the top and the bottom it will prevent the check from lifting until a greater column of water has gathered in the drop leg than is necessary for its operation after the check does lift."

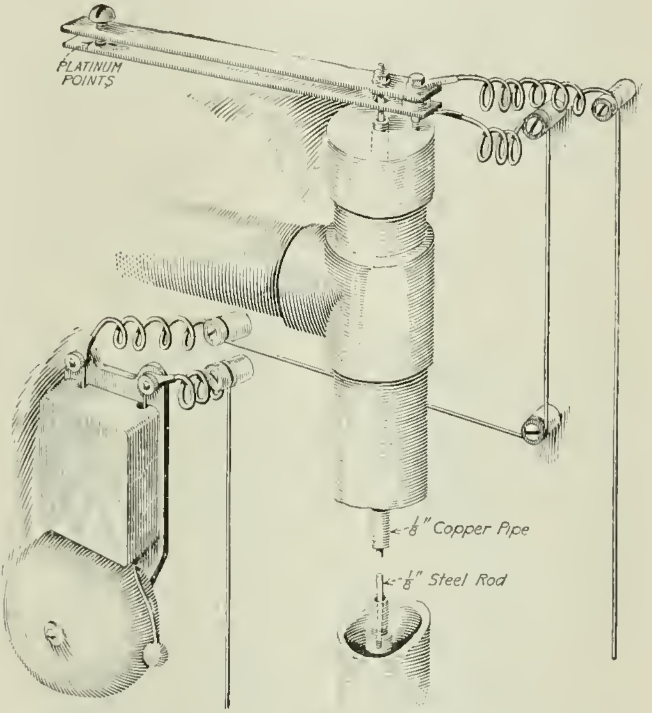
"What's the odds if it does get more water than is necessary to operate? Can't do any harm, can it?"

"The only harm that it would do would be to flood the horizontal pipe *C* and that would, of course, prevent the system from operating. Another thing that will prevent the system from operating is when it gets airbound. That is what the valve *G* is put on for so as to let the steam, water and air blow out when it is opened and so clear the system of air. Then close the valve and away the system will go as slick as a brindle pup chasing a tomcat."

High-Temperature Alarm

By Herbert B. Brand

The device shown in the illustration is for giving an alarm when the temperature of the cooling water, from the jacket of an oil engine or air compressor or the oil in the lubricating system of an engine or turbine, reaches a predetermined point. It consists of a ⅛-in. copper tube (iron-pipe size) 20 in. long, one end of which is screwed into a 1½-in. pipe cap (or other size to suit the piping used). A ⅛-in. steel rod 23 in. long is screwed into a ⅛-in. pipe cap at the lower end of the copper tube. The free end of the steel rod where it projects from the copper tube at the top is threaded for about one inch of its length. The arrangement for increasing or multiplying the motion consists of two pieces of brass ⅛ by ⅝ in. The movable member of this multiplying device carries a brass screw and locknut; the screw and lower contact preferably have platinum contact points. The action depends on the difference in the coefficient of expansion of copper and steel, so that when the copper pipe lengthens from a rise in the temperature of the fluid flowing in the large circulating pipe and the steel rod does not lengthen so much, the contacts will be brought together, closing the electric circuit and ringing the bell.



BELL CIRCUIT CLOSED BY RISE IN TEMPERATURE

Radojet Air Pump

The satisfactory performance of a condenser depends largely on how the air and the condensates are removed, as air is a nonconductor of heat and it is necessary to remove it rapidly from the condenser as the steam is condensed; if not, it will collect and form a noncondensing element around the condenser tubes and impair the heat's transfer.

With reciprocating engines operating with a vacuum of about 26 in., the reciprocating air pump performed its function, but with the adoption of the steam turbine and its high vacuum, a demand for a condenser that would maintain a high vacuum was necessary and this, of course, required a further development of the water and air pumps.

An ideal air pump would be one in which there are no moving parts, simple in construction and operation, together with a low steam consumption, combined with the additional features of minimum space and weight, no foundation, noiseless operation and no attention during operating period, quick starting, continuous service and safety of operation. Such an air pump has been developed by the C. H. Wheeler Manufacturing Co., 18th St. and Lehigh Ave., Philadelphia, Penn. It is called Radojet and is used in connection with surface, jet or barometric condensers, as well as in combination with other apparatus, wherein a vacuum has to be produced and maintained.

The principal characteristic of the Radojet air pump, Fig. 1, is the use of the steam jets for the removal of air. Although this method of removing air is not original with this pump, it has never before been developed to produce high vacuum commercially. The Radojet consists of two steam ejectors working in series, Fig. 2, the top ejector being called the first stage and the lower one the second stage.

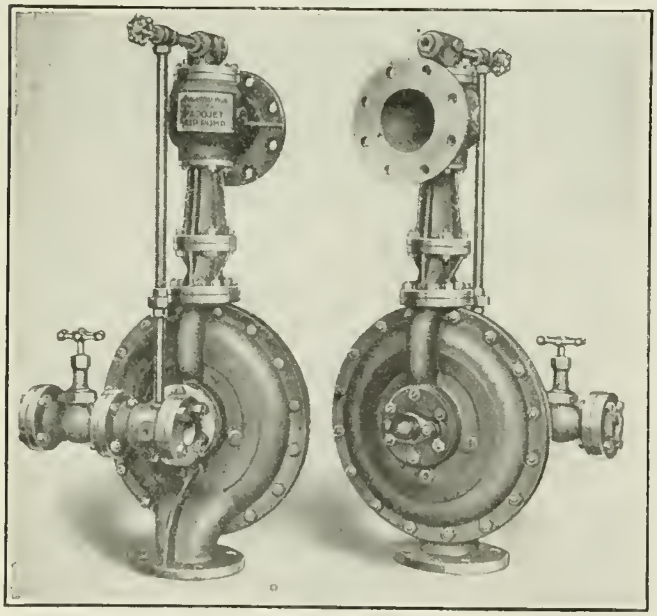


FIG. 1. TWO VIEWS OF THE RADOJET AIR PUMP

A study of Fig. 2 will show how the pump operates. Live steam at boiler pressure enters through the flanged connection *A* and strainer *B* to the expansion nozzles *C*, the path being through the pipe *D*, angle valve *E* and strainer *F*. From the expansion nozzles the steam flows across the suction chamber *G* of the first-stage ejector, which is connected to the condenser through the flanged opening *H*. As the steam expands in the nozzles *C*, it leaves them at a very high velocity, and in crossing the suction chamber *G*, it entrains the air and vapor coming from the condenser. The mixture of steam, air and vapor passes into the diffuser tube *I*, from which it is discharged at a higher absolute pressure than that of the air entering at the opening *H*, into a double annular passage *J* which communicates with the suction chambers *K* of the second-stage ejector.

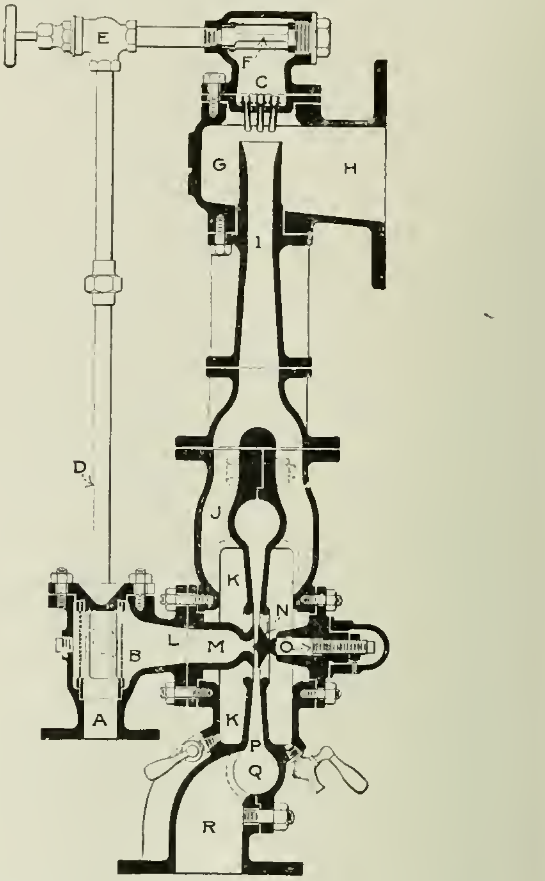


FIG. 2. SECTION THROUGH RADOJET AIR PUMP

Steam is simultaneously delivered through the strainer *B* into the passage *L*, which communicates with the annular expansion nozzle formed between the two circular disks *M* and *N*. The disk *N* can be adjusted toward or away from the disk *M* by the adjusting screw *O*. This is to vary the cross-section of the nozzle passage and thereby change the expansion ratio of the steam.

The steam from the chamber *L* is delivered radially by the annular nozzles *M* and *N* and expanding leaves it as a jet of high velocity in the form of a sheet, and in passing the suction chamber *K* entrains the air and steam coming from the first-stage nozzle and carries them into the annular diffuser *P*, thus compressing the mixture to atmospheric pressure and discharging it into the casing *Q* and out through the discharge opening *R*. The discharge from the outlet *R* may be delivered into a vented tank supplied with fresh water for boiler heating where the steam contained in the mixture is condensed.

The air frees itself from the water and escapes through the vent to the atmosphere. If an open feed-water heater is used, the discharge from the air pump is led directly to it.

In Fig. 3 is shown a surface-condenser installation fitted with Radojet air pumps arranged on a common air-suction header for removing the air. This arrangement provides for different loads and for cutting out one or more air pumps when desirable. It also prevents a total shutdown due either to an unexpected leak or a breakdown.

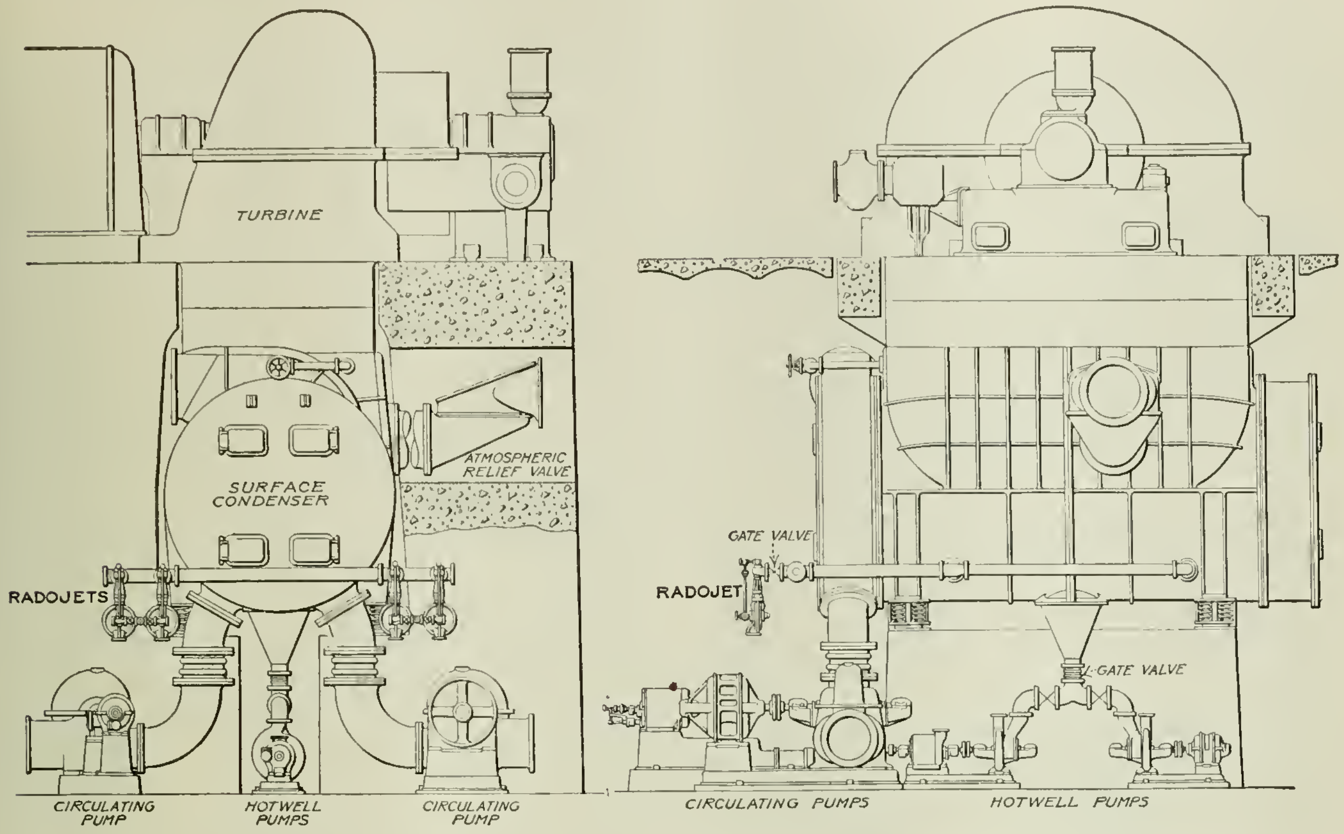


FIG. 3. END AND SIDE VIEW OF SURFACE CONDENSER EQUIPPED WITH RADOJET AIR PUMPS

This type of air pump, when used with the jet type of condenser, has the advantage of independent operation and being separated from the removal pump in that the air pump is started independently of and prior to the removal pump; and because of its ability to handle a large volume of free air even at low vacuum, it quickly creates the pressure difference necessary to lift the injection water. The action of this air pump is such that within one to three minutes from the start (depending on the size of condenser) the main injection valve can be opened, and simultaneously putting the removal pump in operation, the condenser is ready for service. This independence of the air pump makes it possible to vary the speed of the removal pump according to the variations in the discharge heads, thereby obtaining the most economical results.

Fig. 4 shows the application of this design of air pump to a low-level jet condenser. When used on large-sized condensers, two or more air pumps working in parallel are arranged. This gives the advantages mentioned in connection with surface condensers. This air pump will work with the barometric type of condenser equally as well as with those of the surface and jet types.

Owing to the absence of moving parts, this air pump does not require attention during operation, and when once adjusted and supplied with dry saturated steam of the designed pressure, it will maintain continuous service. When starting, the valve controlling the steam supply is opened and that is all there is to it.

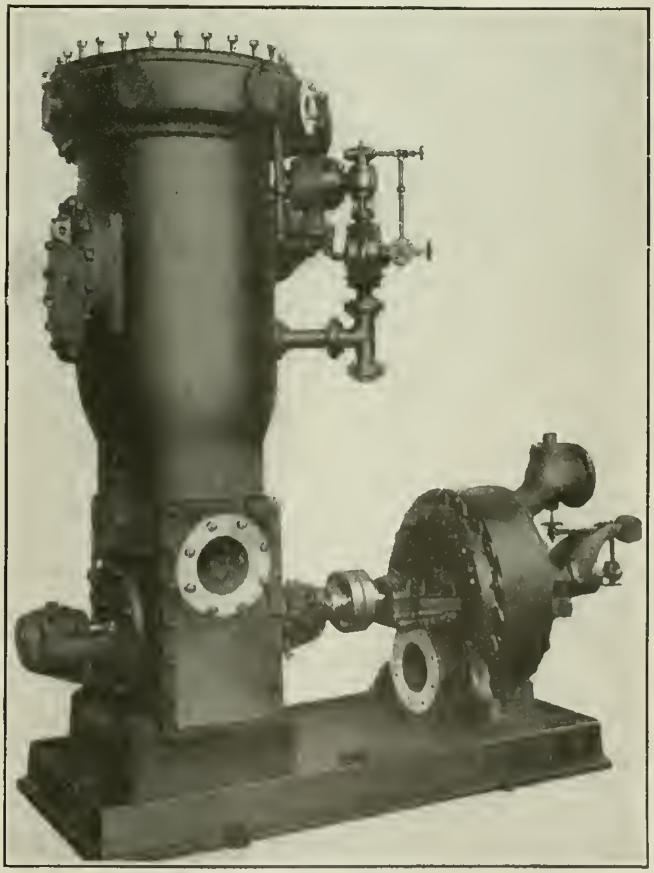


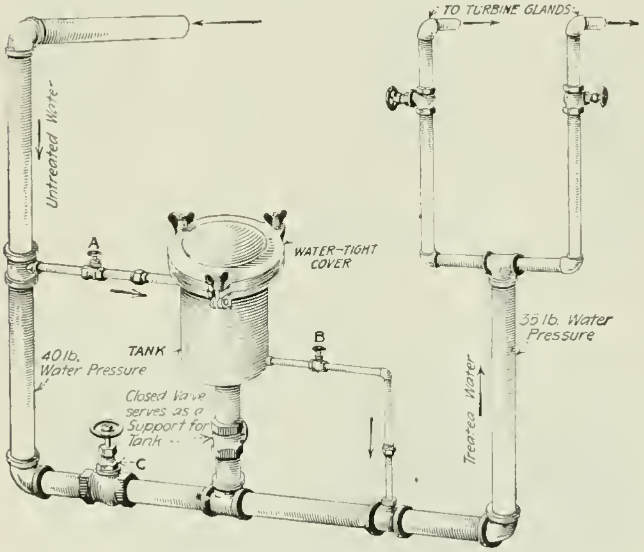
FIG. 4. RADOJET AIR PUMP ATTACHED TO A JET CONDENSER

Purifying Water for Sealing Steam Turbine Glands

By J. B. Linker

In a steam-turbine installation, the glands should be sealed with soft or purified water. This is easily obtained in a plant where condensed steam is available; but in many plants such a supply is not at hand, and other means must be found to keep the glands from becoming clogged with scale. If the glands clog with scale, the runners are liable to be broken, and a kinked or unbalanced spindle may result. Many turbine owners and operators do not attach proper importance to the use of gland water that is free from impurities. The manufacturers of turbines offer arrangements for chemically treating gland water that contains impurities, and yet many customers will disregard this important matter.

The writer was called upon to start up a turbine, and on arriving at the plant found that no provision had been made for using purified or soft water on the glands. The owner wanted the turbine to be put into immediate service and ordered the machine started up by using well water that contained considerable magnesia. The writer informed the owner of the importance of using purified water, but owing to the necessity of getting the plant started, the water that contained the magnesia was used. After two weeks' operation the glands became so clogged with scale that the turbine was shut down for two days to clean the gland casings and runners. This owner doubted that two weeks' run with hard water would cause a shutdown, but it did, and he is now thoroughly convinced that it was a great risk to run. A system for using purified water was immediately installed.



WATER-SOFTENING APPARATUS FOR STEAM-TURBINE GLANDS

On starting up another plant, the same problem of a lack of purified water was encountered. It was decided that this turbine would not be started until some means was found to supply soft water for the glands. It would have required several days to construct tanks and do the necessary pipe work for installing the chemical-feeding arrangement recommended by the turbine builders. To assist the owner to get the machine going as quickly as possible and at the same time take no chance of clogging the gland casings, a temporary arrangement was rigged up to treat the gland water with chemicals. The owner was using a small tank arrangement for feeding boiler compound to the feed water. It happened that an extra tank was available, and it was piped up as shown in the figure, to feed chemicals to the gland water. It took only a few hours' work to install this tank and get the turbine in service. The result was that any desired quantity of chemical could be fed to the gland water. The chemical used was the product of the manufacturer of the tank, which is designed particularly for use in treating boiler-feed water.

In starting the turbine, the two valves *A* and *B* were opened wide and the water pressure to the glands was controlled by the valve *C*. By having the two valves *A* and *B* open, and manipulating the valve *C*, water was forced through the tank, where it dissolved the chemical. The line pressure was about 40 lb. at the valve *C* and somewhat less at the discharge side of this valve. By regulating the opening of the valves *A* and *B*, any strength of solution desired could be obtained.

It is not the intention of the writer to introduce a new arrangement for treating gland water, but it is desired to emphasize the necessity of keeping scale from forming in the gland casings and on the gland runners of turbines requiring water seals. Once the owners and operators of steam turbines are convinced of the importance of this matter, no trouble will be experienced with clogged glands.

Trials of Marine Fuels

Among the efforts to relieve the exceptional present demand upon the liquid-fuel resources of the world is an attempt to burn a colloidal mixture of Navy fuel oil and pulverized coal. Successful runs have been made with the mixed fuel off New Haven upon a vessel which has been assigned to the Submarine Defense Association for this and similar purposes.

A material is in a colloidal condition—as that term has of late been used with regard to graphite mixed with oil, etc.—when it remains suspended in the containing fluid and will not, by reason of the fineness to which it has been reduced, settle out. About 3 parts by weight of coal can be carried in this way by 7 parts of oil, giving a mixture of about the same calorific value per cubic foot as the oil itself. This mixture can be used in the same burners as the plain oil and affords a means of replacing 30 per cent. of the liquid fuel by the more abundant coal and of burning the latter smokelessly and without any complication of the apparatus.

The tests, which are being run by Haylett O'Neill, combustion engineer, of the Submarine Defense Association, will comprise trial runs to determine the practical and comparative steaming values for marine practice of the following fuels: A combination fuel consisting of a colloidal mixture of Navy fuel oil and pulverized coal; Navy fuel oil; pulverized coal with installations by various companies; pulverized coal and Navy fuel oil burned simultaneously in respective burners under the same boiler; pulverized coal and colloidal fuel burned simultaneously in respective burners under the same boiler.

Editorials

Some Benefits of the War

GIGANTIC catastrophe as it is, the world war brings in its train a few effects which may be added to the credit side of the account.

One of the smaller of these is the effect which it has had upon the mental habits of the people. We know more of geography, of peoples and their history; we pay more attention to the utterances of the leaders of the world's thought; we have a keener perception of the social and industrial problems of life. The proletariat has taken to serious reading and thinking.

The war has forced upon us a demonstration of the possibilities of thrift. We have been a nation of spendthrifts. President Wilson said in his address to the War-Savings Committee: "I suppose not many fortunate byproducts can come out of a war, but if the United States can learn something about saving out of this war, it will be worth the cost of the war; I mean the literal cost of it in money and resources. I suppose we have several times over wasted what we are now about to spend. We have not known that there was any limit to our resources; we are now finding out that there may be if we are not careful." Many a person who would have spent his all as he got it will come out of the war with a snug little sum in Savings Stamps or Liberty Bonds, and even if enforced economies have demonstrated how much one can go without and inculcated the saving habit, it will be worth something.

Closely akin to enforced economy is enforced efficiency. Shortage in materials and man-power has driven us to making better use of what we have. The carelessness in the use of coal of the old plentiful days is no longer tolerated. The possibilities of cheaper fuels are demonstrated, wastes are discovered and stopped, fuel-saving devices are sought and used, and a premium has been put upon efficiency in the power plant. Owners, engineers and firemen are alive as never before to the savings that can be made, and a standard of efficiency is being established that will set a new pace when the war is over. The same thing applies in a broad sense to all industrial operations.

To those who participate in its various activities the war will bring many advantages in an enlarged experience of the world, in contact with other people and other lands, in associations and acquaintances and friendships, in honors achieved, in an outgrown provincialism and a sense of duty done.

It will greatly improve the physical powers of millions of men. The systematic régime of the training camps, the regular routine of the cantonments, and service in the field and in the trenches will strengthen and temper the country's manhood, the fiber of which had been in danger of becoming asthenic through ease and luxury. Similarly, the widespread employment of women in the industries will result in a decrease of idle and purposeless living and an improvement in physical well-being. So there must necessarily follow a tremendous expansion of our biological capital, the benefit of which the nation will receive in the coming generation.

The war will put America on an independent basis with regard to many things for which we have been dependent upon others. It has forced us into new lines of manufacture, such as dyes, chemicals, glass for optical instruments, nitrates. It is forcing us to develop our neglected resources, as the soda deposits of Utah, the water powers, the beds of lignite and peat. It has intensified the search for oil and compelled new methods of refining its most demanded products. It has stimulated invention and research and has led to the perfecting of numerous industrial processes of permanent value.

The war revived our drooping industries and has made us the creditor nation of the world. It has made work plentiful even though it has made living dear. It has opened to us the markets of the world and compelled us to build a merchant marine to reach them and financial and commercial organizations to cultivate them. It has given us a chance to demonstrate the integrity of our purposes, the unselfishness of our motives and the beneficence of our intentions toward all mankind, has allayed the distrust of our neighbors, disarmed the enmities which were brewing against us and bound us with new ties of sympathetic friendship to our Allies. It will win us the respect of an erstwhile contemptuous assailant.

It will sound the knell of attempts at empire building by conquest, by diplomatic duplicity, by spying, intriguing, the shameless abrogation of solemn pledges, bribery, trickery and the force of arms. It may lead to the substitution of the processes of civilization for the savage arbitrament of arms in the settlement of international disputes. It may lead several paces toward the Federation of the World, when all the wealth and energy and ingenuity which nations now expend in preparing for attack or defense can be devoted to the common good of that federation.

But perhaps the greatest good that can come to this country from the war is the impetus which it has given to the concept of national efficiency. The mobilization of the industrial, the agricultural, the transportation facilities of the nation for the purposes of war will suggest their mobilization and organization and systematization and correlation for the purposes of peace. The possibilities of intelligent, systematic, scientific regulation of the food and fuel supply, of a unified system of transportation, of business conducted with a view to the greatest over-all efficiency and the common good rather than to exorbitant profit and unnecessary opportunity for gain, will be so forcibly apparent that either by the voluntary coöperation of the participants or by the forceful imposition of the common will they will be realized.

The Engineer Coming Into His Own

EVER since the beginning of the development of engineering science the engineer has been willing to work along quietly, seeking his reward only out of the joy of his accomplishments. Great as these achievements were, only recently has it occurred to the engineer and the man of science that they were entitled to greater recognition in the affairs of state. For years the legislative bodies enacted laws both wisely and unwisely without even a semblance of approval or protest from the engineers of the country.

However, times have changed and the engineering profession is coming into its own; the engineer is beginning to speak for himself. He has learned the value of coöperative effort and coördinated action on the part of engineers of all classes. As a medium of coöperation between the engineering societies, the Engineering Council was formed last June, consisting of twenty-four representatives from the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Institute of Mining Engineers and the United Engineering Society, to speak authoritatively for the member societies on all public questions of interest or concern to engineers.

H. W. Buck, past president of the American Institute of Electrical Engineers, said in his presidential address, June, 1917: "It is an encouraging beginning toward universal coöperation among engineers in all branches of work. In this Engineering Council we have for the first time an engineering body representing some thirty thousand engineers of sufficient scope and standing to create an engineering public opinion. Its influence is likely to be far reaching in building up the prestige of engineers in both technical and civil affairs."

That the Engineering Council is making itself felt and through it the engineer as a force in affairs of government is evidenced by the resolution adopted by this council and presented recently to the National Industrial Conference Board, that the council was opposed to certain Navy and Army bills being considered by Congress, which contained proposals detrimental to well-tried industrial methods for improving efficiency and increasing production in manufacturing plants. It is gratifying to note that after expressing the opinion, "It appears that the members of the great engineering societies of the United States are peculiarly qualified by virtue of their knowledge and experience to express an opinion upon the present efficiency of our production and the most practical means of increasing the productive capacity of both management and men and to call to public attention questionable proposals threatening our efficiency as a nation and therefore our capacity to perform our full duty in this great struggle," the National Industrial Conference Board in a resolution "respectfully requested the engineering societies of the United States to investigate and to publicly express themselves as to whether or not we are losing or gaining in industrial efficiency, and to state what causes, if any, in their opinion are influencing the condition, in what manner broadly they believe our industrial efficiency can be further stimulated."

Is not this and many other instances that have taken place during the past year only the beginning of the important part that our engineers are destined to take in our Government in the future, a part that is justly theirs by virtue of their training and qualifications, such as judgment, character, human understanding, resourcefulness, etc.?

The Opinion of An American

ANOTHER great American engineer, Dr. John J. Carty, has been awarded the Edison Medal, as reported on another page of this issue. Dr. Carty no doubt is the greatest genius in the science of telephone engineering today, having attained his high position without a college education. Although the American people may well be proud to honor him as an engineer and scientist, they should be even more proud of his thorough American spirit and his confidence in the genius of the American people. This magnificent spirit of Dr. Carty is most eloquently expressed in his address on accepting the Edison Medal, in which he says:

> We hear a great deal about the German scientist and the wonderful things he has done and has been planning. Many years ago, when German "Kultur" was interpreted by many to mean German culture, it was suggested to me that we should send to Germany to get some of the Herr doctors to teach us the high science. I always opposed that, believing that the Yankee mind, the Yankee boy, when his attention was turned to scientific problems, would surely outdistance a German. I concluded that our work could be trusted to these young Yankee minds and that they should be trained in our work and that through them we would undertake to outdistance anything that has been done in Germany. That policy has worked out successfully. The young men who have collaborated with me all these years are graduates of over one hundred universities, all here in America.
>
> When at the opening of the war there was a searching of hearts, and a census, and a taking account of stock to find out who was loyal and who was to be suspected, I know you will all be pleased to hear that among all of these scientists and all of these engineers all working in the Bell System all over the United States we were not able to find one single Hun; they were all true Americans to the core.

If this is successful in Dr. Carty's case, can it not be made so in every American industry? Have we not in the past been overlooking the great genius at home for the lesser abroad?

On May 17, Theodore M. Knappen, in an article in the daily press, said: "Tomorrow the one hundredth De Haviland 'plane equipped with a Liberty motor will be shipped to France. The De Haviland Four, with its Liberty motor installed, is the fastest flying machine in the world. It can be seen daily at the field of the Dayton (Ohio) Wright Company flying circles around the Rolls-Royce in the same sort of 'plane, and the Rolls-Royce is admittedly the most powerful aërial engine that the Old World has produced." Yes, the Yanks are coming.

Our publication of the Blackstone Roll of Honor in our issue of April 23 has got us into trouble, for it has produced an avalanche of lists from other plants. It would be impossible, of course, to reproduce all of these. One of these letters from E. C. Bingham, chief engineer of the Waldorf-Astoria, contains 134 names from his department. We wish that we could print every name, not only in this but in all of the other patriotic groups.

Correspondence

Smokelessness and Fuel Saving

On page 565 in the issue of Apr. 16 are given a number of prize-winning posters designed to encourage the abatement of smoke in Pittsburgh. The poster awarded the second prize, at the top right-hand corner of the page, and, to a lesser degree, that at the bottom right-hand corner, appear to the writer to call for a little friendly criticism. While an admirable design and "eloquently practical," the top poster might appear to give a wrong impression, yet a common one. It says "20% of Coal is lost in Smoke." But this is not quite true. The losses up the stack are about 20 per cent., sometimes more, but this is not smoke, but the total losses of heat, due either to incomplete combustion on the one hand or excess air on the other and the necessary loss chargeable to draft, and so on.

Roughly speaking, the loss due to visible smoke is perhaps between 1 and 2 per cent. in carbon and hydrocarbon particles. In addition there is the loss due to carbon monoxide or combustible gases carried away unburnt, amounting perhaps to 13 per cent. (to be added to those of actual heat carried away). These are losses due to incomplete combustion. Then there is the loss due to excess air because of air infiltration, a loss usually considered as being greater than that due to incomplete combustion and deficiency of air, because with excess air, if thoroughly mixed with the gases of combustion, the stack tends to smoke less and does not attract attention, thus leading to carelessness in firing and failure to maintain the fuel bed and apparatus in good condition.

Smoke may be due to insufficient air, insufficient furnace space, insufficient furnace temperature and insufficient intermixing of air and combustible gases. Too many plants, lacking proper settings and furnace proportions, resort to excess air as the simplest method of conforming to civic smoke ordinances, and thus smoke is reduced by resorting to excess air and inefficient combustion, increasing the invisible but decreasing the visible losses up the stack. It is well known that to obtain smokelessness without on the one hand having excess oxygen and on the other hand too little, forming carbon monoxide, is difficult. In fact, one always suspects a stack that never gives off smoke at some time as indicating an inefficient plant, where the setting and furnace proportions are favorable, but where excess air is occurring. It is also often found that higher evaporation, with some settings, can be obtained with a smoking stack than without smoke, because in such cases incomplete combustion is less wasteful than excess air. Excess air is the arch enemy of efficient combustion, because, unlike smoke, it may occur unseen and persist insidiously, instead of attracting attention.

There are too many plants attempting to overcome their smoke troubles and keep within the law by using excess air. But as a rule conservation of fuel and smoke abatement go together, since accomplishment of the former must comprise the latter, while the reverse of this is not necessarily true and unfortunately, too rarely is it true. Conservation means efficiency and smokelessness. Smoke means waste and so also may smokelessness.

I believe that many, in attempting to live up to the creed of the posters mentioned, will waste coal instead of saving it. They will attempt to prevent smoke by increasing the air supply, and while reducing smoke, will lower the efficiency of combustion and thereby waste coal. Moreover, of the 20 per cent. or more loss up the stack, that actually due to visible smoke is very small.

The writer believes he is voicing the opinions of many of *Power's* readers when he suggests that the poster awarded the second prize by the Smoke and Dust Abatement League of Pittsburgh be changed to read "20 per cent. of the Coal is lost up the Stack" instead of "20 per cent. of the Coal is lost in Smoke." The reasons for the change are twofold: First, the losses up the stack due to smoke, and even resulting from sooted boiler-heating surfaces, constitute only a small portion of the total loss; second, if a fireman bases his conclusions upon the degree of smoke emitted to indicate combustion performance, while trying to eliminate smoke by excess air, a lower efficiency will be likely to follow, although the stack does give a good indication of performance under some conditions. Smoke means fuel wasted. But for the majority of plants a smokeless stack also suggests fuel wasted. A fireman who accomplishes combustion efficiency will have little worry about smoke. It seems worth while to emphasize the difference at this time and avoid anything that tends to give a wrong impression.

Chicago, Ill. R. K. LONG.

Troubles and Their Remedies in Gas-Engine Ignition Systems

Referring to Mr. Brennan's article on "Troubles and Their Remedies in Gas-Engine Ignition Systems," Feb. 19, 1918, issue of *Power*, it is hardly fair to compare high- and low-tension ignition systems without showing where each is used at its best advantage. On motors running at high speed the high-tension system has proved itself the better, but on stationary engines of large piston displacement and low speeds, low-tension ignition is used almost exclusively.

The reason for this is that the low-tension arc gives off considerable more heat than the high-tension jump spark and therefore gives a more satisfactory ignition in the large cylinder, especially where low-grade fuels are used. On low-speed engines the mechanical make-and-break igniters give practically no trouble. On engines of large piston displacement and relatively high speeds low-tension magnetos and magnetic plugs have been used quite successfully.

Canton, China. HAROLD B. WILSON

Obstruction in Steam Separator

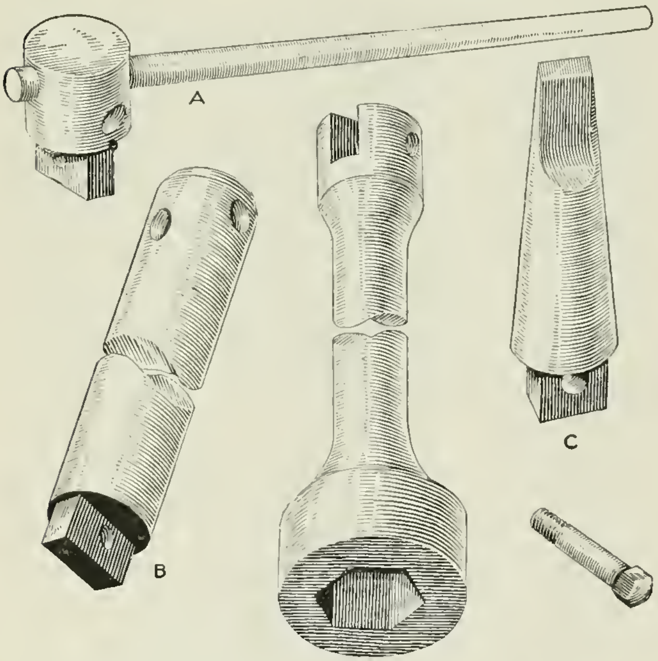
On taking charge of a power plant, I found that there was considerable drop in steam pressure between the boiler and engine at full load. Soon afterward, the cover was removed from the steam separator, and on the boiler side and partly filling the spaces were found numerous pieces of hard-rubber valve disks that had come from the 5- and 6-in. outlet valves on the boilers at different times and had been carried along the main and finally lodged in the separator. When a disk gave out on a valve, a new one would be put on, and the idea had prevailed that the missing parts of the old disk had been reduced to small particles and found their way out of the main. When the separator was cleared, the engines operated at full load without undue drop in steam pressure. This is the first time a case of this kind has come to my notice, and it may be of interest to others. JOHN JAMES.

Kingston, Ont., Canada.

Handy Socket Wrench

The illustration shows some easily made attachments for a socket wrench that will adapt it to a wide range of work. The piece *A* is for use with a bar, *B* is an extension, and the tapered or drill shank *C* permits the wrench being used in an air drill, saving considerable time and labor where a large number of nuts such as on condenser heads are to be put on. The final tightening, of course, is to be done as usual.

Concord, N. H. C. H. WILLEY.

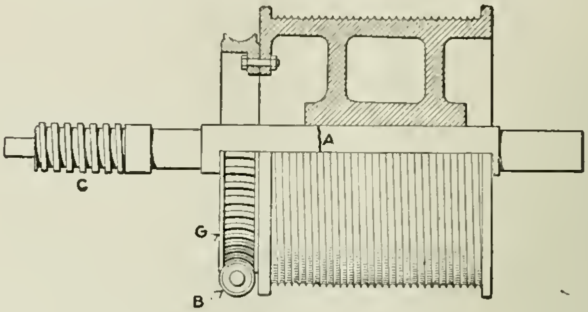


SOCKET WRENCH WITH VARIOUS ATTACHMENTS

Elevator Drum Shaft Broke

It is not an uncommon occurrence for elevators, especially the older type of machines, to drop several stories without setting the safety devices. Although they may not fall fast enough to cause any very serious damage, nevertheless they come down out of control of the operator and hit the bumpers at the bottom of the hatchway.

In the figure is shown in section the hoisting drum and gear of a belt-driven elevator machine, the car of which dropped without setting the safety devices. On inspecting the machine the only defect noticeable was, the limits did not stop the car at the top floor as they did before the accident, and on the down motion the car would stop about two feet above the basement landing. This was corrected by resetting the limit on the threaded end of the drum shaft *C*.



SECTION THROUGH DRUM, SHOWING BREAK IN SHAFT

Two hours after this accident I was called again by the mechanic, who stated that he could not get the worm of the driving shaft to mesh into the gear on the winding drum. The teeth of the gear *G* were resting on the outside edge of the thread of the worm *B*. On trying to reset the slack cable safety device, I noticed that the drum seemed to be raised up at the gear end. It was then decided to dismantle the machine and remove the drum shaft, which appeared to be either sprung or broken. When the bearing cap was removed from the gear end of the shaft, it was found that the end of the shaft could be easily moved in any direction, showing it to be broken just inside of the end of the drum, as at *A* in the figure. The machine had carried loads of 1000 to 1500 lb. with the shaft in this condition, but when sufficient weight was placed on the car the drum was lifted high enough to clear the worm. When the drum was in this position, it was rubbing on the ceiling, the friction of which acted as a brake to prevent the drum from unwinding rapidly enough to release the safety clutch on the top of the car, consequently the car went to the bottom of the hatchway before it stopped.

All elevator cars and machines should be inspected each day for any possible defects, as eternal vigilance is the price of safety. However, the foregoing is something that could not be very easily detected by an inspection. R. A. CULTRA.

Cambridge, Mass.

Sand for Extinguishing Fires

I saw a suggestion the other day that a number of buckets filled with water and some filled with sand should be placed in a convenient place in the electric station for use in case of fire. "Buckets filled with water" doesn't look good to me, as we all know what water and electricity will do, and although careful as possible, somebody is apt to get hold of the wrong bucket, especially if he comes from outside the operating room. D. R. HIBBS.

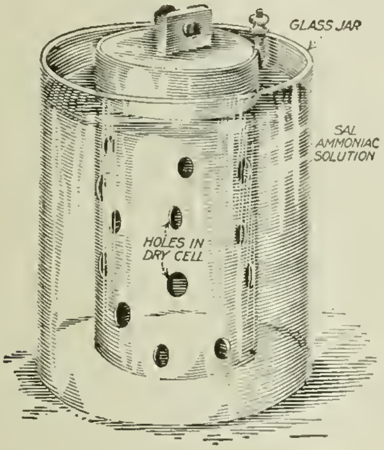
New York City.

Recharging Dry Cells

It is impossible to recharge dry-battery cells by passing an electric current through them as is done with secondary cells, because the chemical action in the cell, while in use, deteriorates and wastes the elements. Dry cells can, however, be partly recuperated by the following method, although the economy in doing this is doubtful in most cases, since new cells can be obtained more cheaply than the cost of material and time expended in recovering the old ones.

If the zinc containers of the cells are free from holes and in good condition, a sal ammoniac solution (0.25 lb. of sal ammoniac to about a quart of water) can be poured into the cell and allowed to soak into the porous compound between the carbon electrode and the zinc container, through holes bored in the asphaltum seal. When the solution has penetrated thoroughly, the cells should be resealed to prevent evaporation.

Another method, is to punch a number of holes in the zinc container and place the cell in a glass jar containing a sal ammoniac solution, using the dry cell as the carbon and zinc electrodes of the so-called wet battery, as shown in the illustration. Those who have occasion to renew their wet batteries can follow out this scheme to good advantage. Old dry cells can be obtained free of charge from most garages; then all one has to do in renewing the battery is to make a new solution and place the cell in it as stated in the foregoing. V. J. KUBANYI.

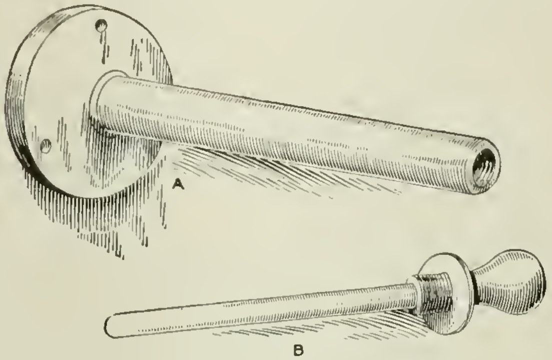


DRY CELL PLACED IN GLASS CONTAINER

New York City.

Filing Record Charts

The subject of keeping and filing recording-instrument charts is one to which considerable discussion has been devoted. The illustration shows a convenient way to file the record sheets of various curve drawing instruments so that they are always easy of access. A piece of brass pipe small enough to slip through the hole in the center of the chart is threaded into a flange as shown and mounted on the wall, as at *A*. The outer end of the pipe is threaded on the inside to receive the movable part *B*, which is made of a small rod threaded into a bushing that can be screwed into the tapped end of the pipe. On the other end of the bushing is threaded a knob and collar. The charts can be placed on the pipe and the rod screwed into the end of it, the collar keeping the charts from coming off. When any particular record sheet is wanted, all that has to be done is to unscrew the rod and slide the charts to the right of the one wanted onto the rod as it is withdrawn, and then the desired chart can be removed and the others replaced. If it is desired to mark the place where the removed chart came from, a piece of blank cardboard the size of the chart can be used for that purpose. W. H. NOSTAN.

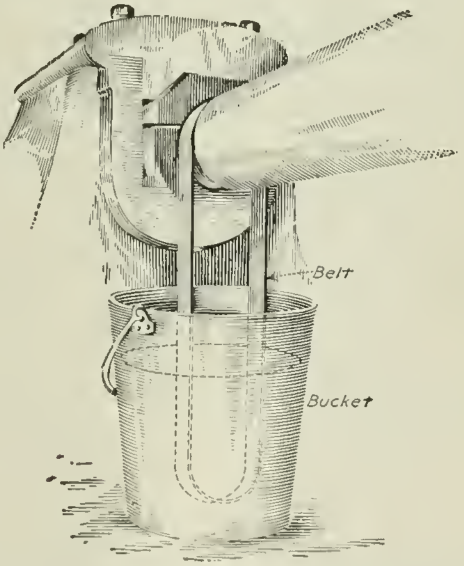


PARTS OF CHART-FILING DEVICE

Philadelphia, Penn.

Keeping Engine Bearings Cool

Some time ago a neighboring engineer had on one of his engines a bearing that ran hot no matter what ordinary measures were taken to keep it cool. As the machine could not be shut down, he tried the scheme shown in the figure with good results. A piece of old belting four or five feet long was placed around the shaft and the ends laced together. A bucket of water was then placed under the shaft and the belt allowed to hang into it. The weight of the belt on the running shaft caused it to travel through the water and carry enough of the latter to the shaft to keep the temperature near normal. Of course water worked into the bearing, but that was better than destroying it and the water did no harm until the machine could be shut down. W. T. BROWN.



ENGINE BEARING AND WATER BUCKET

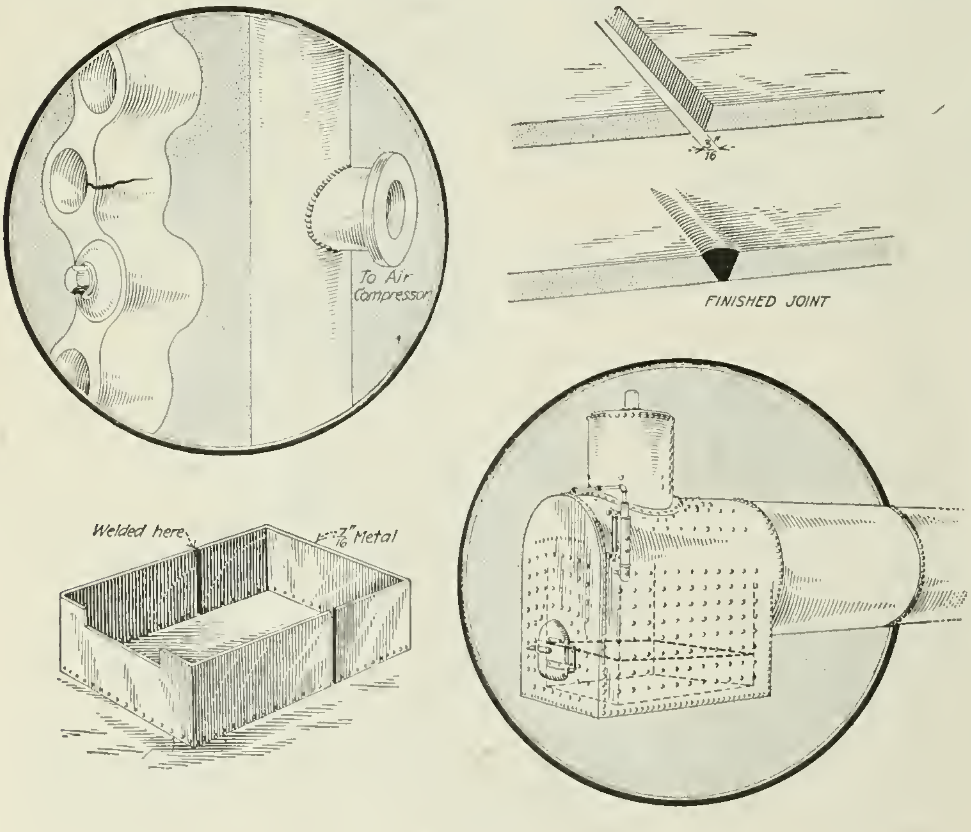
Philadelphia, Penn.

Repairs by Oxyacetylene Torch

I was interested in the way Mr. Oakley repaired the worn valve stem, as described in the issue of Feb. 12, page 230, because the same day that I received that issue I was repairing a valve stem worn in the same way, but I repaired it differently. About eight years ago I became interested in the utility of the oxyacetylene torch as part of my engine-room equipment, and it has saved me a lot of work and expense. I have done many kinds of jobs with it such as repairing broken parts of machinery and filling up worn parts, tapping steam lines, and welding cracks in steam pipes while in place.

A short time ago I put in a new air compressor that required a 4-in. steam connection, so I tapped a 5-in. pipe that was close by. I first cut a flange out of 1-in. plate with my cutting torch and welded the flange to a piece of pipe 6 in. long. Then I shut the steam off the 5-in. line and, with the torch, cut a hole in the pipe and set the 4-in. nipple into it in a straight line toward the air compressor and welded it in, doing away with a tee and two elbows. The actual welding time was an hour and a half, and a lot of labor was saved on this job. Many such jobs can be done with a welder's torch around an engine or boiler plant. About three years ago a crack developed near a handhole plate in a tube header of a B. & W. boiler, but I welded it up and have never "heard from it" since. The welding time was fifteen minutes, and the expense was trifling compared with what it would cost to take the header out and put a new one in. I would like to see brother engineers get to using the welding torch and save themselves a lot of time, labor and money. I have just finished putting in a part of a firebox in a locomotive boiler, as shown in the illustration. I have repaired three in this way, and one has been in use three years, one a year and a half and the last one about a year, and none of them has ever shown a leak although working every day. I would be pleased to see in POWER descriptions of repair jobs done by brother engineers. All that is required is practice and common sense.

Felton, Cuba. **JOHN I. CRANFORD.**



WORK THAT CAN BE DONE WITH THE OXYACETYLENE TORCH

Different Rate of Scale Formation

My attention was engaged by the letter by Thomas J. Pascoe in the issue of Apr. 9, page 521,* describing the scale conditions found in the boilers under his charge. The method of blowing soot from the tubes undoubtedly accounts for the different quantities of scale found in the tubes on the two sides of the boiler. Cleaning soot with the hand steam lance through the side doors would clean only part way across the boiler, and some of the soot blown from the tubes close to the dusting doors will be redeposited on the tubes on the far side, consequently, the rate of heat transmission is much higher on the side of the boiler near the dusting doors. With a uniform feed the amount of scale-forming material per gallon of water will be the same. If, however, on account of a difference in the amount of soot on the outside of the tubes, the rate of evaporation is two or three times as great in one tube as in another, the total amount of scale deposited will of course be greater.

After a certain amount of scale is deposited on the inside surface of the tubes near the dusting doors, the rate of heat transfer through different tubes across the width of the boiler will tend to equalize, because the greater resistance of the soot on the far tubes will be balanced by the greater resistance of the scale on the tubes nearest the dusting doors. The soot deposit accumulates more rapidly than the scale, however, and on account of the dead gas film surrounding the soot deposit, the insulating effect of the soot is much worse than that of the scale. For this reason the rate of steam-making and the amount of scale in the soot-covered tubes can never catch up to those that have been cleaned from soot.

I believe that if Mr. Pascoe will clean all the soot from each of his boiler tubes, he will find that the amount of scale deposited in each tube of one horizontal row will be very nearly the same across the full width of the boiler. The condition he has found is proof of inefficient soot removal by the hand steam lance by side dusting doors. **CHARLES DEVED.**

New York City.

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*See also page 559, April 16, 1918.

Inquiries of General Interest

Cross-Sectional Area of Smoke Uptake—For a horizontal return-tubular boiler should not the smoke uptake have the same areas as the united areas of the flues? T. E.

For good results from the flues as heating surfaces, the smoke area of the flues usually is made one-seventh to one-eighth the area of the grate, but with tight connections, easy courses for the smoke and good stack draft, an uptake area one-tenth of the area of the grate will be sufficient.

Operation of Blowoff Valves in Series—What is the proper manner of operating the blowoff valves on a boiler when it is equipped with two valves in series? R. M. H.

There will be more wear and cutting of the inner valve, and it will be nearly the same whether the outer valve is opened before or after the inner valve; and as the outer valve will be least injured when wide open, in blowing off it is better to first open the outer valve fully and leave it wide open until the inner valve has been fully closed.

Rerolling of Boiler Tubes—Is there any danger of running return-tubular boilers too long without rerolling the tubes provided they have never leaked? The tubes of my boilers have been used for about four years without leaking and have not been rolled during that time. W. P. S.

If the tubes have been properly flared or beaded over at the ends, rerolling them should not be done with the purpose of increasing their hold on the tube sheets as rerolling has the effect of weakening the tube material and should be performed only for the purpose of stopping leaks. To disturb the present setting of the tubes might start leaks.

Burning Wood and Coal Together—Can boiler firing be performed economically by burning wood and coal together? C. R. F.

Much better results are to be obtained, both for fuel economy and boiler capacity, by burning the different kinds of fuel separately. When wood and coal are fired alternately, or together, the light, rapidly formed ash of the wood blankets the coal and prevents a free supply of air, requiring frequent stirring of the fuel bed, which retards progressive combustion of the coal and results in waste from dropping of unburned fuel through the grates.

Composition of Ash in Coal—What does the ash in coal consist of? W. H. L.

The ash in coal may be considered to be derived from the original vegetable material or substances deposited during the laying down of the coal bed, or subsequently. The ingredients as ash exist as a mechanical mixture of silicates, oxides and sulphates; the different percentages vary greatly, usually with predominance of the silicates, and composed largely of silica (SiO_2), oxide of aluminum (Al_2O_3), oxide of iron (FeO or Fe_2O_3), oxide of lime (CaO) and oxide of sulphur (SO_2). Smaller percentages are contained of oxide of magnesium (MgO), oxide of sodium (Na_2O) and oxide of potassium (K_2O).

Adiabatic and Isothermal Expansion and Compression—What is the difference between adiabatic expansion or compression and isothermal expansion or compression? B. H.

When a gas expands and neither receives nor parts with heat during the expansion excepting the loss of heat due to the external work performed by its expansion; or when compressed it neither receives nor parts with heat during compression, excepting the mechanical equivalent of heat received for its compression, such expansion or compression is said to be adiabatic. If a gas expands and receives during expansion the exact amount of heat that it expends in performing work, or when compressed, if it rejects the amount of heat equivalent to the mechanical energy spent upon it, and there is no other heat received or lost, the temperature remains constant and the expansion or compression is called isothermal.

Injector Will Not Feed Boiler—An injector that until recently operated all right for feeding a boiler will lift but will not discharge water to the boiler. What is suggested to remedy the trouble? S. A.

The injector should be supplied with dry steam taken from a separate connection out of the top of the boiler. If any other supply is taken out of the steam connection it is likely to reduce the pressure too much. The steam-supply and water-discharge pipes, valves and fittings should be examined and cleaned of any rust or scale. If the injector will not operate with clear connections to the boiler, it should be taken apart and cleaned of scale and carefully examined. The tubes or passages may be badly worn from cutting action of the steam or from gritty water, requiring the renewal of defective parts.

Lining Up Crankshaft from Guides—Would it be practical to line up the crankshaft of an engine by taking the line from the V-guides in the frame? J. F.

For proper working conditions, the wearing surfaces of the guides should be parallel with the cylinder center line and it would be practical to line up the crankshaft from the wearing surfaces of the guides if they are known to be in proper alignment. It is better to refer all alignments to the cylinder center line, for this always is derivable from the cylinder counterbore which is not subject to wear and bears a constant relation to the framework of the engine; besides, greater accuracy in relative alignment of different parts of an engine is obtainable by referring all adjustments in as direct a manner as possible to a single permament base-line.

Loss of Heat Value from Moisture in Coal—What would be the percentage of loss of heat due to 12 per cent. moisture in coal if the dry coal contains 13,500 B.t.u. per pound? J. W. L.

The water in the coal must be evaporated from the temperature as fired and discharged as steam superheated to the temperature of the uptake gases.

The loss in B.t.u. per pound of the moist coal would be

$$W\,[212 - t + 970.4 + 0.47\,(T - 212)],$$

in which

W = Percentage of moisture;
t = Temperature of the coal as fired;
T = Temperature of the uptake gases;
0.47 = the mean specific heat of superheated steam.

Assuming $t = 60$ deg. F. and $T = 500$ deg. F., the heat loss per pound of the moist coal due to the presence of 12 per cent. moisture would be $0.12\,[212 - 60 + 970.4 + 0.47\,(500 - 212)] = 150.9$ B.t.u.

With 13,500 B.t.u. per lb. of dry coal and 12 per cent. of moisture, each pound of the moist coal would contain 88 per cent. of 13,500 = 11,880 B.t.u., so that the loss due to the presence of 12 per cent. of moisture would be

$$\frac{150.9 \times 100}{11{,}800} = 1.27 \text{ per cent. of the theoretical heat value}$$

of the moist coal. The heating value of the coal reduced to a dry coal basis would be equivalent to 11,880 — 150.9 = 11,729.1 B.t.u. per pound of the moist coal, so that the presence of 12 per cent. moisture renders the coal of

$$\frac{(13{,}500 - 11{,}729.1) \times 100}{13{,}500.} = 13.1 \text{ per cent. less commercial}$$

value than if the coal were dry.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

National Coöperative Convention A. A. E.

MAY 14 at the City Club, Chicago, the American Association of Engineers held its fourth annual convention. Delegates from all engineering societies in the country had been invited jointly by the Committee of Engineering Coöperation and the association, as the question of coöperation was to receive further consideration. Representatives from approximately fifty societies attended. Practically all were local associations, or chapters of the national societies. President E. T. Perkins called the convention to order and the delegates were made welcome by John Ericson, city engineer. To conserve time the convention was split up into five special sessions as follows: No. 1, under W. D. Gerber, to review return reports of a questionnaire that had been sent out to all societies; to consider how they can avoid duplication and coördinate activities, and to report on the advisability of uniform legislation for licensing engineers. Session No. 2, headed by F. R. Low, was to review publicity given the profession due to its activities in the war. No. 3, with W. H. Finley in the chair, considered the demand for and the supply of technical men for war work and the advisability of a central coöperative employment agency to prevent the tax of commissions on engineers employed for Government work. G. W. Heald headed session No. 4, which was to consider what has been done by engineers to increase the distribution and conservation of fuel. In session No. 5 Prof. R. C. Yeoman conducted the discussion on the advisability of standardizing engineering education. Summaries of the discussions in the individual sessions were reported back to the convention at the afternoon meetings.

SESSION NO. 1 REVIEWS QUESTIONNAIRE

The questionnaire, which session No. 1 reviewed, consisted of 24 different questions divided into five distinct groups, as follows: Society activities, war programs, employment features, education and publicity. A summary of the returns from 64 societies having a total membership of 31,500 scattered throughout all parts of the country, but not including the four big national societies, may be of interest.

The number of members in active military service averaged 15 per cent., those who still desire to enter military service, 10 per cent., and the members available for emergency government work, 50 per cent. The general opinion was that the status of the engineer will be better after the war. Only two societies are at present organized so as to give systematic service in securing employment for engineers who return from the war. Other societies will be willing to do all that they can. The present demand considerably exceeds the supply of technical men in all localities except the South. The demand is primarily for engineers in positions below that of an assistant engineer. Many war industries are suffering for want of this class of men. The individual efficiency of technical men can be raised through improved education, through individual concentration, through united societies and through more active part in public life, through mixing and through earnest coöperation. Considering the increased living expenses, the sentiment of all societies is that the technical profession is paid from 50 to 75 per cent. too low; that its members are not paid sufficient for what is expected of them when compared with what other classes of men receive. The war has reduced the amount of work for engineers in private practice for all except chemical engineers. The compensation has remained about the same.

The societies generally favor licensing engineers, especially if license laws are made uniform by Federal action and if proper investigation is made so that the law provided is just. The societies are unanimously opposed to reducing the present four-year engineering courses, as even this is inadequate training. They think that the year should be 50 weeks, and the work more concentrated, so as to reduce the time element. Special short courses are also advocated for those who desire to go into war service immediately. The majority of the societies favor standardizing engineering courses, so as to obtain uniformity throughout the country, standardization to be done only in a general way and so as not to interfere with individual specialization. The societies have had only limited success in securing publicity, that obtained being in the technical press and in a few instances in the local papers. The societies that expressed an opinion recommended coördination of society activities through some national body, but as a whole there was no consensus of opinion as to what that body shall be or how coördination shall be worked out.

COÖRDINATION OF SOCIETY ACTIVITIES

Discussion at the session centered in coördination of society activities. Hunter McDonald presented the Nashville plan as an answer to question 24. It was his opinion that there were at least 200,000 engineers in the country and only about 30,000 were enrolled in the four big national engineering societies. The plan of procedure, having nine subdivisions, follows: (1) Determine what shall constitute an engineer. (2) Take a census of these in each state. (3) Perfect organizations in each state on a common constitution. (4) Determine upon an equitable representation of each state organization. (5) Arrange a central government of delegates in coöperation with the Engineering Council, delegated representatives to have a majority vote. (6) Local organizations to continue autonomous, but to become a working part of state organizations upon a basis to be worked out. (7) All local organizations in any one locality to be combined. (8) National societies to retain their organization and autonomy for technical purposes only, surrendering all other activities to the central body. (9) All other organizations intermediate between the national or central body and the membership or state organization to be disbanded.

A second plan to bring about close unity and fellowship among engineers in each community was presented by C. A. Drayer, of Cleveland. It had been prepared by the administrative committee of the Committee on Coöperation, and while professedly incomplete, owing to lack of uniformity in dues and standards of membership, it was offered as a model that might be expanded to suit conditions. Some of the organization principles in the intersociety relation problems were enumerated as follows:

Existing organizations shall be encouraged to study their own efficiency, shall be strengthened by all possible aid and no new ones created in fields already occupied.

Work shall be divided among existing organizations so there shall be no duplications or waste of effort.

Existing organizations shall be closely knit together by a workable relation capable of vigorous growth and usefulness to the profession and to the public.

Within the community unity shall be brought about as in National and state governments by each engineer belonging to the local society rather than by affiliation of local chapters or sections of the national societies with one another or with the local society. This is the essentially American ideal.

The first principle shall be the good of the whole.

JOINT MEMBERSHIPS

It was recommended that arrangements be made between any two societies that members in either society at the time the agreement is made may be admitted to the proper grade of the other society without further payment of initiation fees and without further payment of dues until the time has expired for which dues have been paid to either society, but not to exceed one year. Thereafter one initiation fee shall admit an applicant to the local society and one national society, provided he make application to both at one time and is eligible by professional qualifications; and thereafter dues in amount agreed upon by the parties to the agreement, but less than the sum of the separate dues, shall be paid to the local society, which will remit the agreed part to the national society. When any member within the jurisdiction of the local society has joined only one society after the conclusion of the arrangement and desires to take out joint membership, there shall be favorable arrangements for him to do so, but such arrangements shall be less favorable than in either of the situations mentioned.

Reference was made to the coördination that had been effected already in Ohio and Minnesota.

In a paper on the same topic presented at the afternoon session, Major Gardner S. Williams considered ideal an organization by states or districts from which members of a central council would be selected or elected and by this central council an executive board be chosen with authority to act and to direct the energies of the whole membership. This is virtually the organization of the Engineering Council, except that its authority is not clearly established. So far as a representative body for the 30,000 members of the four great national societies is concerned, the delegation of authority would meet the case, but it was questionable that it would fill the needs of the much greater number who were today outside of these national societies.

Major Williams considered it desirable to persuade the Engineering Council to provide for a general organization, to have them invite the several strong local or state societies to send delegates and with its aid to build up in every state in the Union an effective organization of the engineers therein.

It was the latter counsel that prevailed. The convention voted that a committee be appointed to confer with the Engineering Council and work out a plan satisfactory to all concerned. The discussion on licensing engineers was postponed, as there was not sufficient time to do justice to a question of so much importance. It was placed in the hands of a committee to investigate and report at the next convention.

Discussion at the Other Sessions

At session No. 2 the discussion turned to the backwardness of the engineer in public life and his undue modesty in not claiming the credit due the profession for the great engineering achievements in war and civil work. It was a defect that must be remedied if the engineering profession ever expected to take its place in the sun.

Session No. 3 brought in a resolution to the effect that the matter of fees being paid to private employment agencies for employment by the Government be brought to the attention of the proper authorities in Washington to the end that the practice be discontinued and the service be obtained from the Public Service Reserve.

A summary of the discussion at session No. 4 follows: To increase the distribution of fuel, the Fuel Administration has divided the United States into zones in order to eliminate long hauls and increase the useful service of coal cars. Industries have also been graded in order that those most essential in the conduct of the war shall have preference in order of their importance. Engineers should use and encourage others to use as far as possible coal produced nearest the point of consumption. It was also recommended that engineers wherever possible urge the prompt unloading of coal cars within twenty-four hours as ordered by the Fuel Administration. Violations of this order should be reported to the nearest local representative of the Fuel Board. Industries were urged to maintain a storage supply of at least sixty days.

To increase the conservation of fuel, engineers should become familiar with and encourage the use of bonus systems. Domestic users should be reminded to heat only such rooms as are absolutely needed, to 70 deg. or less and humidify as much as possible. Fire lightly and often, half of the fire bed at a time, when burning bituminous coal. Sift the ashes and recover the unburned coal if anthracite is burned. Watch the draft. Industrial users should be reminded that steam leaks are fuel leaks, so also are radiation losses. Both are preventable and should be reduced to a minimum. Where heating is done by steam, make the steam first do work. The power developed is a byproduct and the engine or turbine is a reducing valve. Make full use of the exhaust steam. It was the belief of the delegation that the greatest possible conservation of fuel could and should be acomplished by the carbonization of bituminous coal in byproduct coke ovens in conjunction with electric power generating plants, using the resultant coke and gas in place of coal as fuel and recovering the valuable byproducts, which are wasted when the combustion of coal takes place. Coke plants should be located at the mine where feasible.

It was suggested that all legal holidays, national or local, be observed on the nearest Monday, if said holiday should fall on any other day except Sunday. This would avoid a double stop and start each week should a holiday occur in the middle of the week.

Session No. 5 on standardizing engineering education, suggested the appointment of a committee, supplied with funds, to make up a detailed questionnaire to be sent to all societies, schools and individuals who were interested, the results to be analyzed and reported at the next convention. A resolution to this effect was laid on the table.

In the discussion following, the proposed American Academy of Engineers was subjected to severe criticism. It was considered undemocratic and not representative. Self-creation and self-perpetuation were the main objections. Before making the criticism official, a referendum, stating both sides of the question fairly, was ordered by the convention.

Realizing that the time is ripe for an inspiring code of ethics that would be a credit to the engineering profession, Isham Randolph was asked to prepare one and present it at the next convention. Other matters of importance acted upon at the afternoon session were a resolution favoring universal military training and a telegram to Director-General McAdoo to the effect that railway technical engineers did not think it just to base the wage increase on the rate of 1915. They favored the 1918 rate as a basis, and even then it would not compensate for the increase in living expenses.

The Evening Meeting

A dinner meeting in the evening was the last session of the convention. Isham Randolph, who was toastmaster, first called upon E. T. Perkins, retiring president. The work of the association during the past year was reviewed briefly. The rapid growth was gratifying. Several new chapters had been organized and every month 100 new members had been added. Service was the watchword of the association and was the secret of its success.

Samuel Insull delivered a most interesting and instructive address on Illinois War Work. Mr. Insull is chairman of the State Council of Defense of Illinois, which has made such an enviable record in organizing and carrying on the work made necessary by the war.

James A. Davis, chairman of Speakers Bureau, National War Savings Committee, spoke on the topic "Financing the War." To show the necessity of winning the war he enumerated in detail the natural resources in the conquered territory now in the possession of Germany, the great population that would be under her control and the possibilities of the future with these resources back of her. The financial status of this country was reviewed, and the great possibilities of savings were emphasized. An army of savers must stand back of the men at the front, and with their contributions this country could spend 30 to 35 billion dollars per annum for twenty years and be no poorer than today.

Alfred D. Flinn, secretary of the Engineering Council, reviewed the efforts to draw together the four large national associations and the present activities of the body he represented, its aim being "the engineering profession united to serve America."

Following, representatives from various chapters located in Indiana, Wisconsin, Minnesota, Virginia, Georgia, Pennsylvania, Texas, Oklahoma and even as far west as California, spoke briefly. All showed enthusiasm and interest in the organization, which if properly directed should result in great things for the association.

Officers for the ensuing year were announced as follows: W. H. Finley, president; H. W. Clausen, first vice president; G. F. Vivian, C. A. Gaensslen and J. T. Mullin, national auditing committee; Harold Almert, F. K. Bennett, T. M. Chapman, J. N. Hatch, Alexander Potter and J. H. Prior, directors.

When wood alcohol is to be used to any extent, have the room very well ventilated, as it affects the eyes and even produces blindness.—*Marine Engineering.*

Colonel Carty Receives Edison Medal

Dr. John J. Carty, Colonel in the United States Army Signal Corps and Chief Engineer of the American Telephone and Telegraph Company, has been awarded the Edison Medal in recognition of his meritorious achievements in the science and art of telephone engineering.

The medal was presented on Friday evening, May 17, at the annual meeting of the American Institute of Electrical Engineers in the Engineering Societies Building in West 39th St., New York. Colonel Carty is the eighth American scientist to be honored in this way, the others being Elihu Thomson, Frank J. Sprague, George Westinghouse, William Stanley, Charles F. Brush, Alexander Graham Bell and Nikola Tesla.

A statement of the history and significance of the medal was made by Dr. A. E. Kennelly, professor of electrical engineering at Harvard University and Massachusetts Institute of Technology, who was chairman of the Institute's 1917 Edison Medal Committee. Dr. Michael I. Pupin, of Columbia University, told of the work of Colonel Carty, the foremost telephone engineer in the world. The medal was delivered by the president of the Institute, E. W. Rice, Jr., also a scientist of note, who is president of the General Electric Company.

The Edison gold medal was founded in 1904 by the Edison Medal Association, an organization composed of old associates and friends of Thomas A. Edison. It is awarded annually by a committee of 24 members of the American Institute of Electrical Engineers, the first recipient being Elihu Thomson in 1909.

President Rice said in part:

> More than any other man, Colonel Carty is responsible for the development of telephone engineering as it is known today, and it is peculiarly fitting that he should receive this new honor at a time when he is working day and night to promote the best military use of mediums of communication which have been developed largely through his efforts in time of peace for the advancement of the nation's social, commercial and industrial activities.
>
> Colonel Carty is well known as the engineer of the great transcontinental telephone line, the longest in the world, and as the engineer who made possible wireless telephoning over distances up to 5000 miles.
>
> He entered the telephone business when it was in its infancy, and it would be difficult to find a phase of its development which does not bear some imprint of his genius. His technical achievements are so numerous as to prevent full recounting. He first pointed out the correct theory of induction between telephone circuits, showing how to obtain a balanced metallic circuit and devising methods for correctly transposing phantom telephone circuits. That was in 1887.
>
> In 1888 he developed the bridging bell and pointed out the importance of the bridging principle of telephone construction in obtaining efficient operation of telephone systems and in constructing balanced metallic circuits. In 1889 he invented the principle of the best and most generally used common battery system, by which a number of telephone instruments may be simultaneously operated from a single central battery. During this period he also devised important improvements pertaining to switchboard circuits having to do with the busy test feature and the connecting in of operators' instruments.
>
> In 1912 the telephone engineering force built up and directed by Colonel Carty had so far overcome the difficulties in the way of underground telephony as to make possible all-underground talking between New York and Washington, and by 1913 they had extended the range of underground telephony to connect Washington and Boston.
>
> The year 1914 witnessed the fruition of the efforts of these engineers to bring transcontinental telephony into existence, and in 1915 Colonel Carty was able to present to the world important developments in wireless telephony, which made possible the hurling of words through space across the American continent from Washington to Mare Island, California, from Washington to Hawaii, 4900 miles distant, and from Washington to Paris, bringing Europe and America into speaking distance of each other for the first time.
>
> Then came the threat of war with Germany, and in 1916 Colonel Carty coöperated with the Signal Corps of the Army and with the various departments of the Navy in making arrangements which would insure the readiness of the Bell Telephone System for military service in case this country did become involved in the great conflict. In 1917 these plans were put into active use with a marvelous degree of success.
>
> Colonel Carty's technical telephone achievements alone would entitle him to his preëminent position in his field, but he also occupies an equally high place in the regard of scientists because of the character of his work in directing, developing and coördinating telephone engineering.
>
> He has always insisted upon the importance of determining the requirements of the service before undertaking to develop specific ideas. He has always emphasized the necessity for getting the full set of facts in each case and of studying the effects of growth so that a new device may not only be satisfactory at the start, but may fit into the system as it develops. The several hundred engineers engaged by the Bell System in conducting researches, testify to the value which Colonel Carty places upon this phase of telephone work, just as they do the emphasis he puts upon the importance of keeping bad devices and methods out of the telephone plant. Colonel Carty is known also for his marked ability to make friends with and inspire confidence in those with whom he comes into contact, so that his name is one to conjure by among those for whom he works, those with whom he works and those who work for him.

Dr. Pupin said:

> Carty's life is filled with romance. He never went to college. At the age of 18 when other boys entered college he entered the service of the American Bell Telephone Co. and at the age of 25 became chief engineer of the great New York Telephone Co. He started without getting honors, titles, and now he is a doctor I do not know how many times and on the top of these titles colonel of the United States Army. If General Pershing has his way Carty will be a general before many a day. General Pershing understands that Carty is made of stuff of which great generals are made.

Colonel Carty in his speech of acceptance gave credit for the American Telephone achievements to the engineers who have been associated with him in the Bell System and paid a tribute to Maj. Gen. George O. Squier, chief signal officer of the United States Army for his work in planning before the United States entered the war for the rapid mobilization of telephone wires and telephone men for Signal Corps work. Referring to the Bell System engineers, Colonel Carty said:

> We hear a great deal about the German scientist and the wonderful things he has done and has been planning. Many years ago, when German "Kultur" was interpreted by many to mean German culture, it was suggested to me that we should send to Germany to get some of the Herr doctors to teach us the high science. I always opposed that, believing that the Yankee mind, the Yankee boy, when his attention was turned to scientific problems would surely outdistance a German. I concluded that our work could be trusted to these young Yankee minds and that they should be trained in our work and that through them we would undertake to outdistance anything that has been done in Germany. That policy has worked out successfully. The young men who have collaborated with me all these years are graduates of over one hundred universities all here in America.
>
> When at the opening of the war there was a searching of hearts and a census and a taking account of stock to find out who was loyal and who was to be suspected, I know you will all be pleased to hear that among all of these scientists and all of these engineers all working in the Bell System all over the United States we were not able to find one single Hun; they were all true Americans to the core.

Cottonseed Oil Cake as Fuel in Egypt

The high price of coal and the shortage of ocean freight space have produced a condition in Egypt under which cottonseed oil cake is being used as a substitute for coal as fuel, according to *Commerce Reports*. The high price of coal induced experiments with oil cake. The relation of the calorific value of cake to coal was found to be 1¾ tons of cake to 1 ton of north country large coal.

The present price of coal in Egypt is about $80 per ton. The price of oil cake at various times during the last two years ranging between $32.50 per ton and the present price of $15. Cake is now being largely used in place of coal in boiler plants, in hotels, restaurants, and private houses. One large concern saves two men per boiler in burning cake instead of coal. Cake ash has a value as fertilizer of about $25 per ton.

"Coal Week" from June 3 to 8

Coal week, the period from June 3 to 8, has been selected by United States Fuel Administrator Garfield for an intensive and specific drive on the early ordering of coal. The fuel organizations of the various states, the county chairmen of fuel committees throughout the nation, coal dealers, chambers of commerce, mine operators and others are all called upon to do their utmost to make this week's drive a big success.

From some states has come the objection that the trouble about the coal supply does not come from the consumers, industrial or domestic, but from the dealers, who complain that they can not get sufficient coal to deliver. In spite of this, the Fuel Administration is anxious that the early ordering campaign be vigorously pushed.

By accumulating a large volume of orders in the hands of the dealers it is expected that there will be demonstrated to every agency concerned in the distribution of coal the universality and urgency of the demand and this, in turn, will give rise to a steady and increasing pressure for rapid and equitable distribution. This is particularly true as to the railroads and other transportation agencies. Every unfilled order for coal will at once become an active and pressing argument for increased distribution efficiency. By keeping coal orders constantly accumulating, the resulting pressure, it is believed, will have the effect of maintaining production at the highest possible point during the summer months.

It is also felt that with the bulk of the year's supply of coal ordered well in advance, the various distribution agencies of the Government will be in a position equitably and properly to adjust the demands as between different communities. It will be possible accurately to gage the increased demand and properly to divide the available supply.

It is pointed out that it is obvious that the entire coal output of the country cannot all be delivered at once; but at the same time it is clear that no matter what the condition of the supply may be those orders that are on the books of the dealers will be filled prior to those received later in the year.

The state branches of the National Council of Defense are being asked to aid in this "early-ordering" drive, and the Fuel Administration believes that if the bulk of orders, both domestic and industrial, are in hand by July 1 there will result a marked improvement in railroad facilities, especially as by that time millions of dollars' worth of the new equipment ordered by the Director General of Railroads will have come into use.

While particular pains are to be taken in this campaign to reach the domestic consumer in an effort to ward off any possible coal shortage in the homes next winter, it is plain that, after all, the greatest help toward the plans of the United States Fuel Administration must come from the large industrial consumers who, by getting in early their orders for the bulk of the fuel their plants will need, can lend a tremendous impetus toward speeding up production at the mines and delivery that shall employ to the fullest all transportation facilities.

Although the "early ordering" campaign has practically only begun, its effects are already being felt in increased production. The week ending Apr. 27 showed, according to the reports of the United States Geological Survey, a total production of 11,668,000 net tons, an increase of 5.7 per cent. over the preceding week. The average production per working day was 1,946,000 net tons, compared with 1,840,000 net tons the week previous and 1,680,000 net tons during April, 1917.

The week ending Apr. 27 recorded not only the highest rate of production for the past 12 months, but was the third successive week of rising production.

There was also a gradual improvement in car service conditions in the mines during the week ending Apr. 20. Loss of production due to car shortage throughout the entire country was 16.2 per cent. as against 18.1 per cent. in the preceding week. The loss due to labor shortage was 4.8 per cent., as against 3.8 per cent. in the preceding week.

The reports showed an improvement in the demand for coal, due to the coöperation of coal consumers with the Fuel Administration's campaign for early ordering. The loss of production due to "no market" in the week ended Apr. 20 was only 1.8 per cent., for the country as a whole, as against 2.8 per cent. in the preceding week.

The loss due to "no market," however, is still large in the states west of the Mississippi River, where summer production must be maintained if the consumers are to avoid a serious coal shortage next winter. The mines in these states have ample capacity to care for the consuming territory allotted them under the zone system of distribution, but these mines must be kept at work at maximum capacity throughout the year in order to provide a proper supply.

The mines of Kansas and Missouri showed a loss of production of 7.5 per cent. due to lack of demand. Those of Oklahoma and Arkansas showed a falling off of 9.3 per cent. due to the same cause. Iowa mines lost 30.7 per cent. of their production because buyers were not available, the Pacific Coast States showed a loss of 5.8 per cent. due to this cause, and the Rocky Mountain States a loss of 12.3 per cent.

While all these figures showed an improvement as compared with previous weeks, the Fuel Administration will make a determined effort to eliminate all loss of production due to lack of market.

Richmond, Va., To Save Electric Current

The Fuel Administrator of the City of Richmond, Va., has requested the city to sell its surplus electric energy to the Virginia Railway and Power Co. If this idea is carried out, it will save a matter of 6000 tons of coal annually.

Fuel Administrator Byrd states that an investigation by electrical experts disclosed that 4,000,000 kw.-hr. of power generated by water without cost by the electric plant owned by the City of Richmond is not being utilized and is being permitted to go to waste. The commercial sale of this power is prohibited under an existing city ordinance. The sale of this surplus power to the Virginia Railway and Power Co. will enable the release of an estimated quantity of from 5000 to 6000 tons of coal annually. The City of Richmond will benefit by receiving the fair market prices of the power for which they are not now receiving any return.

Before the intercommunication is established between the municipal electric plant and the power house of the Virginia Railway and Power Co., an ordinance must be passed permitting the city to buy and sell electricity. After the passage of the ordinance the administrative board would determine whether the city desired to sell its surplus current, and whether it would sell to the Virginia Railway and Power Co., or to some other consumer. The request of the Fuel Administration is taken in certain quarters to mean the initial step toward the conservation of coal, and if such action is necessary the administration will direct that the surplus current be sold to the commercial company. There exists at the municipal plant from time to time surplus water power which, under present conditions, goes to waste. By connecting the two systems all surplus energy generated by the water power station of the city plant would be thrown into the feed main of the Virginia Railway and Power Co., and would thereby enable a corresponding reduction in fuel consumption at the steam plant of the traction company. Through this interconnection there would be added to the power supply of the city a needed surplus.

If this proposition is carried through, it will create a valuable precedent for many similar cases throughout that section of the country.

It is understood that the intercommunication between the two plants would exist only for the duration of the war, and the individuality of the power houses would in no way be disturbed. The Fuel Administration suggests that a Board of Arbitration be formed to adopt a fair rate at which the surplus electricity will be sold to the traction company, and offers to place priority orders for all equipment needed to effect the connection. It is estimated that the revenue to the city would be about $40,000 per year.

Students To Have Military Standing

To provide military instructions for the college students of the country during the present emergency, a comprehensive plan will be put into effect by the War Department, beginning with the next college year, September, 1918. The details remain to be worked out, but in general the plan will be as follows:

Military instruction under officers and noncommissioned officers of the Army will be provided in every institution of college grade which enrolls for the instruction 100 or more able-bodied students over the age of 18. The necessary military equipment will, so far as possible, be provided by the Government. There will be created a military training unit in each institution. Enlistment will be purely voluntarily, but all students over the age of 18 will be encouraged to enlist. The enlistment will constitute the student a member of the Army of the United States subject to active duty at the call of the President. It will, however, be the policy of the Government not to call the members of the training units to active service until they have reached the age 21, unless urgent military necessity compels an earlier call. Students under 18, and therefore not obliged to enlist, will be encouraged to enroll in the training units. Provision will be made for coördinating the Reserve Officers Training Corps system, which exists in about one-third of the collegiate institutions, with its broader plan.

This policy will accomplish a twofold object: First, to develop as a great military asset the large body of young men in the colleges; and second, to prevent unnecessary and wasteful depletion of the colleges through indiscriminate volunteering by offering to the students a definite and immediate military status.

High-Grade Men Wanted for Army Ordnance

An urgent call for high-grade technical men and operatives to fill war positions in industrial establishments was made May 13, through the Civil Service, by the United States Army Ordnance. Salaries ranging from $1600 to $6000 a year will be paid the men who qualify for the places.

Chemists and chemical engineers, men experienced in the manufacture of gas, mechanical engineers on high-pressure apparatus, engineers to take charge of power houses and foremen of machine shops are needed. Persons of military age accepting appointment will not avoid the obligations of the Selective Service Law.

No applications will be accepted from Government employees or employees of firms or corporations engaged in contracts for the Government or its Allies unless written assent to such application is given by the head of the establishment that might be seriously handicapped in its war work by the loss of the man.

Salaries ranging from $1600 to $2400 will be paid junior mechanical engineers on high-pressure apparatus. Experience in the operation and control of high-pressure hydraulic and gas machinery is necessary. At least one year of such experience will be required of graduates in mechanical-engineering courses from recognized colleges. Four years' experience is required of high-school graduates.

Power-house engineers will be paid $1800 to $2400 a year while working for the Ordnance Department. Supervision of operation of water-tube boilers, condensers, pumps, steam turbines and alternating- and direct-current generators and motors are among the duties of these men. Machine-shop foremen with salaries from $1800 to $2400 also are wanted. Ten years' experience as machinists, three years in a responsible supervisory capacity, is required.

Assistant operatives in the manufacture of water gas and producer gas, mechanics experienced on high-power apparatus, and operatives of acid and chemical apparatus are needed. Many positions are open. The needs of the service are so imperative that applications will be received indefinitely. Further information is obtainable of the Civilian Personnel Section, U. S. Army Ordnance, 1330 F St., Washington, D. C.

Women for the Drafting Room

In response to an appeal from the Government to help find engineering designers and draftsmen, Dean M. E. Cooley, of the University of Michigan, has suggested the plan of fitting women for tracers and as inspectors of materials. This would relieve men for the more important duties of draftsmen and designers and help fill places made vacant by the draft. Inquiries among engineers developed the fact that those who had employed women in such capacities were enthusiastic. They were particularly neat in their work, accurate and dependable. Due to shortage of help, other engineers were anxious to give them a trial. As a result, the University of Michigan has arranged as a war-time measure a summer course to prepare women for this new work. Similar action might well be taken by other engineering colleges of the country, and it should be to the interest of engineers to support the movement and help it along by employing the girls when they have received their training. In this connection the following resolution, passed at a joint meeting of the Detroit Engineering Society and the Detroit Section of the American Society of Mechanical Engineers, shows that the possibilities of employing women in the drafting room and allied work are appreciated, and that there is the desire to allow them to give direct help in winning the war:

Whereas, The demands of the country for men and means to fight the war have resulted in a deficiency of skilled workers in the trades and professions; and

Whereas, The women of this country could with a short period of training fit themselves to fill these positions, as women have done in other countries at war; and

Whereas, Among the things that women could do advantageously are drafting and tracing, inspection and testing of materials, both physically and chemically; therefore be it

Resolved, That the universities, colleges and technical schools throughout the land be asked to consider the question of meeting this demand by providing special courses of instruction open to women students qualified to pursue such courses; and further

Resolved, That employers who could use such skilled help exert their influence with their universities, colleges and technical schools, and coöperate with them in developing and making available a great body of intelligent and adaptable women who are as eager and willing to serve their country as their brothers; thereby bringing about not only increased effectiveness in fighting the war, but also a greater mutual respect and saner relationship of our men and women.

Control of Ice

New York State Senate Bill No. 605, an amendment, approved by the Governor and now law, states the following, in part:

The ice comptroller is hereby given power to regulate and control the manufacture of artificial ice in the City of New York, on Long Island, or in the counties bordering on the Hudson River, up to and including the Counties of Albany and Rensselaer; to regulate and control the storage and transportation of natural and artificial ice in said locality; and to regulate and control the sale, delivery and distribution of natural and artificial ice in any city having more than one million inhabitants. A person, partnership or corporation shall not manufacture artificial ice, for sale or any other purpose, in the City of New York, on Long Island or in the counties bordering on the Hudson River up to and including the Counties of Albany and Rensselaer, nor shall a person, partnership or corporation engage in the business of selling and delivering or distributing artificial or natural ice in any city having more than one million inhabitants after Mar. 1, 1918, or before Feb. 1, 1918, without first obtaining a license to be issued by the ice comptroller in a form and upon terms and conditions to be prescribed by him.

Heavy penalties are provided for violation of this law.

Area and surface are not synonymous, and sometimes men mix them up as did the man who corrugated a piston, thinking that in so doing he was increasing area and making his engine more powerful.—*Marine Engineering.*

West Virginia Water-Power Legislation

It seems highly probable that there will be water-power legislation at the next session of the West Virginia legislature which will convene in January, 1919. During the special session of May, 1917, the Senate adopted a resolution requesting Governor Cornwell to appoint a committee of three to investigate the water-power situation and to submit a report to the next legislature, with such recommendations as to future legislation to encourage development as the committee might deem necessary. The governor appointed as members of that committee the Hon. Wells Goodykoontz, president of the Senate, and Senators Fred L. Fox, of Sutton, and C. C. Coalter, of Hinton. Recently that committee held its first meeting but went no farther than to make arrangements to study the present laws and to take up at a later date the drafting of new water-power statutes.

It is generally conceded that the present water-power laws of the state are prohibitory so far as any development is concerned. This has been fully attested to by the fact that since the present statutes were enacted in 1915 there has been no water-power development except on a very limited scale, although there are in the state many streams that will furnish all the power needed for years to come. Owing to present conditions, therefore, a valuable resource is not being utilized and is in fact being allowed to go to waste. As this is a time when every resource and every ounce of energy must be utilized, sentiment for legislation which will encourage water-power development and yet fully protect the rights of the state is pronounced, especially in the New River and other sections where water power is available and only needs to be harnessed.

Thrift Stamp Day a Huge Success

Thrift Stamp Day in the United States has come to stay. The results of the first Thrift Stamp Day, May 6, were so satisfactory that the National War Savings Committee of Greater New York has decided to hereafter set aside every first day of each month as Thrift Stamp Day, and all business houses throughout the Greater City have been asked to coöperate and make a special drive to boost the sales of Thrift and War Savings Stamps on those days. The results of the first big Thrift Stamp Day has convinced the workers and the managers in charge of the drive that the setting aside of one day each month for a War Savings offensive would be a splendid idea.

The question of setting aside the first day of each month for Thrift Stamp Day was broached to the leading business men of the city, and they all received the idea with great enthusiasm. Special literature has been prepared for the occasion, and the thirty-odd thousand authorized agents of the Treasury Department have been asked to do at least as well on future Thrift Stamp days as they did on the first day.

New Publications

ESSENTIALS OF DRAFTING. By Carl L. Svensen. Published by D. Van Nostrand Co., New York. Cloth, 200 pages; 6 x 9 in.; 450 illustrations. Price, $1.50.

As a book prepared especially for the evening technical school it seems to be well suited for that purpose. The treatment of the various subjects is somewhat brief, as it is expected that personal instruction is also to be given. It is therefore not a strictly "self-instruction" book, but a guide for both student and instructor.

HANDBOOK ON PIPING. By Carl L. Svensen. Published by D. Van Nostrand Co., New York. Cloth, 359 pages; 6 x 9 in.; 359 illustrations and 8 folding plates. Price, $3.

An orderly presentation of the subject beginning with a short introductory chapter of ten pages, giving an insight into the history and manufacture of pipe, followed by six others treating of "dimensions and strength of pipe, pipe threads, pipe fittings, pipe joints, standard valves and special valves." Chapters 8 to 15 deal with piping systems under the following heads: Steam piping, drip and blowoff piping, exhaust piping and condensers, feed-water heaters, piping for heating systems, water and hydraulic piping, compressed air, gas and oil piping, erection, workmanship and miscellaneous. Chapter 16 is on piping insulation, Chapter 17 on piping drawings, and the closing chapter—specifications—contains the Stone & Webster standard piping specifications and a model specification by the Walworth Manufacturing Co. The eight folding plates referred to are reproductions of the piping drawings, by Stone & Webster, for the Cannon Street Station of the New Bedford (Mass.) Gas and Edison Light Co. While this book is frankly a compilation of information and tables considered standard and the illustrations are mainly from manufacturers' catalogs, it contains much information that, when brought together in this manner, is readily accessible when needed by the engineer or student.

Personals

Edw. A. Cordes has tendered his resignation to take effect July 1, as master mechanic for the Babcock & Wilcox Co., at Barberton, Ohio. He will locate in Chicago, Ill.

H. D. Wright, who has been manager of the San Francisco office of the Brown Hoisting Machinery Co., has been appointed Pacific Coast representative, succeeding the Colby Engineering Co. in the northwest territory.

Engineering Affairs

The Society for the Promotion of Engineering Education will hold its twenty-sixth annual meeting at the Northwestern University, Evanston, Ill., June 26-29. The subject of discussion will be "The Engineering School and the War."

The Iowa Section of the National Electric Light Association will hold its convention May 31 and June 1, at Des Moines. The subjects to be discussed are as follows: The Labor Situation, by T. Crawford, Clinton, Iowa; Isolated Plants, by Austin Burton, Waterloo, Iowa; Rate Increase, by F A. Warfield, Peoria, Ill.; The Coal Situation, by F. W. Linebaugh, Boone, Iowa; Boiler-Room Economy, by E. S. Hight, Peoria, Ill

Miscellaneous News

A Furnace Boiler Exploded in the basement of the Russell House, Montreal, Canada, on May 11, injuring five persons who happened to be in or near the hotel at the time. It is said the explosion was caused by someone having turned off the water from the furnace.

The First Commercial Shipment of coal from the mine operated by the Alaskan Engineering Commission was made in the last week of April. A consignment of 100 tons from the Chickaloon field went to Seattle, Wash., on the steamship "Alameda." The coal was shipped in sacks under a freight rate of $5 per ton for shipments of 100 tons or more and $7.50 per ton on shipments less than 100 tons.

A Wire from Folsom to the Washington State Fuel Administrator, dated May 10, announces that "We are advised that a large number of tankers are to be withdrawn from the Pacific Ocean for Atlantic service within six months. This will necessitate changing of Northwestern industries to coal wherever possible, regardless of cost." It is understood that oil consumers in the Northwest who cannot change to coal will be required to submit by June 10 a statement giving the nature of their business and reasons for not making the change.

The City of Pasadena and the Southern California Edison Co. have filed a joint application with the California Railroad Commission asking for permission to lease the company's distributing system to the city for two years with an option of purchase. The city is to pay rental on a basis of 8 per cent. on the valuation of $513,102, with an additional rental for extensions made after Dec. 31, 1918. Under the terms of the lease the city is to purchase power from the company for a price ranging from 0.0095c. per kw.-hr. for the first 250,000 kw.-hr. to 0.0075c. for all over 750,000 kw.-hr. Pasadena agrees to lease all of its lines and distributing system outside of the city for a rental basis of 8 per cent. on a valuation of $27,928.

At the Del Monte Convention a letter from the Pacific Coast Petroleum Administrator, D. M. Folsom, was read, which stated that even with the most careful economies, the oil stored on the Pacific Coast will be exhausted within a year and the curtailment of consumption may be expected within six months or less. There has been a decline in drilling operations thus far this year of 40 per cent. as compared to last year. All fuel-oil consumers will probably be classified and only those entitled to priority rating will be supplied with oil. In the case of companies which use oil for generating power, the oil supply will be continued only if consumers served are entitled to priority rating and the burden of proof that consumers are entitled to such rating will rest upon the power companies.

Cleveland Plants Interconnected—An agreement recently made between the Cleveland Municipal Light plant and the Cleveland Electric Illuminating Co., through the National Council of Defense, will result in the interchange of power output between the two stations. An overhead connection is to be built immediately between the East 53rd Street Municipal plant and the Cleveland Illuminating Co. at East 72nd St. to provide interchange of power in case either plant breaks down. This practically guarantees war plants against stoppage of work through accident. The connection will cost $90,000. It will be financed by the Council of National Defense. Government officials agree to speedy delivery of the city's new 10,000-kw. generator, so that it will be ready to increase the municipal plant's current by fall instead of by Jan. 1.

The U. S. Circuit Court of Appeals recently reversed the decision of a lower court in the famous Elk Hills suit between the Southern Pacific and the Government on the ownership of California oil fields. In discussing this, Paul Shoup, president of the Pacific Electric Railway Co., Los Angeles, who has recently been at Washington, said that a compromise on the suit for the duration of the war is to be forthcoming very soon and that these lands which have so long been tied up in litigation will probably be opened up and developed at an early date in the most expeditious manner. Nevertheless drastic measures in curtailing the consumption of oil will doubtless be put into effect. Embargoes and restrictions of oil shipments and oil consumption generally may be expected.

NEW CONSTRUCTION

Proposed Work

N. H., Derry—The Derry Electric Light Co. plans to extend its electric transmission line from here to East Derry. D. F. Griffith, Supt.

Mass., Boston—The Board of Education will soon award the contract for the installation of a direct radiation system in the public and high school. Estimated cost, $20,000. J. J. Mahar, City Hall Annex, Consulting Engr.

Mass., Brookline—The Town is in the market for equipment for its incinerator including a steel apron conveyor complete with steel chute, motor and connections, 2 paper baling presses with motors and connections, etc. A. Varney, Engr.

N. Y., Buffalo—Cousins & Co., 74 Wahash St. will soon award the contract for the erection of a 1 story, 95 x 125 ft., reinforced concrete steel and brick boiler plant. Estimated cost, $35,000. Noted Dec. 11.

N. Y., Brooklyn—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard, here, under Schedule No. 1812, Klinger type, water gage, reflex glasses; under Schedule No. 1808, mechanical thermometers, mercury for thermostats thermometers, 4000 common mercurial thermometers, 2000 water thermometers, 2000 maximum and minimum thermometers and 1000 mercury, storage battery thermometers.

N. Y., Brooklyn—The Bush Terminal Co., 100 Bway., New York City, plans to build an addition to its local transformer station.

N. J., Hoboken—The Remington Arms Co. has awarded the contract for the erection of a 1 story, 81 x 160 ft. factory, to the Austin Co., 16,112 Euclid Ave., Cleveland, Ohio, $40,000. A low pressure boiler for steam heat will be installed by owner.

N. J., Jersey City—The Central Railroad of New Jersey, Communipaw Ave., has had plans prepared for the erection of a local power house. Estimated cost, $50,000. A. E. Owens, New York City, Ch. Engr.

N. J., Newark—The Heller and Merz Co., Hamburg Place, will soon award the contract for the erection of a power house. R. G. Corey, 39 Cortland St., New York City, Archt. Noted May 14.

N. J., Newton—The Sussex Print Works will soon award the contract for the erection of a 50 x 50 ft. addition to its power plant. Estimated cost, $10,000. A. Kidd, Jr., 95 Liberty St., New York City, Arch.

N. J., Woodbridge—Bids will be received until June 3, by the Township Committee for the installation of a heating system in its new municipal building. A. Keyes, Clerk.

Penn., McKeesport—The McKeesport Tinplate Co. plans to install a steam power plant in its mills here. Estimated cost, $1,200,000.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., is receiving bids for the erection of a new power plant at the aircraft factory on League Island.

Wash., D. C.—The Bureau of Supplies and Accounts, Navy Dept., Wash., D. C., will soon receive bids for furnishing at various Navy Yards, under Schedule No. 1806, steam pressure gages.

Va., Norfolk—The Bureau Yards and Docks, Navy Dept., Wash., D. C., is having plans prepared for the installation of an electric lighting and power system in Shipbuilding Slip No. 1. Estimated cost, $15,000.

W. Va., Junior—The Gage Coal and Coke Co. plans to install a 150 kw. 250-275 volt generator in its mine.

S. C., Charleston—The Bureau of Supplies and Accounts, Navy Dept., Wash., will soon receive bids for furnishing at Navy Yard here under Schedule No. 1817, regular, steam and water, seamless drawn, brass pipe; extra strong, steam and water, seamless drawn, brass pipe; regular seamless drawn copper pipe; hard drawn, seamless brass tubing in commercial lengths and hard drawn, seamless copper tubing in commercial lengths.

Ga., Acworth—The Acworth Hosiery Mills is considering plans for the installation of electrically driven knitting machines. Estimated cost, $10,000.

Tenn., Lenoir City—The Public Light and Power Co. of Chattanooga plans to rebuild its electric transmission line from here to Rockwood. W. R. Stern, Winchester, Mgr.

Ohio, Cincinnati—The G. B. Curd Co., 602 Merchants Library Bldg., plans to build a 1 story, 40 x 60 ft. boiler shop on Highland Ave.

Ark., Helena—The A. M. Richardson Lumber Co., recently incorporated, is in the market for power plant equipment.

Tex., Brackettsville—The City plans to extend and improve its electric lighting plant.

Tex., Knippa—C. A. Lindsay, 203-4th Natl. Bank Bldg., Wichita, Kan., and associates, are having preliminary surveys made for a hydro electric plant and an irrigation system on the Frio River near here.

Tex., Mercedes—The Mercedes Water, Light and Power Co. is in the market for a new 100 hp. engine and new generator.

Okla., Miami—The Lightfoot Oil and Mining Co. is in the market for engines, boilers, etc., to install in its proposed concentration mill soon to be erected. Total estimated cost, $100,000. W. Lightfoot, Supt.

Okla., Oklahoma—The Chickasaw Hosiery Mill plans to build a large plant. Plans include the installation of 150 hp. steam and electric power plant, etc.

Okla., Prague—The City will soon award the contract for the erection of a 22 mile transmission line south and west of here to connect with the system of the Oklahoma Power and Transmission Co. The work includes the construction of a sub-station and the installation of three 75 kva. 33,000 to 2300 volt, 60 cycle, single phase, transformers, two 500 gpm., 220 ft. lift, direct connected, motor driven, centrifugal pumps, etc. R. Parks, Mayor.

Idaho, Sandpoint—The Falls Creek Mining Co. plans to install a power plant.

Wash., Seattle—The Northwest Trading Co., L. C. Smith Bldg., is in the market for electric lighting and power plant equipment including a turbine generating set directly connected, a three-phase, 6600 volts, 5 cycles, electrical system, etc.

Wash., Waterville—The Chelan Falls Power Co. has petitioned the Douglas County Commissioners for authority to build a transmission line here.

Ore., Astoria—The Hammond Lumber Co. plans to install additional electric power equipment including a turbine and generator and four 600 hp. water tube boilers.

Ore., Portland—The Pacific Power and Light Co. plans to build a 660 volt, 3 phase transmission line from here to the plant of the Utah Idaho Sugar Co. I. C. Martin, Engr.

Ore., Reedsport—The Umpqua Light and Power Co. is having preliminary plans prepared for the erection of a transmission line over the Umpqua River.

Calif., Bolinas—The Chetco Mining Co. plans to install electrically driven pumping equipment in its plant here.

N. S., New Watford—The Dominion Coal Co., Sydney, plans extensive power developments including the erection of a central power station here.

Que., Grand Mere—The Laurentide Power Co. plans to install 3 additional units, 20,000 hp. each. J. Ruddick, Beaupre, Engr.

Ont., Sault Ste. Marie—The Great Lakes Power Co. plans to rebuild its power plant which was recently destroyed by fire. A. E. Pickering, Mgr.

Ont., Thedford—The Town plans to install a lighting and power system. W. Brookes, Clerk.

Sask., Regina—The City is in the market for a 5000 kw. electric unit. Estimated cost between $175,000 an $200,000. G. Beach, Clerk.

B. C., Revelstoke—The Lanark Mines Co. plans to build a power plant and install equipment in same. W. B. Dornberg, Spokane, Wash., Mgr.

H. T., Pearl Harbor—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., is having plans prepared for additions and improvements to the power plant here. Estimated cost, $150,000.

CONTRACTS AWARDED

Ohio, Cleveland—The Illuminating Co., Illuminating Bldg., has awarded the contract for the erection of a 1-story, 35 x 168 ft. addition to its power house on East 70th St., to the National Concrete and Fireproof Co., 1315 Citizens Bldg., $60 000. The owner is in the market for electric equipment, switch boards, etc.

Ohio, Columbus—The Board of Education has awarded the contract for a heating and lighting system in the shop school wing to the Huffman-Conklin Plumbing Co., 669 North High St., Erie, Penn. Estimated cost, $27,500.

Okla., Miami—The Mint Mining Co. is building a concentration plant. Estimated cost, $100,000. Work includes the installation of boilers, engines, etc. J. Labsap, Supt.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania..	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.00	$4.35	$3.90
Barley	2.15	1.50	2.40	1.75
Buckwheat ..	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes...	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas. Pennsylvania and W. Va.	Hocking.East Kentucky and West Va. Splint
Prepared sizes...	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.65-3.00	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg....	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut.....	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen....	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed..	2.15-2.50	2.15-2.35	2.15-2.35

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba.	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, JUNE 4, 1918 No. 23

The Fellows Who Know

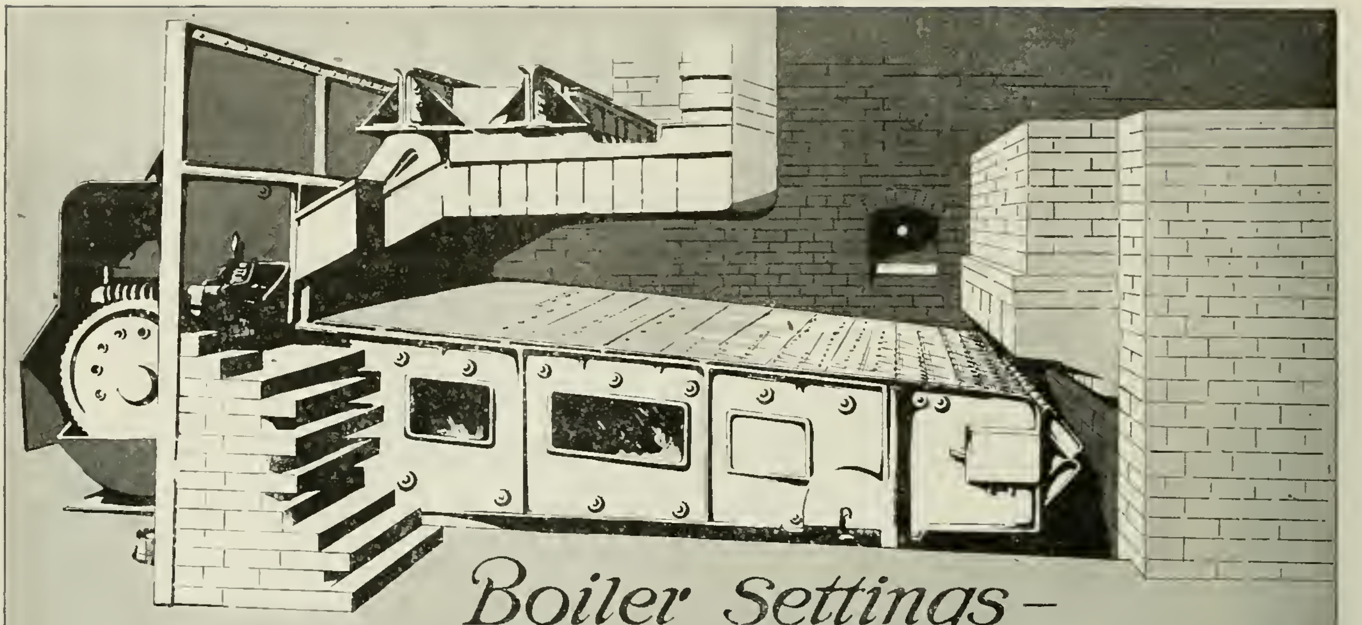
By RUFUS T. STROHM

SADLY enough, in this era of trickery,
  Humans are trying to be what they're not,
Heedless that coffee compounded with chicory
  Seldom can pass through the test of the pot.
Thus, though pretenders may capture the galleries
  And by audacity garner the dough,
Still, in the long run, the choicest of salaries
  Drop in the jeans of the fellows who know.

SOME of the ignorant, wantonly venturing,
  Knowing they're either dead right or dead wrong,
Blind to the danger and deaf to the censuring,
  Trust to their bluffing to help them along;
Thus, while they're constantly fearful and quavering,
  Wondering whether they'll stay or they'll go,
No such alarms or suspicions of wavering
  Trouble the lives of the fellows who know.

BLUFF and deception may win temporarily,
  Leaving Old Honesty far in the rear,
Still, prudent folks will consider them warily,
  Choosing instead to be strictly sincere.
No reputations of worth and solidity
  Out of imposture and knavery grow,
Yet recognition with pleasing rapidity
  Comes to the doors of the fellows who know.

GUESSWORK is weakness—a sand rope whose rottenness
  Millions of toilers still stupidly try,
Though it betrays into lasting forgottenness
  Those who so foolishly on it rely.
Knowledge is power, and men of sagacity,
  Yearning for honors the world can bestow,
Ceaselessly striving for increased capacity,
  Share the rewards of the fellows who know.



Boiler Settings—Chain Grate Stokers*

by CHARLES H. BROMLEY
Associate Editor of Power

One of several articles on boiler settings for various boilers and types of stokers most suitable for the different coals. The chief purpose of the articles is to assist those in the Middle West and Northwest who are confronted with combustion problems by reason of the zone system for the distribution of bituminous coal enforced by the Fuel Administration. Several excellent chain-grate settings are shown in this article.

ONE does not have to argue the adaptability of the chain-grate stoker for the coals of the Middle West and Northwest, or, as they are sometimes called, Eastern Interior coals. They have demonstrated it. The writer does not, however, indorse the statement that this type alone is *most* suitable for these coals. This claim defied refutation until recently because the underfeed stoker had not shown what it could do with them. The chain grate is admirably suited to these coals where the load conditions do not impose boiler ratings of more than 250 per cent. of builders' rating.

The chain grate, like all other stokers, frequently suffers because of poorly adapted boiler settings. Sometimes these are unavoidable; that is, in places where sufficient headroom is not available for raising the boilers, where conditions prohibit lowering the stoker or floor line, or because the purchaser is obstinate or wants "something nearly as good for less money." The builder, therefore, cannot always put in his ideal setting.

The seriousness of this is felt, especially during times like these when coals of considerably poorer grades than those for which the setting is at all adapted find their way into the plant. High settings with correct arches originally installed, avoid troubles due to using coals of widely varying volatile content, and where high combustion rates are necessary or may become so.

Some excellent chain-grate settings are shown herewith. Notice that no secondary arch is used with this particular stoker, the arch being very long. Fig. 1 shows a Stirling boiler, and what strikes the observer as unusual is the absence of a secondary arch, simplifying construction, though not appreciably increasing maintenance charges.

Where secondary arches are provided, they do not always exert any appreciable effect, at least upon the incoming coal, owing to the curtain wall between the two arches. The arch in Fig. 1 is effective over the whole fuel bed. This is important where smokelessness and high combustion rates are needed, because with a chain-grate stoker the resistance to the fuel bed is comparatively small and the thickness, density and porosity of the fuel bed do not conduce to such thorough mixture of air and gases *in the fuel bed* as with an underfeed fire, high combustion rates considered. The arch is, of course, ventilated.

The height of a Stirling boiler setting is taken as the distance from the center of the bottom drum to the floor line. The setting, Fig. 1, would be improved for Middle Western coals if this was 6 ft. instead of 5 ft., as shown. Have in mind that this applies to the chain grate; for the underfeed stoker it should be at least 1½ ft. higher. For lignite combustion would be improved if the setting were not less than 8 ft. The author bases this opinion upon recent performances of underfeed stokers burning lignite.

Broadly, it may be said that the tubes of a Stirling boiler should always be exposed to the direct heat of the furnace gases and fuel bed. In fact, it is the writer's opinion that tubes immediately above the fire should never be covered with C tile or with any other material

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*For previous articles see the following issues "Power": "Zone System for the Distribution of Bituminous Coal," May 14; "Coals of the United States," May 21; "Boiler Settings," May 28.

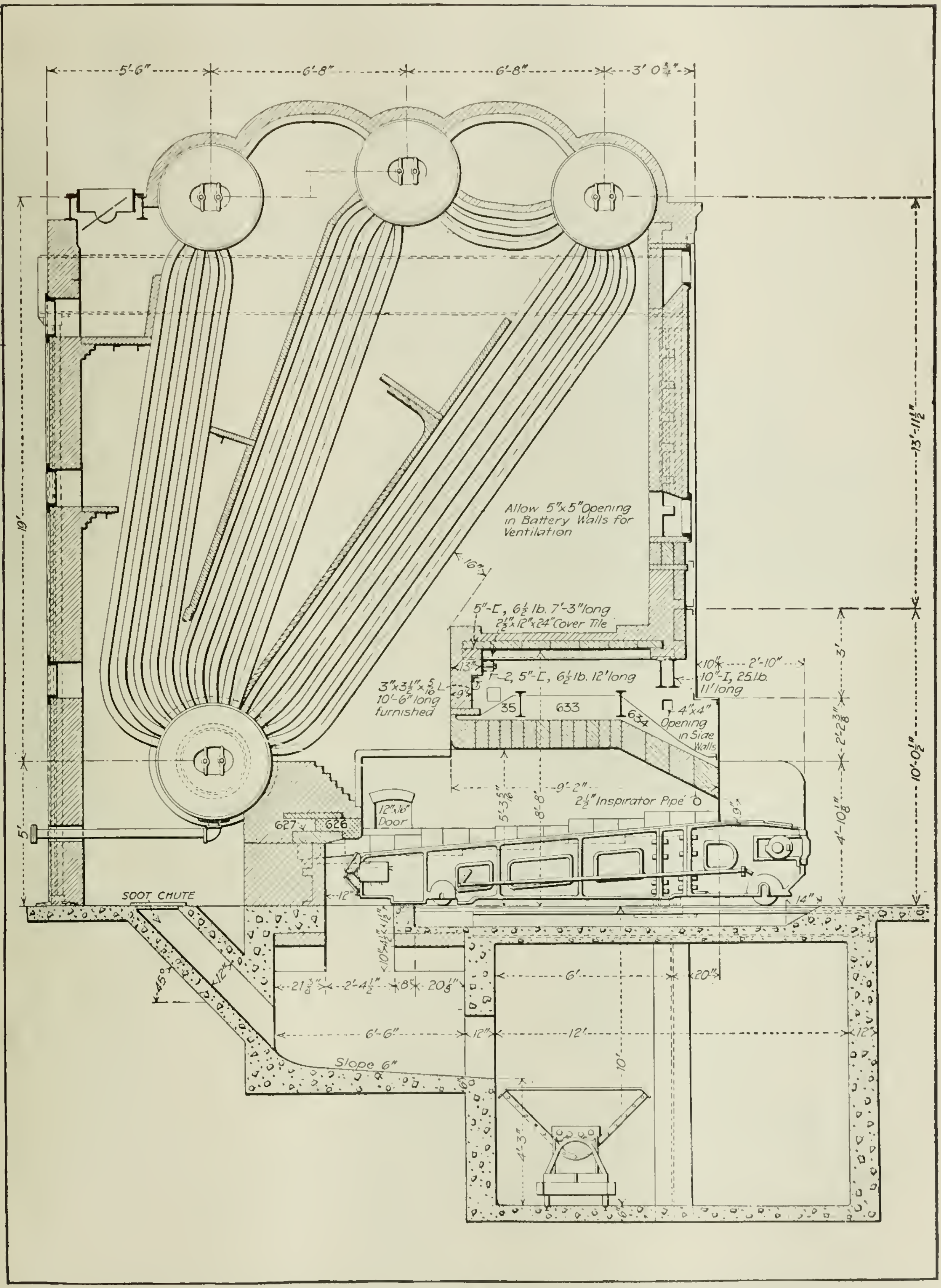
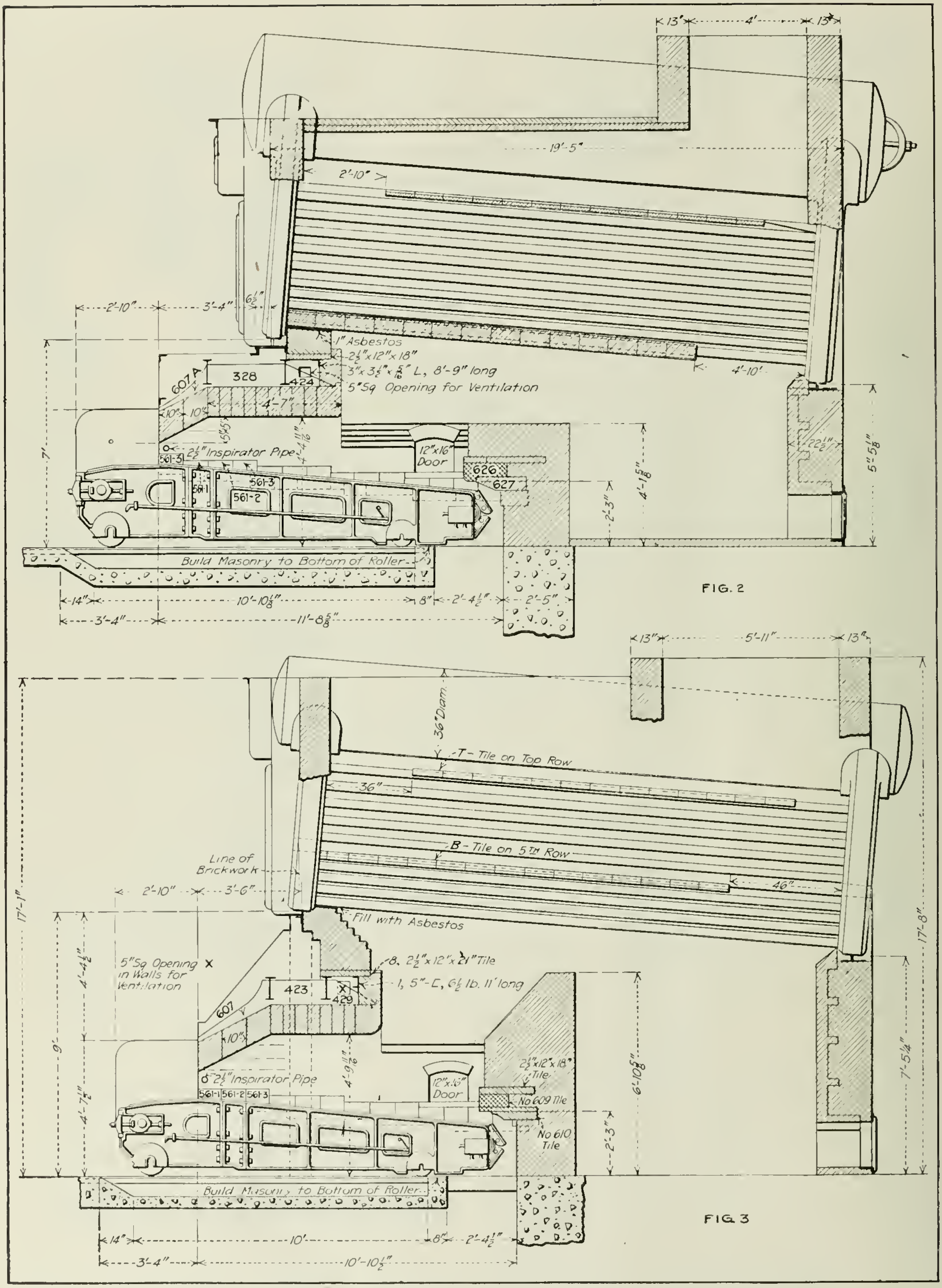


FIG. 1. EXCELLENT CHAIN-GRATE STOKER SETTING FOR BOILERS OF STIRLING TYPE

The setting would be improved if the distance between center of mud drum and floor was 6 ft. instead of 5 ft. Notice that no secondary arch is used.



FIGS. 2 AND 3. CHAIN-GRATE STOKER SETTINGS, BOILERS HORIZONTALLY BAFFLED
Fig. 2—The objection is that the setting is too low and that the baffle is on the lowest row of tubes. Fig 3—A good setting; notice baffle is on the fifth row of tubes

that completely covers them, shutting out the radiant heat of the fire. This applies to any boiler. Some tubes should be exposed to the direct heat; this avoids excessive tube failures and better distributes the evaporation per square foot of tube surface of the boiler.

The setting shown in Fig. 1 is installed in a famous soap manufactory in Kansas City, Kan. Notice that no water-back is used; bauxite tile, furnished by the stoker builder, is provided. The number referring to the bricks denotes the trade designation.

Fig. 3 shows an excellent setting for water-tube boilers of the type illustrated. The boiler is 9 ft. above the floor, insuring large combustion volume. Combustion would be improved if it were 10 ft., and for lignite, 12 ft. The arch is the same as in Fig. 1. The bottom tile is on the fifth row of tubes. This seems a little high; but it is probable that there will soon be a universal abandonment of tile on the very bottom row. It is the writer's belief that the boiler manufacturers would welcome this change. Fig. 2 shows a setting for a horizontal baffle boiler with the tile on the bottom row of tubes.

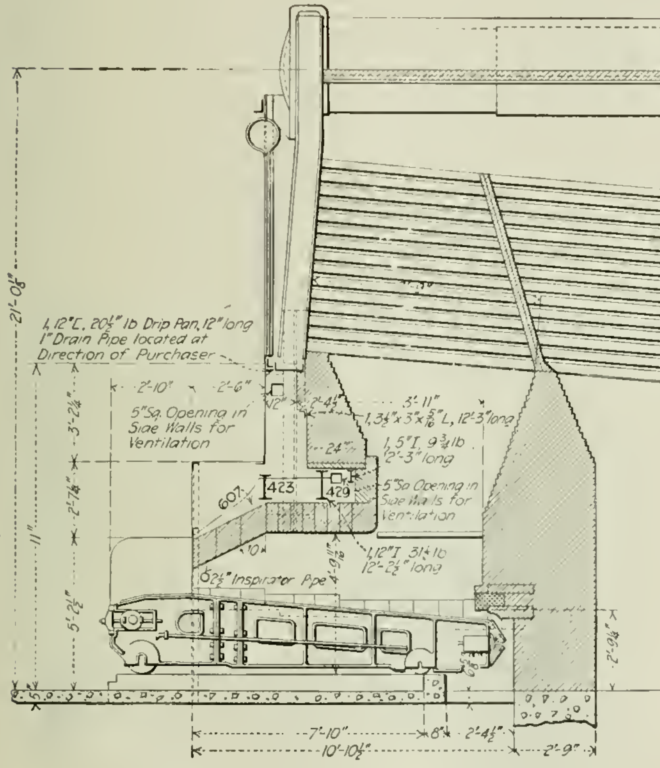


FIG. 4. AN 11-FT. SETTING FOR HIGH-VOLATILE COAL

The setting in Fig. 4, for a vertical baffled boiler, is good practice. The boiler is set high, being 11 ft. above the floor, and the arch and bridge-wall insure a fairly good mixture of air and combustible gases.

The baffling is designed to give an approximately uniform gas velocity throughout the entire flame travel. The setting is adapted for any Middle Western coal. Notice that the flame plunges directly among the tubes from the incandescent zone. The high setting permits of this, but only a high setting permits of it.

Fig. 5 shows a good setting for an Erie City boiler or any boiler of this general type. All the important dimensions are given.

Where lignite or slack high in moisture is to be burned on a chain grate, the reflecting arch is to be recommended. Some excellent settings using these arches, the function of which is to throw the flame forward so that the heat may assist in evaporating the moisture from the coal as the latter comes onto the grate, were shown in *Power* for Apr. 2, 1918, p. 472, and Apr. 30, 1918, p. 611.

The Standardization Committee of the Smoke Prevention Associations recently recommended the following:

> Water-tube boilers are constructed of tubes having 1 in. pitch to the foot, 1½ in. pitch to the foot and 3¼ in. pitch to the foot. Chain grates are of two kinds, the horizontal and the inclined grate, and the height of the boiler setting is determined from the vertical line immediately back of the front boiler header to the water-back of the stoker. This distance we propose as being five feet, and means that the water-back is located five feet back of the inner side of the front header. Three feet in front of the water-back a line is drawn that measures seven feet from the under side of the lower tube [row of tubes?] to the top of the grate. This standardizes all chain-grate stokers on all horizontal water-tube boilers, and is applicable to all settings requiring only 50 per cent. overload. [50 per cent. more than builders' rating?] If larger overloads, such as 200 or 250 per cent. rating, are required, this line should be extended about three feet.

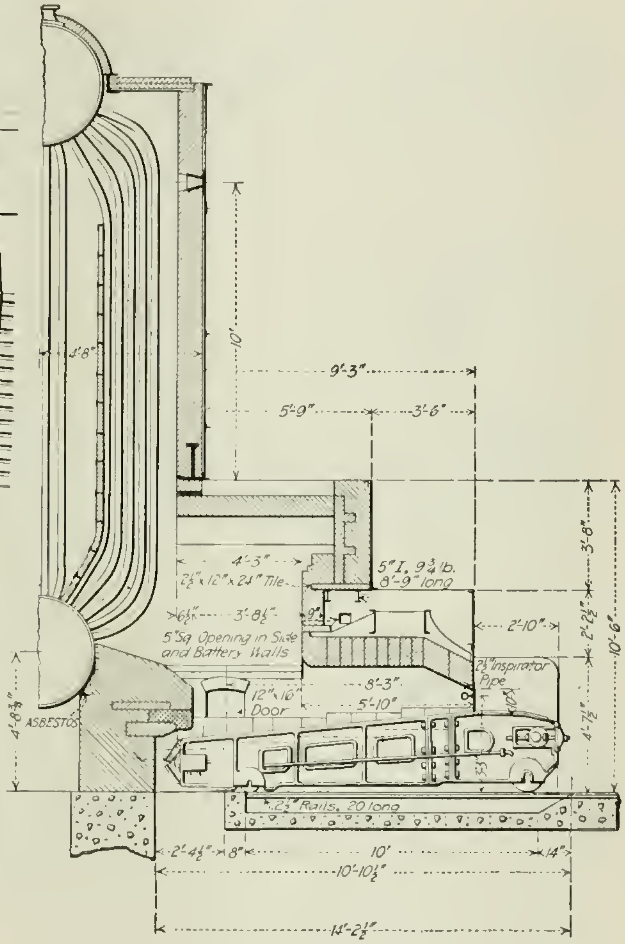


FIG. 5. FOR ERIE CITY AND SIMILAR BOILERS

The dimensions given will be found satisfactory for the coals of the Middle West, but it is probable that for lignite the settings should be 2 ft. higher. Experience indicates that lignite needs extraordinarily high setting.

If the moisture is 15 per cent. or more, a reflecting arch, after the fashion of Fig. 6, will be found a valuable aid to combustion, as such an arch sweeps the flame forward, evaporating the moisture in the coking region, thus avoiding serious loss of temperature at the surface of the fuel bed. In Fig. 6 *A* shows the arch applied to a step-grate stoker, *B* to a chain-grate stoker.

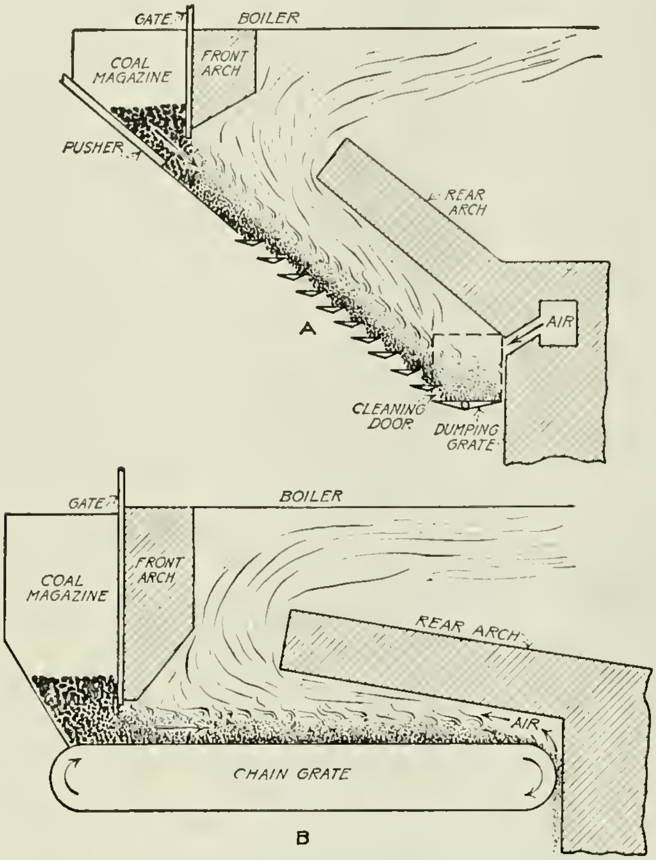


FIG. 6. REFLECTING ARCHES FOR LIGNITE AND HIGH MOISTURE COALS SUGGESTED BY KREISINGER OF THE BUREAU OF MINES; A, STEP-GRATE; B, CHAIN GRATE

Fig. 7 shows a setting recently developed by the American Radiator Co. for burning lignite in heating boilers. Notice there are no grates, that the coal feeds down when a shovelful or two of ash is removed. The writer does not have any performance data on this setting, but it may suggest something to those interested in furnace design for lignite under power boilers. The distribution of air is interesting.

Condenser Was Full of Ammonia

By T. T. Grover

After having operated without trouble for two years, a small packing-house refrigerating plant showed excessive head pressure. The trouble started in the early spring while the condensing water, which was taken from a river, was something like 38 deg. It was evident that if the pressure was more than normally high at this time, it would practically render the plant inoperative in summer when the water temperature went up to 80 to 85 degrees.

The plant had been superficially overhauled during the winter, and the condenser coils, which were of the atmospheric type, had been scraped and the scale removed. The only reasonable conclusion was that considerable air had been drawn into the system during the overhauling and the operators forthwith proceeded to purge the condenser.

A considerable portion of the ammonia charge had disappeared; the condenser pressure remained nearly as high as before and gradually got higher as the water temperature increased.

The heavy summer load was coming on, and the operators were at their wits end as to what to do about it. Finally it was concluded that the only remedy was to increase the condenser capacity by adding more stands to the ten already in service. Before deciding on this point, however, the chief called in the writer to investigate the problem and if necessary add more weight to the request for a larger condenser when it was put up to the management.

After purging the condenser once more and testing the pressure gages and doing everything else that I could think of, the head pressure still remained much too high. After roughly estimating the amount of gas handled by the condenser, I found that it was doing only about two-thirds of its normal capacity, based on the manufacturer's rating and from my experience.

I went over the condenser a second time, putting my hand on each stand to see if all the coils were working—something I had neglected to do the first time. To my surprise one-half of them were at the temperature of the condensing water. This pointed to the coils being airbound, and I at once got busy and purged them again.

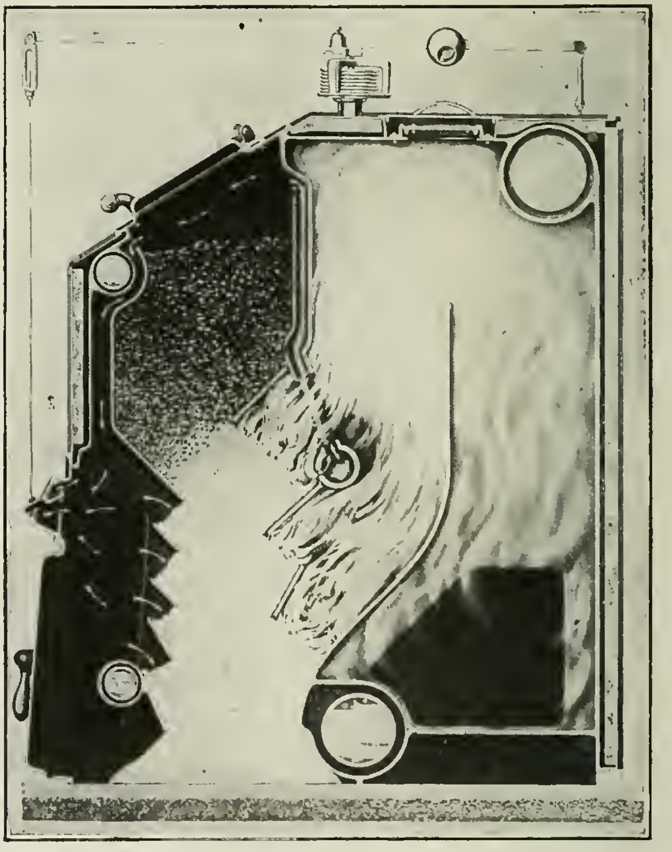


FIG. 7. FURNACE FOR BURNING LIGNITE IN HEATING BOILERS; NO GRATES ARE USED

To my surprise there was practically no sign of air; after it had been blowing for a few seconds, there was the unmistakable crackling of the water in the barrel that I was purging the coils into, that is always an indication that mainly all ammonia is coming from the coil that is purged. It had no effect on the condenser pressure. Evidently, it was not air or foul gases in the condenser that was causing the trouble. Furthermore, if there was no air in the coils, it was a foregone conclusion that they were full to the top with liquid, as otherwise the dead coils would have been of the same temperature as the others.

The only logical explanation was that the outlet from the coils to the liquid line was blocked in some way, and this assumption was not unreasonable after I investigated the connections at the bottom where each coil connected to the liquid line. The coils of the condenser were made up of 2-in. pipe, and at the bottom, where they connected to the liquid line, this had been reduced to ½-in. by means of a reducing elbow. Evidently, scale or other foreign matter had accumulated in the coil and collected at the reduced point in sufficient quantities to entirely block the passage.

The remedy was quite simple. I shut off all the dead coils at both ends and pumped them out until the pressure was down to atmosphere. The rest of the system was pumped down so that when the dead coils finally were pumped down to near atmospheric pressure, there was about 225 lb. pressure on the coils that were working. Leaving the pump-out connection to the dead coils open and the valve on the discharge end of the coils shut, I quickly opened the valve in the connection between the coil and liquid line for a few moments. This put a pressure of about 225 lb. on the blocked section and in the reverse direction of the normal flow, and it cleared it immediately as was evidenced by the coil frosting at once and the suction pressure "taking a jump."

When the plant was settled down to normal operation again, the head pressure was down to 125 lb. as against 175 lb. Also, there was an abundant supply of ammonia. With the coils blocked, the liquid had accumulated in the coils every time they had been purged until they probably were full up to the top at the time the trouble was discovered. At first, when there was considerable air in the condenser, this accumulated in the dead coils and prevented a large accumulation of liquid, but as this was gradually blown out, the coils slowly filled up, and this explained the gradual disappearance of the ammonia.

Power Loss in Waterwheel Pit

BY DAVID R. SHEARER

Scattered throughout the country there are numerous small water-power developments representing practically every type or design of waterwheel, operating under various conditions. Some of these installations are equipped with all the refinements of engineering practice, while others are nothing more than crude makeshifts.

Considered from the standpoint of efficiency in power production about 90 per cent. of these plants show one serious fault—a fault not easily corrected in existing installations, though easily obviated at the time of installation. This is "water reaction" in the wheelpit under the turbine, which may decrease the hydraulic efficiency to a marked extent. In many cases the trouble is caused by not allowing a sufficient depth of dead water directly under the draft tube of the wheel, or it may be caused by the inadequate size of the wheelpit or tailrace.

To secure the maximum efficiency from a waterwheel, it is necessary that the flow of water from the draft tube and through the tailrace should be slow and quiet, somewhat as shown in Fig 1. The water level in the wheelpit should also be at practically the same point of elevation as the tail water of the stream into which it discharges. A loss of even a few inches head in the tailrace may seriously affect the power of a low-head development. Frequently, the utmost care is used to conserve all the available head above the wheel and then a serious loss is allowed to occur in the tailrace or wheelpit.

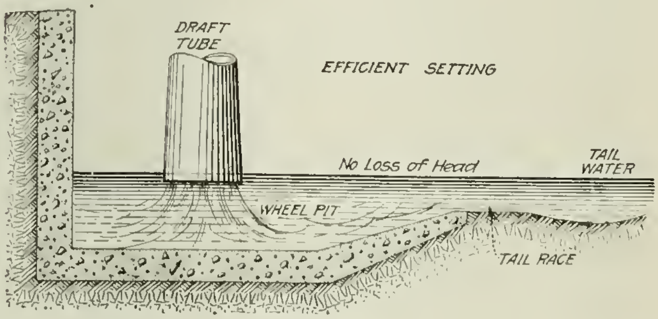


FIG. 1. CORRECT DESIGN FOR TAILRACE

Some months ago a small hydro-electric plant was tested to determine what had caused a marked decrease in the available power. The head was eleven feet and the wheel was supposed to develop about 150 hp., but at the time of the test the maximum output was only about 100 horsepower.

After some investigation it was found that a recent flood had partly filled the wheel pit with gravel and had so choked the tailrace that eighteen inches of the original head was lost. In this case the remedy was easy, for it was only necessary to clean out the gravel to the bedrock in order to secure normal power. However, in many small plants the original excavation has not been carried to a proper depth, as in Fig. 2, and the water is choked at the end of the draft tube and boils forth like a small geyser, dissipating in this watery ebullition much of the energy which should be given to the wheel and turned to practical purposes.

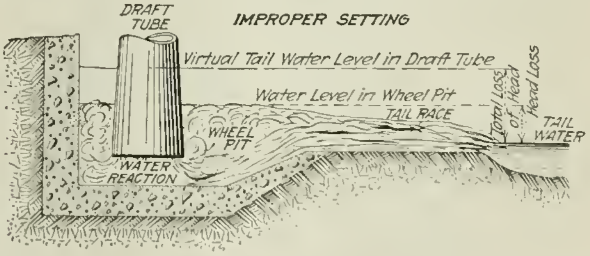
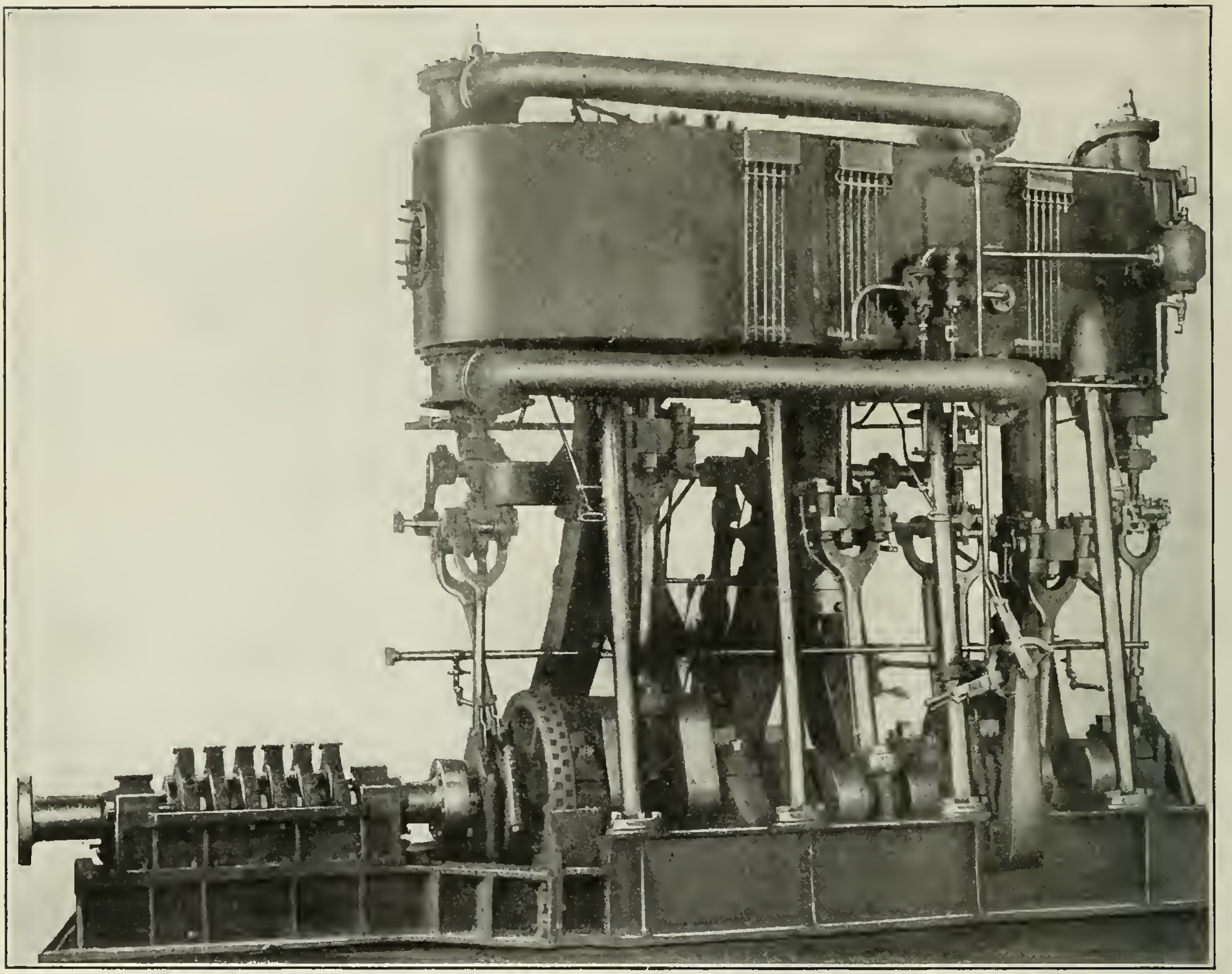


FIG. 2. TAILRACE TOO SHALLOW AND SMALL

At this particular time, when all the water power is urgently needed to save coal, it is of vital importance that efficiency investigations be made for the purpose of determining how to increase power production and that corrections be applied where possible. Some slight changes in the wheelpit or tailrace at little expense may add considerably to the output of the plant.

Emergency Fleet Engines



THE attack of German submarines on the shipping of the allied and neutral countries has resulted in the sinking of a large number of cargo steamers, the lost tonnage of which must be made good. Because of these losses and the advisability of getting the greatest efficient movement from the available tonnage, the United States Shipping Board has complete charge of all the merchant ships afloat flying the American flag.

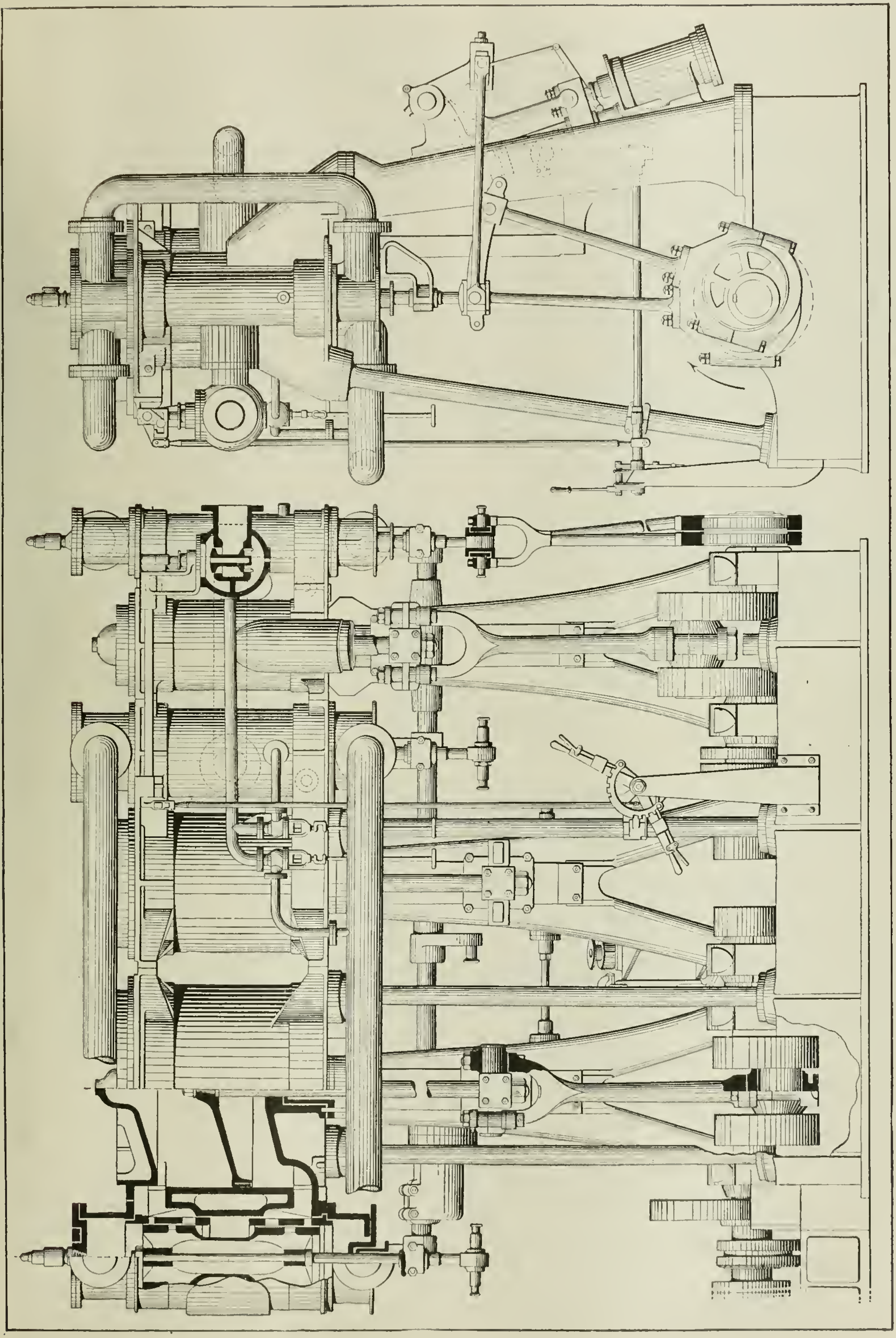
The American Fleet Corporation is a subsidiary of the United States Shipping Board, and its duty is to build ships. As a result of the Shipping Board activities, it has the supervision of the output of more than 150 shipyards throughout the United States, which are all engaged in the greatest shipbuilding program that any nation has ever undertaken. Some of the ships laid down in these yards are completed, others are nearing completion, and the next few months will bring about the launching of a large number of merchant ships that will be engaged in carrying supplies for our own and our allied soldiers. As a matter of fact, under direction of the Shipping Board there have already been launched something like 236 steel and wooden vessels, with aggregate tonnage of 1,440,627. There are now operating 157 shipyards with 753 ways in use, with a predicted launching of four ships per day.

Engineers are interested in the general type of engine that is to be used in these ships that are being built. One of the fore and aft triple-expansion engines, built by the Buckeye Engine Co., Salem, illustrated herewith, shows the general arrangement, the line cut showing a front and end view. It is of 700 hp. capacity and has a $15\frac{1}{2}$-in. diameter high-pressure cylinder, a 26-in. intermediate and a 44-in. low-pressure cylinder. The stroke is 26 in. Piston valves are to be used on all cylinders and are $7\frac{1}{16}$, $14\frac{1}{16}$ and 15 in. in diameter respectively, and are 3 ft. $\frac{15}{16}$ in. long.

The columns on which the cylinders are secured are 7 ft. 1 in. high and are 7 ft. wide at the base. The frame consists of a front and back column, as shown in Fig. 2. This front column is $4\frac{1}{2}$ in. in diameter and the back column is an A-shaped form when looked at from the forward end. These columns carry the guide bars.

As is common practice, the crank rod and eccentric rod are made with the well-known type of boxes. The crankpins are $8\frac{1}{2}$ in. and the wristpins $4\frac{1}{2}$ in. in diameter. The shaft is $8\frac{3}{8}$ in. in diameter. and the cranks are placed at 120 deg. apart.

Two engines, port and starboard, will be the equipment of each ship in most instances in which these engines are placed.



SHOWING THE GENERAL ARRANGEMENT OF THE EMERGENCY FLEET FORE AND AFT TRIPLE-EXPANSION ENGINES

The Electrical Study Course—Characteristic Curves of Compound Generators

The voltage characteristics of compound generators under varying loads, the method of adjusting the series windings to obtain the correct amount of compounding, also the long-shunt and short-shunt connections, are discussed.

WITH a series winding on the polepieces along with a shunt winding, as in the compound generators, Fig. 3, the load-voltage curve will to a certain extent be a combination of the shunt characteristic curve, Fig. 2, and the series curve, Fig. 8, in the previous lesson, issue of May 21. In the compound-connected machine, Fig. 3, current is flowing through the shunt-field winding only, and this is adjusted by the field rheostat to give normal voltage at the armature terminals. When a load is connected to the machine, as in Fig. 4, the current passing through the armature will tend to cause the voltage at the brushes to decrease, but the total-load current flowing through the series winding will increase the strength of the magnetic field and cause a greater voltage to be produced to compensate for the drop in the armature and series-field winding. If we assume that the machine is normally generating 110 volts at no load, the density of the magnetic circuit would correspond to point *A* on the magnetization curve, Fig. 1. When the machine is carrying full load, if the current flowing in the series-field winding increases. the magnetic density to correspond to point *B* on the curve, then the armature will be generating about 124 volts; that is, the voltage generated in the armature has increased from 110 to 124, or 14 volts. Now, if the volts drop in the armature, from no load to full-load, is only 14, then the volts at the armature terminals at full load will be the same as at no load.

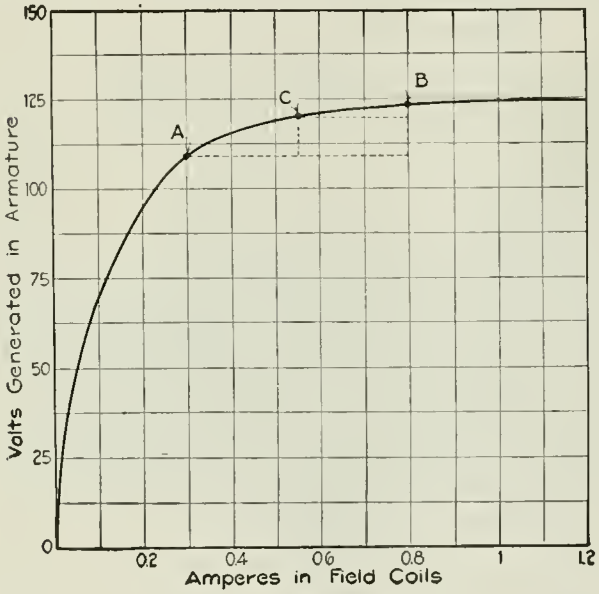


FIG. 1. DIRECT-CURRENT GENERATOR VOLTAGE CURVE

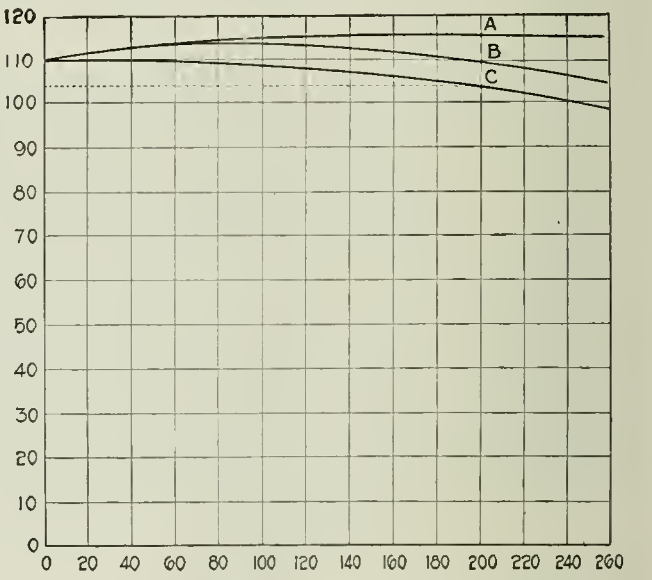


FIG. 2. COMPOUND-GENERATOR LOAD-VOLTAGE CURVE

At first thought it may seem an easy matter to proportion the series-field winding so that it will just compensate for the drop in the armature circuit. A further consideration of the curve, Fig. 1, will show that this is impossible. If point *A* indicates the no-load voltage and point *B* the volts generated in the armature at full load, point *C*, half-way between *A* and *B*, will indicate the volts at half load. But from *A* to *C* the voltage has increased from 110 to 120, whereas from *B* to *C* it has only increased from 120 to 124, or 4 volts, against 10 on the first half of the load. The volts drop in the armature is proportional to the amperes, consequently if full-load current causes a drop of 14 volts, then half full-load current will cause 7 volts drop. But with half full-load current flowing in the series-field winding, in this case, it caused 10 volts increase, therefore, the voltage at the brushes is 3 volts higher than at no load What has really happened to the voltage of the compound generator from no load to full load is indicated in curve *B*, Fig. 2, assuming 200 amperes full load. Here it is shown that although the voltage is the same at full load as at no load, nevertheless, it has not been constant between these points, increasing in value during the first half of the load and then decreasing to normal again during the last half. Furthermore, it is not possible to design a compound generator that has a constant voltage from no load to full load. However, conditions similar to that indicated by curve *B*, Fig. 2, can be approximated.

A compound generator that develops the same voltage at full load as at no load is said to be flat-compounded. It is possible, by proportioning the shunt- and series-field winding, to design a compound machine where the voltage will increase from no load to full load, as indicated by curve *A*, Fig. 2. For example, we assume that the full-load current causes 14 volts drop in the armature. Now, if the current flowing through the series-field winding caused a 20-volt increase in the armature, then the voltage at the armature terminals will be 20 — 14 = 6 volts higher at full load than at no load. When the voltage of a compound generator increases from no load to full load, the machine is said to be over-compounded.

On the other hand, suppose that when full-load current is flowing in the series-field winding it caused only 8 volts increase; then, since there is 14-volts drop in the windings at full load and only eight of these volts are compensated for, the pressure will decrease at the brushes, 14 — 8 = 6 volts. Such a condition is represented by curve *C*, Fig. 2. A compound generator the voltage of which decreases from no load to full load is known as being under-compounded.

Another feature in obtaining the proper amount of compounding of the generator is the proper number of turns in the series winding. This winding in the large-sized machine is made of a heavy copper bar, as in Fig. 5, therefore, the terminals will have to come out on opposite sides, so that the connection can be made conveniently between the coils. This means that the minimum number of turns in the coil must be 1.5. Then, to maintain the proper position of the coil's terminals the number of turns will have to be 1.5, 2.5, 3.5, etc. One-half turn in the series-field winding at first thought may not seem to be of any serious importance. However, when it is considered that in a 200-kw. 110-volt machine the normal full-load current is approximately 2000 amperes, and this current flowing through one-half turn gives 1000 ampere-turns, the effect that only a small fraction of a turn in the series winding will have upon the voltage of such a machine at once becomes apparent.

Here again, in the design of the series winding, it is impossible, except by a coincidence, that the correct number of turns can be obtained. The result is that as the series-field winding is designed on most compound generators, the machine is over-compounded.

For example, assume that in working out the design of a machine it is found to give the proper amount of compounding, that 3.8 turns will be required in the series winding In this the designer has the choice of using only 3.5 turns and having the machine slightly under-compounded, or using 4.5 turns and over-compounding the machine. The latter is the best course for several reasons. Due to imperfections in the materials and workmanship, the machine may vary somewhat from what was expected of it. In fact, it is practically impossible to build two machines after the same design and from the same lot of stock and have them both possess the same characteristics. Therefore, it is good policy to use a liberal design in the series-field winding, since there is a simple means for adjusting the ampere-turns of this winding when the machine is over-compounded. This consists of connecting what is known as a compounding shunt directly across the series-winding terminals, as shown in Fig. 6.

After the machine is built and in operation in the shop, a test is made to find out the amount of resistance that must be connected across the series-field terminals to give the required compounding, and then a shunt is made for this purpose and connected to the terminals of the series winding. Then, instead of all the load current passing through the series winding, only part of it does, depending upon the resistance of the shunt. If the full-load current of the machine is 1000 amperes and only 800 amperes are required to compensate for the volts drop in the series and armature windings, at full load, then the shunt is made to have a resistance four times as great as that of the series winding, so that when it is connected in parallel with the series winding one part of the current will pass through the shunt and four parts through the series winding, or any degree of over-compounding may be obtained up to the maximum by increasing the resistance of the shunt. Direct-current generators have been built for railway work in which the voltage increased from 500 at no load to 550 at full load, this increase in voltage being

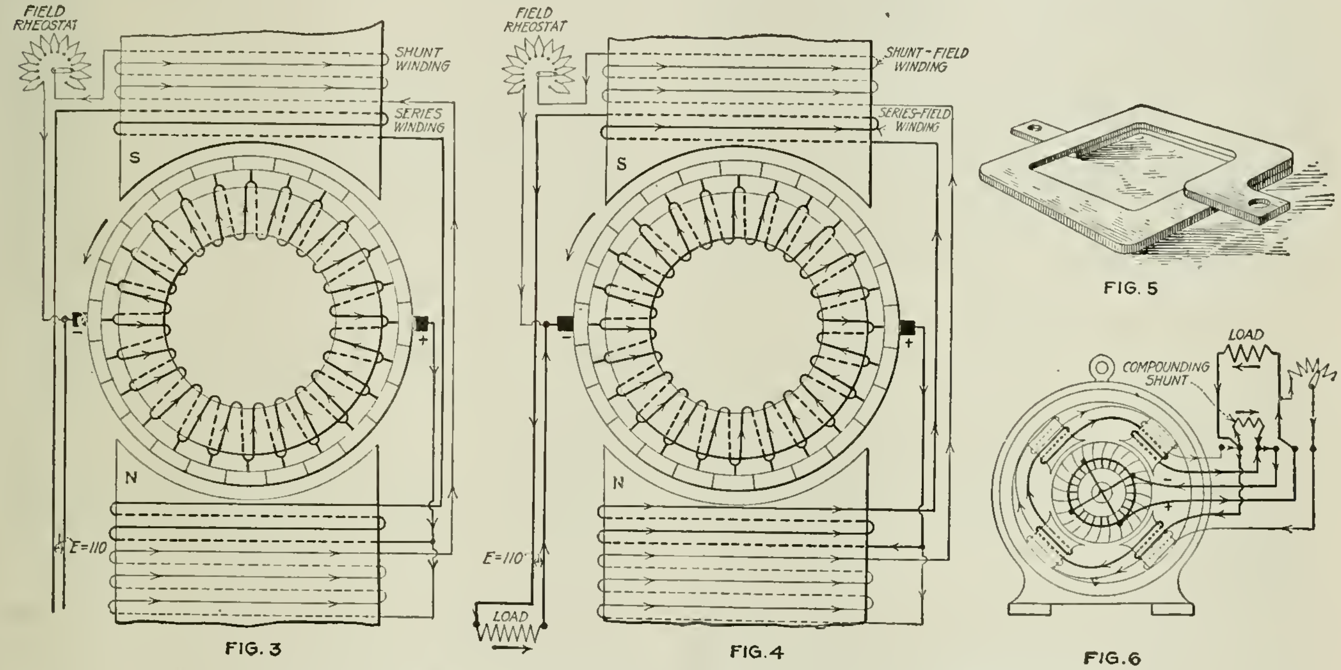


FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 3 TO 6. COMPOUND-GENERATOR CONNECTIONS AND SERIES-FIELD COIL

Fig. 3—Diagram of Compound Generator. Fig. 4—Diagram of Compound Generator Connected to Load. Fig. 5—Large-Capacity Series-Field Coil. Fig. 6—Compound Generator Showing Location of Compounding Shunt

used to compensate for the volts drop in the feeders.

In passing, attention may be called to the way that the shunt-field windings are connected. In Figs. 3 and 4 the shunt winding is connected directly to the armature terminals. This is known as a short-shunt connection. In Fig. 6 the shunt winding is connected directly across the series winding and armature in series, so that in this case the shunt-field current passes through the series winding also. This is known as a long-shunt connection. Since the shunt-field current is only a very small percentage of the total load of the machine, it is evident that it makes little difference which connection is used, the choice being more a matter of convenience than anything else.

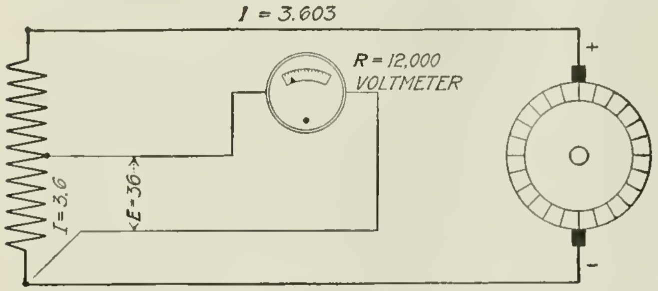


FIG. 7. VOLTMETER CONNECTED ACROSS SECTION OF RESISTANCE

Fig. 7 gives the layout of the first problem in the last lesson. This problem is solved by Ohm's law. The current flowing through a voltmeter is in all cases equal to the volts impressed across its terminals divided by its resistance, or in this case equals $36 \div 12{,}000 = 0.003$ ampere. The resistance of the section of the circuit that the voltmeter is connected across is equal to the volts drop across the section (the voltmeter reading), divided by the current, or $36 \div 3.6 = 10$ ohms. The total current in the remaining part of the circuit will be that taken by the voltmeter and that flowing in the section the voltmeter connects to, or $0.003 + 3.6 = 3.603$ amperes.

The second problem was, if the resistance of a voltmeter is 15,000 ohms and when connected across a given circuit 0.01 ampere flows through it, does the instrument indicate the correct voltage of the circuit if the needle points to 140 on the scale?

In all cases the correct reading of a voltmeter is equal to the resistance of the instrument times the current passing through it, in this problem, $15{,}000 \times 0.01 = 150$ volts. In this case the instrument reads 140; therefore. it is indicating $150 - 140 = 10$ volts low.

A given compound generator develops 125 volts at no load, the armature and its external connection has 0.075 ohm resistance, the series field winding 0.045 ohm. Neglecting the effect of the load upon the shunt field, what will be the voltage across the armature terminals at a 150-ampere load, also across the line terminals, if the load current of 150 amperes through the series winding causes the armature to generate 20 volts more than at no load?

A Day With the Refrigerating Troubleman

By E. W. MILLER

The troubleman takes the reader along on two hurry calls for help from plants where the refrigerating machines refuse to properly perform the work.

A REFRIGERATING plant of 15 tons capacity had been installed in a large department store. The equipment for the building was electrically driven, and the heat was supplied from an adjoining building; so the plant was operated by the electricians. After the refrigerating plant was installed, a man was left with the chief electrician for a short while.

A month after the man had left, we received a rush order from the chief electrician to come at once; the crankshaft of the machine had been broken. It was plainly not a case of defective material. I asked the chief electrician what had taken place, and he appeared to be as much in the dark as I about it. He said he was out of the engine room at the time of the accident and when he came in the belt was on the floor and the machine had stopped.

I was unable to find anything wrong, and to keep peace in the family we sent out another crankshaft. This was in the latter part of February. About the middle of April we received another complaint from this plant. I was sent out again, and this time the electrician informed me that he could not maintain the required temperatures in the various rooms.

I first turned my attention to the compressor, with which, of course, I was thoroughly familiar. Judging from the sound of the valves, the load indicated by the wattmeter and the suction and discharge pressures, I was sure that the compressor was not to blame.

The compressor was running very hot; the suction line was bare, and there was not a sign of frost as far back as where the line passed out through the wall to the coolers. The condenser pressure was lower than I would expect for the temperature and speed of the compressor, and the suction pressure was also low for the temperatures carried in the coolers, which were liberally piped.

On entering the cooler room, I found that the coils were only slightly frosted; the sharp frost line that is always present on an expansion valve that is working properly was missing, and the liquid line leading to the valves was warm—considerably warmer than it should be according to the water temperature and the head pressure carried.

Everything pointed to a shortage of ammonia. The problem was to account for its disappearance, as we had provided a liberal charge when the plant was started. The electrician said there had been no blowouts and he had never detected a leak except at the stuffing-box.

The entire system was pumped down to vacuum, after which I cut in the coils one at a time. In this way one could determine just about what proportion of the ammonia had been lost by seeing how many coils could be operated with the ammonia on hand.

Expansion cocks had been provided instead of valves. When I opened the first one, after pumping down, I was surprised that there was no sound of liquid passing the valve. There was no sign of frost on the valve. Always, after pumping down in this way the expansion valve will frost at once it is opened. This coil was entirely dry and had evidently not been used. Upon inquiry the chief informed me that it had not been in service since the plant had been started. This led to further investigations, and I had a hunch where all the ammonia had gone to. The suction valve was shut.

COIL FULL OF LIQUID

I casually asked the chief if he had ever had this coil in service and if so, for how long. This brought forth the information for which I had been looking: He said that he had cut it in on the day he found the crankshaft broken and had shut it off again and had not used it since.

I had him get one of the men to open the valve slowly after we were back in the engine room. I then partly closed the suction stop valve on the machine and awaited developments. There was a succession of thumps in the machine, and the belt nearly came off and screeched as it slipped on the pulleys. I gave the suction stop valve a spin that sent it shut at once and the racket stopped as suddenly as it had started. The thumps were so severe that it jarred the floor of the engine room and made the pipes connected to the compressor dance in the hangers; two of the joints started to leak.

It was then explained to him that this was what happened when he had opened up this coil at the time the crankshaft had broken; that the coil evidently was full of liquid, that he likely opened the valve quite lively and sent a slug of liquid of large volume into the suction line, the shock twisting off the shaft.

The suction stop valve was then gradually opened until the entire mass had been worked through the compressor. The system was pumped out and the bonnet removed from the expansion cock of the coil that had caused the trouble. Here I found that a piece was broken out large enough so that when the valve was closed as far as it would go, it would not quite shut off the flow to the coil. A new cock was put in and the plant started. It went along splendidly and did the work easily.

SUCTION VALVE SHOULD HAVE BEEN OPEN

The leaking cock had allowed the coil to gradually fill with liquid ammonia. The weather was cold at first, and sufficient ammonia was left in the rest of the system to keep the temperatures down until the weather became warmer. When he had attempted to open the valve and cut in the coil at the time the crankshaft broke, the large amount of liquid had, as stated before, rushed into the suction line and back to the compressor, causing the accident. He had then shut off the valve, and the coil had gradually filled again, removing a large portion of the ammonia from the active part of the system, and when the weather warmed up there was not enough to do the work. If the suction valve had been left open all the time, as it should have been, none of this trouble would have happened and the leaking expansion cock would have been detected in a short time by the inability to close it tightly.

In another case a 25-ton plant had been installed in a hotel. About two months later we received a call to come and "straighten out the plant," as it refused to work. Arriving, I was informed by the engineer that the cooler temperatures were "scooting up," the compressor was ice-cold, the suction pressure was down below atmosphere, and the expansion valves were barely cracked open.

Cooling was done by brine circulated from the engine room. A triple-pipe brine cooler was used, and a centrifugal pump circulated it. At first I could discover nothing wrong. The brine pump was spinning along merrily, and to all appearances everything was working nicely. The temperature of the brine as it left the cooler was much higher than usual, and judging from this in connection with the low suction pressure and the cold machine, it looked as though the cooler was not doing the work.

Thermometers in the inlet and outlet of the cooler showed the temperatures were about the same. Evidently the cooler was out of commission. I opened one of the drain valves at the bottom of one of the coils to see if there was any circulation; nothing came out. I removed one of the return bends and found ice. The rest of the coils were more or less in the same condition.

THAWING OUT THE COOLER

The machine and pump were shut down and a steam hose used to thaw the ice. Burlap and bags were used to wrap the cooler and hot water from the feed-water heater run over it. This thawed it out rapidly. All the return bends were removed; heated rods driven into the center pipes.

When I thought most of the brine was out, I opened up the valves in the inlet between the cooler and the pump and also the suction valve to the latter, intending to utilize the head on the pump to force out the remainder of the ice in the bottom pipes. To my surprise nothing happened. I ran the rod clean through the pipe, and a little brine trickled out.

Opening the pet-cock on the top of the pump showed there was no pressure on it. But brine flowed freely from a drain valve on the other side of the suction stop valve. Evidently there was something wrong with the suction stop valve to the pump. On removing the bonnet from this, we found that it had dropped the gate; remained closed, and as there then was no circulation through the brine cooler, the brine froze. As soon as the cooler was frozen, there was nothing to boil the ammonia, and it came back to the machine and froze it; the suction pressure, of course, also came down, as there was no ammonia evaporated.

To prevent further recurrence of the trouble, another thermometer was provided for the inlet to the cooler and the temperatures read every half-hour. If this had been done before, the trouble would have been noticed before the cooler froze and an investigation would have located the trouble before any damage had been done.

Stets Boiler-Feed Controller

The function of a controlling element on a boiler feed-water line is to maintain the water level in the boiler at a predetermined height and to do so by maintaining a continuous flow of water to the boilers. Numerous designs of regulators have been devised of both the float and the thermostatic-control type. The more simply a feed-water regulator is constructed the less likely it is to get out of order and the more dependable it will be. It has been difficult to make the float of the float-controlled regulator strong enough to withstand the high steam pressure now carried and at the same time buoyant and powerful enough to operate the controlling valve.

The design of the water-controlling valve is also an important matter, and the proper type of valve seems to have been adopted in the new Stets boiler-feed controller, which is manufactured by the Williams Gauge Co., Pittsburgh, Penn. This controller is self-contained, and the float-control principle is used. It is made of two types, as shown in Figs. 1 and 3.

The controller, Fig. 1, consists of a horizontally split casing containing a copper float which actuates the feed valve by means of a lever, as shown. As the working parts are all in the pressure space, stuffing-boxes have been omitted. The float and the control valve are the interesting features of the controller.

The copper float is heavy enough to withstand a cold-water pressure of five times the working pressure. When the boiler is in service, the upper half of the float is surrounded by steam of a temperature corresponding to the pressure of the steam in the boiler, but the lower half is surrounded by water that does not have a temperature equal to the pressure. Therefore, the temperature inside the float is a mean between that of the steam above and of the water below the floating line of the float. As the float contains a certain amount of volatile liquid having a boiling point lower than that of water, it vaporizes at the mean temperature existing inside the float and builds up a pressure approximately equal to the boiler pressure on the outside of the float.

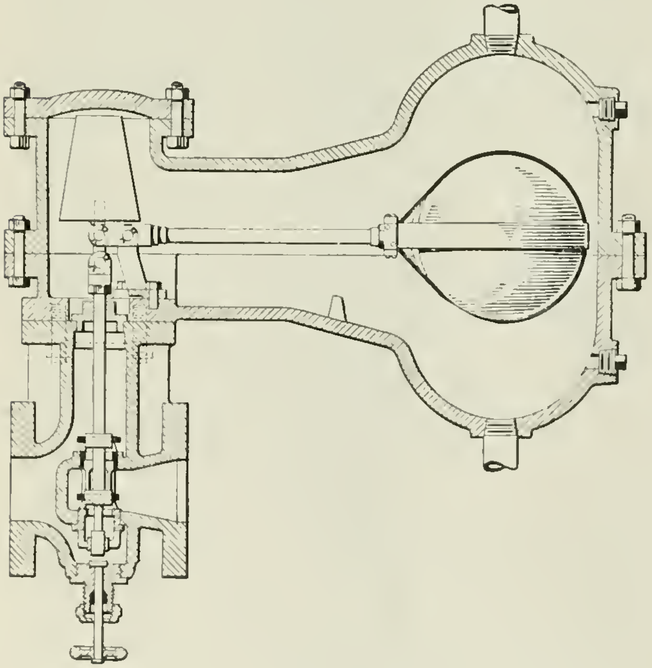


FIG. 1. SECTION THROUGH TYPE-A CONTROLLER

A balanced piston type of valve is used, both pistons being of the same diameter. This piston fits in a sleeve in which there are four V-shaped ports near its upper and lower ends. The central portion of the sleeve has three large openings, the area of which is considerably in excess of that of the upper V-ports. As the lower end of the valve sleeve only is threaded to its seat, it can be withdrawn without disturbing the valve or breaking any of the pipe connections.

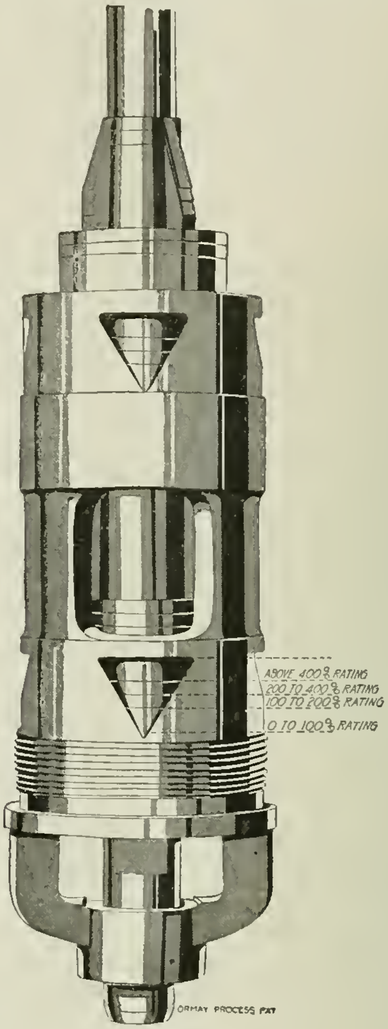


FIG. 2. DETAILS OF THE VALVE

The valve does not seat, but is designed to control a continuous flow of water through the V-ports. Fig. 2 shows the piston disks in three positions and gives a general idea of the different degrees of valve opening required to feed a boiler at the rating indicated and with a normal excess pressure on the inlet side. About $\frac{5}{16}$-in. lift takes care of the feed requirements for usual loads.

The movement of the valve stem is directly proportional to the movement of the water in which the float rides, but the flow of water through the ports is proportional to the amount that they are uncovered by the piston.

The controller shown in Fig. 3 operates on the same principle as that shown in Fig. 1. The casing, however, instead of being split horizontally, is provided with two top openings through which the float lever and counterweight are placed in position. Instead of putting the counterweight on top of the valve stem, as shown in Fig. 1, a housing is provided on the end of the controller casing and the counterweight is placed in a horizontal position instead of in a vertical one. This casing is designed for high pressures up to 350 lb. and for the higher pressures is constructed of cast steel. The casing shown in Fig. 1 is for pressures up to 250 lb. and is made of cast iron.

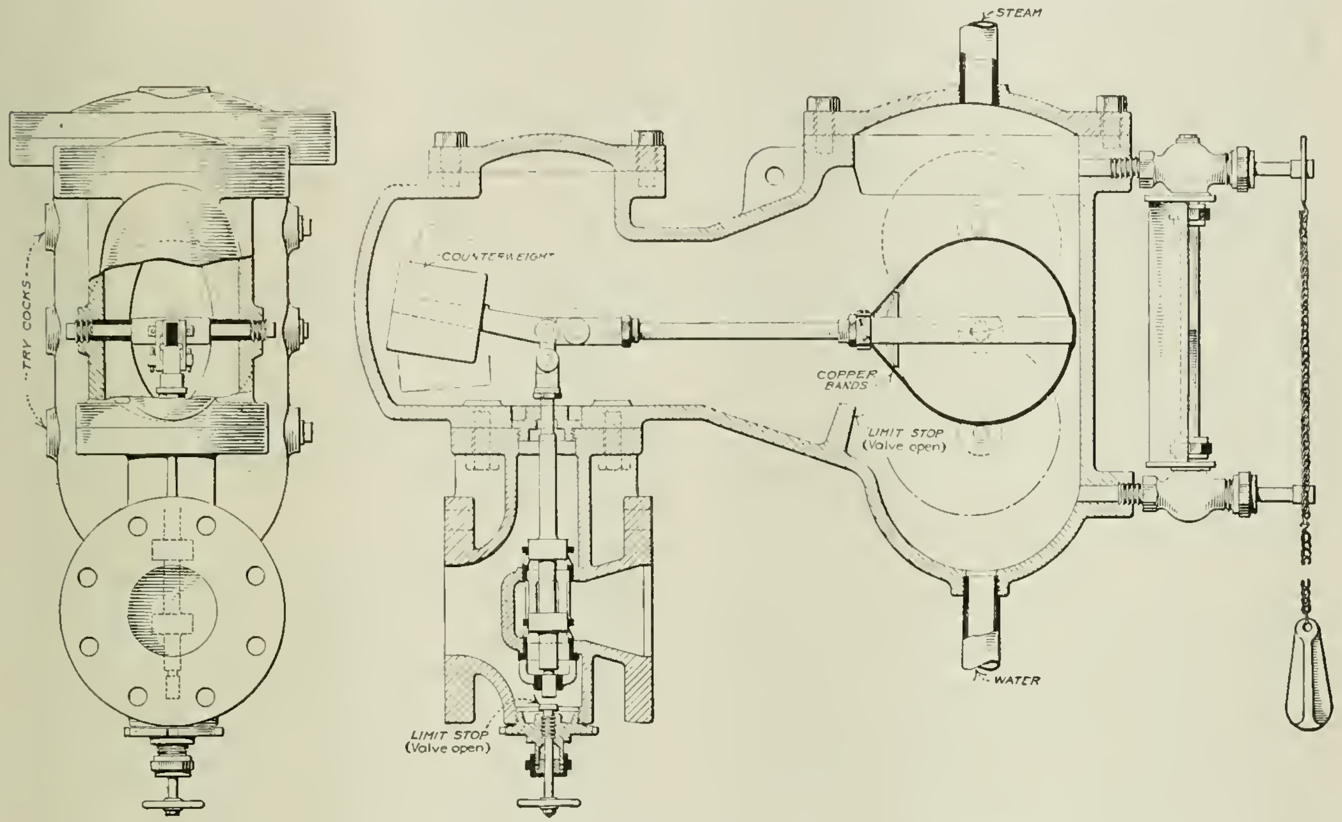


FIG. 3 END VIEW AND SECTION THROUGH TYPE-B CONTROLLER

The controller may be set at the corner of the boiler setting and connected to the boiler with the usual steam and water piping. The controller shown in Fig. 1 is used in conjunction with a water column; that shown in Fig. 3 is in itself a water column and is fitted with the usual try-cocks and gage-glass.

Atmospheric Vapor-Absorption System

By G. C. Derry

In a power plant at Port Henry, N. Y., on the shores of Lake Champlain, a troublesome vapor condition existed in cold weather from cold air coming in and condensing the moisture in the warm air in the boiler room, which caused a fog so dense that the firemen could scarcely see their steam gages and water glasses from the floor of the boiler room. Several plans for getting rid of the vapor were tried without success. The coal supply was just outside the boiler room, and there was a continual opening and closing of doors as the firemen brought the coal in. The fog was so dense, in fact, that when the firemen started in with the coal, they had to shout in order to avoid running into each other, and it was difficult to get men to stay and work under such conditions. Water tenders had to be put on in order to watch the water gages from an elevated platform constructed in front of the boilers.

A condition existed which resembled the blowing of one's breath into cold air in the winter time, and it seemed to me that the logical thing to do was to bring the incoming air up to the temperature of the room or possibly a little higher, so it could carry off some of the vapor. Proceeding along these lines, a large heater and multivane fan were installed, which drew the air from the room, mixed it with some fresh air from outside and forced it through a duct system leading along the sides of the room and down each side of each door and up against the cold surface of the windows. The fan and heater were installed on an inclosed platform over the door which led to the coal pile, and advantage was taken of this platform—making it a ceiling of a room into which to pour a large amount of heated air.

The fan had a capacity of 33,000 cu.ft. of air per minute, and the air in the room was changed every three minutes. The heater was capable of heating this amount of air from 10 deg. to 158 deg. when supplied with steam at 60 lb. pressure. The system had the advantage of removing the steam in the winter and also providing a means of ventilation in the summer.

The owner has advised us that the system worked satisfactorily, removing every trace of the vapor even during the extremely cold weather last winter.

Most engineers would have a fit if cast-iron nuts were furnished for the valve chest and cylinder covers, yet one end of these studs is always in a cast-iron nut. But on that account there are no fits, showing that it makes a mental difference which end of the stud you are thinking about.—*Marine Engineering.*

Not because he loves cast iron less, but steel more.

Conditions in the Power Industry

BY LUDWIG W. SCHMIDT

A digest of the reports of the United States consuls on the power situation in the various parts of the world and the influence of the war upon this important industry. Also, see "Power," March 5, 1918.

THE electrical power development of the world outside the United States has been influenced by two distinct factors during the last three months. One has been the increasing demand for electrical power and the other the lack of funds to make the urgently needed extensions. As a result, most of the existing central stations report increased business and all say that they could do more if they had the necessary installation.

In Europe, where the immediate needs seem to have been largest, extensions have been made where urgently wanted so as not to cripple the activity of the national industries. Outside Europe, however, development has been held back, and there is plenty of evidence that many projects which should have been carried out during the present year have been deferred to a later time. Central stations in all parts of the world report that they have difficulty in making contracts for additional equipment and that where it has been possible to place the orders the contractors remain behind with their deliveries.

Norway seems to be an exception to the rule. The expansion of hydro-electric enterprise which has been characteristic of the economic life of that country during the last year continues during the present. Commercial Attaché Erwin W. Thompson writes from Copenhagen (C. R. 1.)[1], that it is proposed to develop 100,000 hp. from the Gaudefaldene waterfalls near Stavanger. The power to be obtained will be used principally for the production of carbide and for other electrochemical industries. To provide for the labor essential to the new industries it is intended to build a village near the falls.

UTILIZING WATER POWER FOR SMELTING IRON ORE

The same consul reports a scheme to utilize water power for the smelting of iron ore. Norway has large iron-ore fields which yield more iron than can be used in the country. This ore at the present time is exported to be smelted, but it is thought feasible to smelt it in the country. The beginning will be made with ore produced in the Braastad mines, near which 2500 hp. can be created (C. R. 3). As there is a lack of hydraulic and electrical machinery, it is expected that large quantities will have to be imported. Electrical smelting also will be resorted to in a new steel mill which is to be built in Risor, near Christiania. This mill is expected to turn out from 30,000 to 40,000 tons of steel every year. The power for smelting will be taken from the Hoge Falls, where from 150,000 to 200,000 hp. can be obtained. Only 22,000 hp. will be needed for the beginning (C. R. 64).

If the utilization of hydro-electric power for smelting should become more general in Norway, it is certain that this country will be in need of much machinery which, for a while at least, she most likely will buy either from England or from this country. The machinery for the Gaudefaldene scheme is to be supplied by England.

Most of the Norwegian electrochemical enterprises seem to have been operated with considerable success during the last year. The annual report of the Norsk Hydro, which controls 300,000 hp. and has a capital of $15,450,000, shows that this company has increased its net profit from $4,900,000 during 1916 to $6,650,000 during 1917. The business year covered by the report runs from July to June for each year (C. R. 33).

ENGLAND MAKING PREPARATIONS FOR POST-WAR DEVELOPMENT

In England all electrical-power development at present is influenced by the preparations made for the reorganization of all power supply which is expected to follow the war. With the possibility that great changes will be made in the production and distribution of power, local enterprises show little inclination to invest in new installations. Only the most urgent additions are made. New installation work is also hampered a good deal by lack of labor and materials which are needed more urgently somewhere else.

In the meantime the local power and traction companies are doing good business. The Glasgow Corporation tramways, for instance, have to report an increase in takings of $391,618 for the period from June 1 to Nov. 30, 1917, in comparison with the same period of 1916. During the six months of 1917, 212,961,987 passengers were carried as against only 192,399,712 in 1916 (C. R. 4). No new enterprises of any extent are reported, but Consul J. S. Armstrong, Jr., writes from Bristol that the municipal authorities will be compelled to extend the local electrical plant by installing a 6000-kw. turbo-alternator, four water-tube boilers and switch gear. The additional installation is made necessary by the increased demand for electrical power.

LACK OF ELECTRICAL ENGINEERS IN SPAIN

During the last year Spain has had a fair share of the so-called war prosperity, which in many cases has made necessary additions to the existing generating stations. It seems to be generally realized that that country in the future will have to rely more than ever on its own industrial resources, which in turn will necessitate the provision of better electrical-power facilities than heretofore. So far there has been a lack of sufficiently trained Spanish electrical engineers. This deficiency will now be eliminated by giving increased opportunities for the study of electrical engineering. The City of Barcelona therefore has added a special Institute of Electrical Industries to the Industrial School of that city, the influence of which should very soon be felt in the electrical industry of the country (C. R. 11).

Italy has made good use of its great hydro-electric possibilities during the war. Consul Joseph E. Haven in Turin points out in this respect that many factories in Italy which formerly were operated by steam power are now using electrical power and that electricity has

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[1] C. R. indicates "Commerce Reports" of 1918.

become the standard motive force. This change has been made possible by the erection of big electrical central stations, which in some instances supply power over distances of hundreds of miles. Before the war Germany supplied most of the electrical-power machinery in use in Italy. Since Italy entered the war, connection with Germany, of course, has been broken off, and now American, English and Swiss machinery is used in preference. Also the Italian electrical industry has made considerable progress (S. C. R., Feb. 8, 1918).[2]

The industrial census of Africa for the year 1915-16 has shown again the great progress made in the use of electrical power in that country. There were in South Africa proper 1214 establishments using electrical power to the extent of 121,229 hp., as against only 689 using 564,664 hp. generated by steam, 440 using 5985 hp. generated by oil engines, 181 using 6266 hp. generated by gas and 152 using 3759 hp. generated by water. In the Transvaal 430 establishments used 84,634 hp. generated by electricity and 226 used 294,956 hp. generated by steam (C. R. 6).

ELECTRICAL POWER INDUSTRY IN SOUTH AMERICA

The last year has brought much activity to the electrical power industry of South America. Many new industries have sprung up to supply those articles which the South American countries cannot buy any longer from Europe owing to the war, and these industries had to be supplied with cheap and reliable power. So an increased use has been made of electricity. In Venezuela an attempt will be made to use one of the waterfalls in proximity to Caracas. Consul Homer Brett in La Guaira says that this development will be carried out by American capital. The water power to be used is that of Naiguata Falls, which have a drop of 3373 ft., and it is expected that 8000 hp. will be created from this source. The necessary investment will amount to approximately $1,000,000, which will be obtained with the assistance of American banks (C. R. 6).

State ownership of electrical enterprises has advanced another step in Uruguay, where the government just now has acquired its sixth electrical power plant. The station in question is that of Mercedes, which was the property of the firm of Preve y Hermanos. The government also owns electrical central stations in Montevideo, Colonia, Canelones, Maldonado and Pando. All government plants are under the control of the Administracion General de las Usinas Electricas del Estado (C. R. 40).

Consul William Dawson in Montevideo reports in the same connection (C. R. 41) that all the state electrical plants are burning oil fuel, which under a special contract is supplied by the West India Oil Co. Under its agreement with the company the state has the right of preferential treatment as to supplies and has just now made an order that the company keep a reserve of 5000 tons of oil, to be held for use of the government.

Consul Charles L. Latham in Kingston, Jamaica, says that there is a demand in that island for small individual power plants to be installed in country houses. Electrical power so far is available only in the cities. Farmers and planters realize well the great advantages to be derived from the employment of electricity in the operation of farm machinery, the lighting of houses, etc. Power outfits should consist of a kerosene engine, a dynamo mounted on the same shaft preferably, and a bank of storage batteries. The price should be approximately $400 (C. R. 38).

INDUSTRIAL ACTIVITY IN JAPAN AND CHINA

The enormous increase in industrial activity in Japan resulting from the war has caused a great demand for electrical power, which has necessitated the erection of many new power stations. Although there is, strictly speaking, no boom in power development, business nevertheless has been very active and the number of electrical enterprises has increased 50 per cent. There are now 674 electrical stations in Japan having a combined capital of $339,422,119. The combined power supplied by these stations has a daily average of 922,940 kw., of which 700,870 kw. is generated by hydro-electric stations. The remainder is generated mostly by steam. During the last year steam generation has made greater progress than water-power generation. There was a total increase of the average daily power supply of 131,706 kw. (C. R. 36).

The activity in the electrical industry in eastern Asia, however, is not confined to Japan only. From a report by Consul General P. S. Heintzlman in Canton, China, it appears that China has had its share. There has been apparently a good deal of difficulty in securing the supply of electrical-power-station machinery in China during the last three years, which has hampered considerably the development of the industry. The Kwangtung Electric Supply Co., for instance, has contemplated an extension of its power equipment for a long time. It has now been possible to place a contract with a firm of American engineers for the purchase of two American high-pressure condensing turbo-alternators, rated 2500 kw. three-phase 60-cycle 2300-volt; one American high-pressure noncondensing turbo-generator, 35 kw. 125-volt direct-current; and switchboards, pumps and other accessories. The contract also provides for four 750-hp. Babcock & Wilcox boilers. In all, $433,500 in gold will be spent for the new equipment.

The Kwangtung Electric Supply Co. is a Chinese enterprise which was established during 1909 with a capital of $480,000, American money. Its monthly takings are now approximately $60,000. The plant has been a success from the start, and will be the second of importance in China after the completion of the extensions now ordered.

CENTRAL STATIONS IN SOUTH CHINA

South China contains a number of electrical central stations. As the most prominent of these the consul mentions the following: Kowkong, Kongmoon, Sainam, Taileung, Sheklung, Chanchuen, Sunning City, Suncheng, Fatshan, Shin Hing, Siulam, Shekki and Kiungchow, all in the Kwangtung Province, and Wuchow and Nanning, in the Kwangsi Province. Most of the electrical equipment of these stations is of American manufacture, though most of the machines were purchased from England. The plant in Sunning City is equipped with Swedish machinery. Most of the stations in question are private enterprises. Those in Fatshan, Sainam, Shin Hing, Nanning and Wuchow are owned by the

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[2] S. C. R. indicates "Supplement, Commerce Reports."

Chinese government. The motive power is provided practically everywhere with the help of internal-combustion engines. Now experiments are made with native coal, and the new plant in Canton will be the first burning Chinese coal under its boilers (C. R. 4).

The war also has brought much business to the central stations of India. Southern India to-day has three large electric-power companies, says Consul Lucien Memminger, of Madras (C. R. 44). These are at Madras, Bangalore and Hyderabad. So far only one electric railroad is operated in the district of the consulate, which is that in Madras. This is 28 miles long, but the war has made necessary an extension of the system which may be taken in hand very soon. The report tells of several new electric railroad schemes. One of these refers to a line from Kulaskharapatnam to Tiruchendur in South India. This line will have a length of 29 miles and it will be built by an English firm. Electrical expansion in India suffers as anywhere else from the lack of available capital. So it seems that two projects—one to establish railways in Mysore and the other to extend the power station at the Cauvery Falls—both of which have been worked out by S. G. Forbes, an American engineer and chief electrical engineer of the Mysore government, will have to wait. The estimated cost of these undertakings will be $3,147,000. The Mysore power undertaking has just received permission from the government to install an electric-lighting system in Madura. Orders have been placed in the United States for hydro-electric machinery at a value of over $1,000,000 to be used in connection with the Andhra Valley development executed by the Tata Hydro-Electric Power Supply Co.

Evertite Sta-Lok Nut

A nut that is likely to work loose is a source of danger, trouble and anxiety to the user. Numerous devices have been employed to prevent nuts from loosening, some being home-made and others patented. A recent addition to the number is known as the "Sta-Lok" Nut, manufactured by the Evertite Nut Corporation, Detroit, Mich.

This nut will not loosen under heavy stress, nor from violent or prolonged vibration, such as is experienced with some types of high-speed machinery. It looks like any other nut from the outside. On the interior, however, there is a hardened steel ball that runs in a groove between the bolt threads, Fig. 1. This ball is kept in contact with the threads, Fig. 3, by a spring, and when the nut tends to unscrew the spring forces the ball to wedge in the threads, which tightens the nut and so prevents it from working loose.

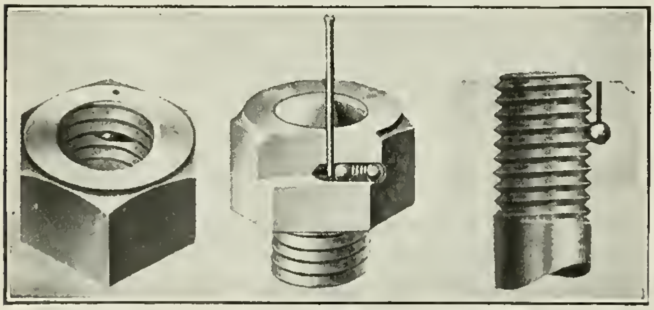
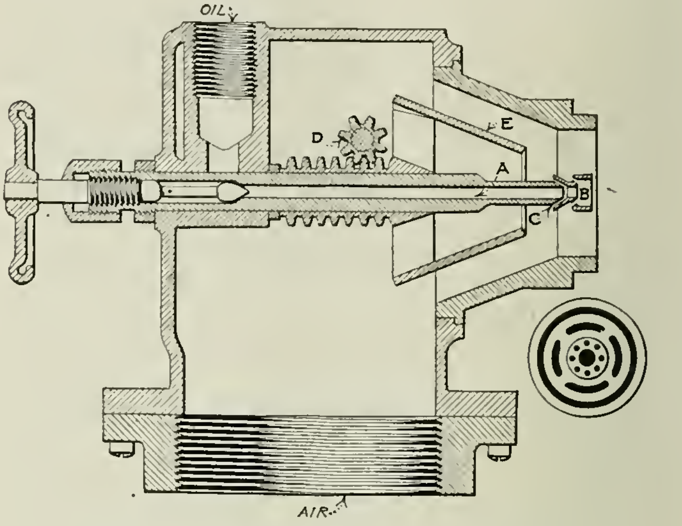


FIG. 1. THE NUT. FIG. 2. UNLOCKING. FIG. 3. LOCKING

The only way to remove the nut is to release the ball from its lock position, which is done by inserting a pin through the keyhole shown in Fig. 2. Should the keyhole become filled with dirt it is easily cleaned by inserting a small pin or wire.

Lindsay Low-Pressure Oil Burner

The Lindsay oil burner has recently been placed on the market, and although it was primarily designed for use in assay and metallurgical plants it will doubtless be found suitable for use by engineers for heating small furnaces, etc. It has a central channel *A* through which the oil flows; the oil is discharged through an enlarged orifice *B* in a thin circular film. It is caught by a rotating blast of air and thrown from the nozzle as a fine swirling mist. The burner is manufactured by the Mine and Smelter Supply Co., New York City.



SECTION THROUGH LINDSAY LOW-PRESSURE OIL BURNER

Part of the air supply passes through the tip of the innermost orifice at *C*, thus preventing the clogging of the oil line. The burner will work successfully on any oil from a heavy one of 18 deg. Baumé to the lightest gas oil. As there are no delicate parts to clog, it is not necessary to take the burner apart frequently for cleaning, although all parts are accessible if for any reason it is desirable to open the burner. The oil consumption is low, running from 1 to 1½ gal. per burner per hour for the smaller sizes, up to 2 gal. and up for the larger ones.

The air pressure required for the Lindsay low-pressure burner is from 6 to 8 oz. On account of the burner construction this pressure gives perfect atomization, while the oil is fed to the burner by gravity. The air supply is controlled by merely turning a regulating adjustment situated on the side of the burner and which does not get hot. This can be done instantly and while the burner is in use.

As the adjustment is turned that reduces the quantity of air, a movable cone *E* decreases the area of the air vent, so that the pressure remains constant, though the volume is less. This prevents loss of efficiency, which would occur if a less quantity of air were permitted to go through the same sized orifice. This movable cone is regulated from the adjustment on the side of the burner through a rack and pinion *D*, and is held in position by a pawl and spring so that the adjustment will not change.

Where Does the Heat Go?

Of the total amount of heat energy represented by the coal fired in a boiler furnace, only from 6 to 15 per cent. is obtained in the form of useful work at the belt wheel of the engine. This article shows where and how the heat is lost.

ONE pound of good coal has a heating value of 13,500 B.t.u.; but when that coal is burned under a boiler and the steam produced by it is used in an engine, the work obtained at the belt is only a small fraction of the energy contained in the fuel. The reason is that the greater part of the heat is lost in various ways.

A part of each pound of coal drops through the grates and is carted away with the ashes. As this coal is not burned, its heating value is not given up, and heat is thus thrown away. The loss in any particular case will depend on the kind and grade of coal, the form of grate and the skill of the fireman. As an average, the loss may be taken as 1 per cent., or 135 B.t.u.

The furnace is inclosed in brick, and the steam drum is protected by a nonconducting covering; but even these precautions cannot wholly prevent heat from being radiated from the boiler. The amount thus lost may be assumed to be 5 per cent., or 675 B.t.u.

The two losses just mentioned, however, are small when compared with the loss due to the escape of the hot gases at the top of the chimney. About 2970 B.t.u., or 22 per cent. of the heating value of the coal, passes away through the chimney.

Of the 2970 B.t.u. thus lost, much is used in heating the air supplied to burn the coal. The air entering the ashpit has a temperature of, say, 60 deg. F., but the gases escaping at the top of the chimney have a temperature of 500 or 600 deg. F. This large increase of temperature requires heat, which is taken from that developed by combustion of the coal.

The chimney gases also contain steam, formed by the combustion of the hydrogen in the coal as well as by the vaporizing of the moisture in the coal and in the air supply. A part of the 2970 B.t.u. is accounted for by the escape of this steam.

Further than this, there may be unburnt carbon and hydrogen in the chimney gases. If all the carbon is not burned to carbon dioxide (CO_2) and all the hydrogen is not burned to steam, the escape of these unburnt combustibles represents a loss of heat. The loss due to combustibles in the chimney gases accounts for the remainder of the 2970 B.t.u.

The three items of loss thus far considered total 28 per cent., which represents the boiler loss. The difference between this and 100 per cent. is 72 per cent., which is the boiler efficiency; that is, the boiler puts into the steam 72 per cent. of the heat it receives from the coal. At this efficiency, therefore, the boiler utilizes 13,500 × 0.72 — 9720 B.t.u. per pound of coal burned.

A part of the heat in the steam—say 10 per cent., or about 1000 B.t.u.—is needed to run the feed pump and other auxiliaries; but when these are run noncondensing, it is possible to reclaim about 780 B.t.u. by passing the exhaust steam through a feed-water heater. In this way the amount of heat put into the steam for each pound of coal burned is 10,500 B.t.u. When the steam is conveyed through the main pipe to the engine and pumps, there is a further loss due to radiation and leakage, amounting to about 210 B.t.u.

The pipes and cylinders of the auxiliary apparatus are often left bare or are not well covered, and of the 1000 B.t.u. delivered to them, about 3 per cent., or 30 B.t.u., is lost by radiation. As 780 B.t.u. is reclaimed in the heater, it follows that 1000 — (780 + 30) = 190 B.t.u. is lost in the exhaust from the heater.

Of the 10,500 B.t.u. in the steam, 1000 + 210 = 1210 B.t.u. is accounted for by the radiation losses and the demands of the auxiliaries. The remainder, or 10,500 — 1210 = 9290 B.t.u., is delivered to the engine. Leakage and radiation from the steam chest, cylinder, etc., will cause a loss of about 3 per cent., or 280 B.t.u., so that the heat left to be converted into work is 9290 — 280 = 9010 B.t.u.

A good modern condensing engine will probably produce a horsepower on 2 lb. of coal per hour, or half a horsepower on 1 lb. of coal per hour. A horsepower is 33,000 ft.-lb. per min., or 1,980,000 ft.-lb. per hour, and as 778 ft.-lb. is equivalent to 1 B.t.u., a horsepower requires 1,980,000 ÷ 778 = 2545 B.t.u. per hour. As the engine is assumed to produce half a horsepower, it will use 2545 ÷ 2 = 1272.5, or, say, 1273 B.t.u. per hour. If only 1273 B.t.u. is utilized in producing power, the remainder, 9010 — 1273 = 7737 B.t.u., represents the heat discharged into the condenser and carried away by the circulating water and the condensate.

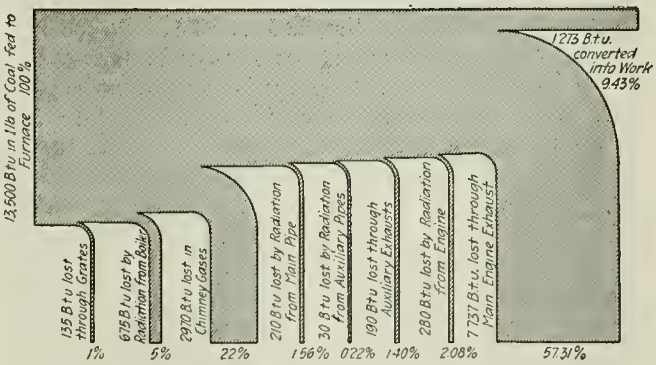


DIAGRAM SHOWING HEAT LOSSES

Not all of the 1273 B.t.u. converted into work is available at the belt wheel, for friction will waste about 8 per cent., even in a good engine. If the engine is assumed to have the high mechanical efficiency of 92 per cent., therefore, the heat equivalent of the work available at the belt will be 1273 × 0.92 = 1171 B.t.u. Thus, from 13,500 B.t.u. put into the furnace in a pound of coal, only 1171 B.t.u. is converted into useful work. This is equivalent to 1171 ÷ 13,500 = 0.0867, or 8⅔ per cent., of the heat in the coal.

The accompanying diagram shows graphically the various heat losses, expressed as percentages of the heating value of the coal. It is evident that the largest losses are those due to the hot chimney gases and the exhaust steam from the engine, and wherever the losses are greatest, opportunity for saving is greatest.

Federal Inspection of Power Plants

Power Plants Must Be Efficient As Well As Safe
The Needlessly Wasteful the Last To Get Fuel

IT HAS been definitely determined by the United States Fuel Administration to institute a system of classification of power plants, based upon the care and efficiency with which they are operated, and the idea has received the approval of fuel administrators in New England, Connecticut, New York and Pennsylvania. The details have been worked out by David Moffat Myers, Advisory Engineer of the United States Fuel Administration.

It is estimated that from 25,000,000 to 50,000,000 tons of coal per year can be saved in power plants, simply by the more careful and intelligent use of existing apparatus and the elimination of easily preventable waste. To effect this purpose an Administrative Engineer will be appointed in each industrial state, to be attached to the office of the State Fuel Administrator. W. R. C. Corson, of the Hartford Steam Boiler Inspection and Insurance Co., is to be the engineer for Connecticut; E. N. Trump, vice president of the Solvay Process Co., for New York; Thomas R. Brown, of the Westinghouse Air Brake Co., of the Pittsburgh district; and Walton Clark, vice president of the U. G. I., of the Philadelphia district of Pennsylvania. Other states will be organized as fast as possible. A questionnaire will be sent by these engineers to the owner or operator of each fuel-operated power plant in the state, asking him to furnish the administrator within a stated number of days such information as the type and number of boilers; kind of service or product; kind of draft and method of firing; amount and kind of coal burned during the preceding 12 months; proportion used for power, heating and process work; amount of purchased power; whether records of coal consumed, water evaporated and flue-gas analysis are kept; type and size of steam-using units; what provisions are made for weighing coal and water, and what records are kept; what provision is made for heating feed water; if means are provided for measuring the draft over the fire and for determining excess air by gas analysis; if dampers are provided for equalizing the draft in the furnaces; if there is a convenient means for regulating the draft by the main or uptake dampers; if there is an automatic damper regulator in working order; what provision is made for keeping soot and ashes from boiler-heating surfaces; whether the grates are warped, broken or otherwise defective; whether there are leaks in boiler settings, openings between boiler and setting, badly warped fire-doors, etc.; if heat-radiating surfaces are covered; if the exhaust steam from noncondensing engines is used and to what extent; if live steam at low pressure is used in the plant and for what purposes; if a competent man is detailed to supervise the work of fuel conservation in the boiler and engine rooms and the transmission and use of power in the factory.

Arrangements have been made whereby inspectors of the steam-boiler insurance companies, state factory inspectors, engineering students from technical colleges, volunteers and others will visit these plants and verify the answers given in the questionnaire. Each plant will be given a rating, based upon the data so obtained. The ratings will be divided into five classes, and in case of a fuel shortage the plant that has been found to be needlessly wasteful will be one of the last to be allowed to draw upon the available supply.

It is recognized that plants must be dealt with as they are found. No extensive and expensive installations of more efficient apparatus will be expected, but there are many economies that can be brought about by stopping leaks in boiler settings, repairing baffles, covering heat-radiating surfaces, trapping outlets, returning drips and making an intelligent use of the exhaust. A plant will be judged, not on its inherent efficiency as a plant, but by the use which it makes of its own conditions and opportunities. The whole attitude of the administration will be one of suggestive helpfulness rather than of coercion. The inspectors who visit the plants to verify the questionnaires will in many cases be able to give sound advice, and the State Administrator will be furnished with a list of approved professional consulting engineers to whom power-plant owners may turn for more extensive consultation.

The Fuel Administration is also preparing a series of official bulletins on Steam and Fuel Economics. These will include boiler and furnace testing, flue-gas analysis, saving steam in heating systems, boiler-room accounting systems, saving steam and fuel in industrial plants, burning fine sizes of anthracite, boiler-water treatment, oil burning, stoker operation.

Burning Natural Gas Under Boilers

By Charles Jablow

On account of the present interest in fuel conservation it may be interesting to note the saving effected in one plant from a study of the operating conditions.

The plant, containing 770 rated boiler horsepower, was using as fuel natural gas, at a pressure of over fifteen pounds. Three of the boilers had four burners each. It was found by several evaporation tests that by reducing the pressure to about two or three pounds the equivalent evaporation was changed from 0.471 to 0.494 lb. per cu.ft. of gas, the highest heating value of which was 619 B.t.u. per cu.ft. But with this pressure reduction there was a reduction in the boiler horsepower from 212 to 148, partly because the gas main leading to the plant is only 3 in. in diameter and the pressure change was made at a gas regulator about 1000 ft. distant, so that with the lower pressure the capacity of the line was reduced too much. I recommended that the regulator be moved to the plant and that the 3-in. line be subjected to the high pressure of the main. An additional burner was put under each boiler at the same time, and our expectations relative to the performance of the boilers were fulfilled and the rating of the boilers was easily developed.

The fuel bill for the last few years has been about $10,000 annually, and the saving by these changes amounts to about $450 per year.

Editorials

Government Insistence Upon Power-Plant Efficiency

EVER since its foundation *Power* has insisted upon Governmental regulation of power plants. It holds that the owner of a factory or a department store has no right to invite the public into a building in the cellar of which are boilers upon the safety of which no competent authority has passed, operated by laborers selected for their willingness to work for meager pay rather than for their knowledge of the forces with which they are dealing. Regulation and inspection exercised by foreign governments have reduced casualties until the number of those in the United States is by comparison lamentably high in proportion to the number of boilers in use.

It appears to be axiomatic that it is not only the right but the duty of the Government to look after the safety of the citizen. Several years ago we ventured a suggestion that the time might come when the Government would insist upon efficiency as well as safety in the operation of power plants. If a boiler explosion is a communal disaster, adding, through its destruction of buildings, plant and material, its interruption in production and reduction of output, in increased rent and insurance and prices of product, and in care of the injured and dependent, to the burdens of the community, how much more of a communal disaster is a sustained waste, going on year after year, using up the resources of the country and paid in the final analysis by the ultimate consumer. The idea has found expression by others and would have found justification and adoption in the course of ordinary events.

But the war has produced a condition of fluxibility in which the fixed patterns and formulas of an old conservatism are torn loose and jostled about with a chance of setting down upon lines which are sound and right and capable of producing results. And so, quite naturally, when the scarcity of fuel becomes pressing the people—that is the Government—say: "Why should this man be allowed, through simple carelessness, to burn twice as much coal as he needs, making his product (if its selling price is based on its cost as it should be) cost more to its users, using up man-power and railway facilities to get coal to waste while others suffer for the want of it?"

Over forty per cent. of the coal mined is used in industrial plants. A saving of even ten per cent. in this field would go a long way toward making up the shortage. The Fuel Administration has resolved to put this saving into effect. An engineer will be accredited to the Fuel Administrator of each of the industrial states, and under his direction a questionnaire will be sent to the owner or operator of every fuel-operated power plant in the state. The replies to this questionnaire will enable the state engineer to determine whether the plant is being operated with care and intelligence or needlessly wastefully. Inspectors will visit the plants, verify the answers returned and offer helpful suggestions. No insistence will be put upon the installing of more efficient apparatus, but an effort will be made to get the best results out of present equipment with such simple improvements as can be made under existing conditions and improved methods of operation. In the light of the information thus obtained, the plants will be classified, and those which use their fuel with the least care and intelligence will be the last to get any when the shortage comes. The attitude of the Administration will, however, be suggestive and helpful rather than coercive. The inspectors will not be called upon to advise as to possible improvements in apparatus and methods. The state administrators will be prepared to recommend reliable professional engineers for those who care for more extensive advice.

One of the beneficial results of this action will be to direct the attention of the office to the power plant. In the interim allowed between the receipt and the filing of the questionnaire, the owner or his representative will be interested to get the plant into as creditable a condition as possible so as to get as far as possible from that lower stratum which will be the first to be deprived of coal. This will be the opportunity of the engineer to get much-needed apparatus and to have repairs and overhauling done, his recommendations for which have not met with a favorable response in the past.

The movement ought to result in the improvement of a multiplicity of plants and the saving of many tons of coal, and should receive the hearty approval and coöperation of plant owners and operators and of fuel administrators everywhere.

Work or Fight

THE latest amendment to the selective draft law, recently announced by Provost Marshal General Crowder, whereby, after July 1, every man of draft age must either go to work in employment essential to winning the war or join the fighting forces in France, is the most encouraging news that has come from the Provost Marshal's office for some time and should be received by every American with red blood in his veins as a wholesome change in our military policy. According to the order gamblers, race-track and bucket-shop attendants, fortune tellers and idlers head the list, followed by waiters, bartenders, theater ushers and attendants, passenger-elevator operators, attendants at clubs and hotels, domestics, clerks in stores, baseball players, jockeys, professional golfers, and other professional sportsmen. Looking this list over, it would appear that the Provost Marshal has an excellent insight into non-essential industries as far as men in their prime are concerned, since many of those listed, especially the first five, the nation can well do without not only in times of war, but in peace also, with profit to itself. The other occupations might be considered healthy men's jobs when the nation is at peace, but they certainly can all be filled by women or men too old to enter the industries or the fighting ranks or dispensed with entirely when the nation is facing a shortage in its man power like the present.

We have long passed the time when we can afford to allow able-bodied men to loaf away their time in poolrooms, on park benches, in dance halls and cabaret shows, while millions of others are working overtime in our industries to supply the sinews of war for other millions we are sending to the battle front to suffer all the privations of modern warfare and die if need be to make the world safe for democracy.

There has been considerable discussion as to what are nonessential industries and who is able to distinguish between the nonessential and essential. However, General Crowder seems to have attacked the problem by a process of elimination and has excluded the least essential at first. Although his first step is a modest one, there is no doubt that if the war continues for a considerable period longer this ruling will be extended to other industries until every able-bodied American citizen will be either in the military forces of the country or engaged in industries essential to the war machine. This latest ruling should give assurance to many that whatever may be termed semiessential industries of the country will not be robbed of their employees until at least every able-bodied loafer has been put to work or fighting, and that the Provost Marshal intends to meet the emergency with as little hardship to the country's industries as possible.

Boiler Settings

WITH the advent of high combustion rates on stokers and the quest for economical production of steam, to say nothing about smoke abatement, the matter of boiler furnace design became one of the important factors in power-plant practice. The wider use of the Middle-Western coals and lignites, both high in volatile, together with the desire in many quarters to burn these fuels at high combustion rates, gives added significance to the boiler setting or combustion volume.

In 1913, when the water-tube boilers in the Two Hundred and First Street station of the United Electric Light and Power Company, New York City, were set ten feet from bottom of front header to the floor line, there was general explanation. Today, engineers will do much to overcome any obstacle that stands in the way of setting this type of boiler less than twelve feet above the floor, even for Eastern low-volatile coal and a combustion rate of 250 per cent. builder's rating of the boiler. One finds boilers set thirteen and even fourteen feet here in the East, while boilers of the Stirling and Connelly types are being set with the center of the mud drum anywhere from eight feet for high-volatile coal to over eleven feet for lignite, when burned on underfeed stokers. Not only do engineers recognize the value of large combustion volume, but one finds all builders of stokers urging a minimum height for settings, varying with the boiler and coal and combustion rate. In those plants which change over from hand-firing to stoker-firing, nearly all builders of stokers will refuse the job if the prospective purchaser insists on too small combustion volume.

The articles now appearing in *Power* on the subject of boiler settings are valuable not only because they show what is current and excellent practice for high-volatile coal particularly, but because the numerous drawings carry all important dimensions, and in addition numerous performance data will be presented.

Concrete Boilers Next

CONCRETE construction has entered many fields of commercial enterprise, and although at one time opinions might have been held that it was suitable only for sidewalks and not any too good at that, the art of concrete construction has developed into broad channels, so much so that entire buildings are made of it. Its latest application is that of concrete ships. Now, according to the *San Francisco Chronicle*, cement may be used in the construction of boilers in the near future, as it is understood that an experiment will be made at the Union Iron Works. The report says that considerable figuring has been done and numerous sketches have been made, and that a boiler will be constructed shortly. It is stated that it is expected that with the exception of the boiler shell there will be but little change, and instead of one thick boiler sheet the new construction of shell is to consist of two thin sheets of steel, probably one-quarter inch in thickness, and these will be fastened together, leaving between them two or three inches of space, which will be filled with a high-grade cement.

In these days of progress and invention one is not safe in asserting that this or that proposed idea will not work out satisfactorily. It is only a few years ago that the practicability of the steam turbine was earnestly disputed. It is only a few months ago that the practicability of building a concrete ship was seriously doubted, and although it is early to state whether the concrete ship will be a success as compared with steel-ship construction, the odds are in its favor. So to condemn the concrete boiler before the idea has been tested out would be, perhaps, premature, although one is inclined to wonder what will occur to the concrete when the boiler expands from a cold state to the temperature it will have when under working pressure.

There are 2,078,222 now in the Army; a million men ready to embark; ninety thousand sailed in the first ten days of May. All thoroughly equipped. America can raise an army of five million this year without going outside of Class One.—*Representative Caldwell, of the Military Affairs Committee, to the House.*

The American shipyards are averaging one steel ship a day. May output more than 200,000 tons. Two ships just launched were completed from keel to aërial in fifty-five days, and one in fifty-seven days. In the next eighteen months six hundred ships will be put in commission on the West Coast alone. Ten steel ships were finished and eighteen others launched in one week.

Yes, indeed, the Yanks are coming.

The latest advices from Boston are to the effect that Garabed Giragossian is suffering from an attack of constipation of energy.

Correspondence

North Dakota Lignite for Boilers

Your editorial and Henry Kreisinger's article on the combustion of North Dakota lignites, in *Power*, Apr. 30, are interesting and instructive. To those not familiar with the fuel it may appear that our lignite is not suitable for steam coal except with a specially designed furnace and grate. All the power plants in the western part of this state are using lignite successfully in ordinary furnaces provided with suitable grates, and we are obtaining efficiencies equal to those had when burning bituminous coal in the eastern part of the state, where, I have noticed, it required 78,000 B.t.u. in the coal for generating one kilowatt-hour. Under the same conditions with lignite we are generating a kilowatt-hour on 61,000 B.t.u. These figures are based on units that consume 40 lb. of water per kilowatt-hour delivered to the circuits and Eastern coal containing 13,000 B.t.u. and lignite 7000 B.t.u.

The same conditions prevail in flour making when comparing heat units required per barrel in Minneapolis with mills operated by lignite in this part of our state. It will therefore appear that here is a reason for suggesting a furnace for burning bituminous coal more efficiently.

The reason that our lignite is not used more extensively in the eastern part of North Dakota and neighboring states is the cost of transportation. It seems that the railroads have not favored it, as the rates on lignite from the mines to the eastern border of the state, a distance of about 210 miles, is $1.25 the ton; and in the next zone east of the border line the rate is $2.15 the ton; the freight on lignite to St. Paul and Minneapolis, a distance of about 500 miles, was about equal to the cost of Pennsylvania slack coal laid down there before the war.

On the border line the prices of Pennsylvania slack and our lignite were about equal and nobody would give the latter any consideration. No doubt the railroads took the advantage of shipping all our grain and stock to Minneapolis, St. Paul and Duluth and had cars returned this way loaded with coal from the harbor at Duluth. The rates on coal from Buffalo to Duluth via the lakes is very low. There was no market for our lignite, but since the shortage of the Eastern coal and congestion in transportation had been severely felt, people living in these zones have begun to look in our direction for their next winter's fuel supply.

The railroads now have the lignite rates under consideration, and the real value of our low-grade fuel will soon come to its right.

In this part of our state the poor man's fuel for domestic use is lignite. Those who can afford to burn anthracite do so regardless of its cost. Some would abuse lignite to a great extent even if we have beds 8 to 18 ft. thick, covering over 30,000 square miles. Some of this is surface coal that contains about 6000 B.t.u. per pound.

The largest mine in the state is in Burleigh County, the coal from which runs on an average of 7000 B.t.u. The best coal known to the writer is in Mercer County and runs on an average of 7500 B.t.u. A recent sample showed a commercial heating value of 8058 B.t.u., 30.6 per cent. moisture, 5.3 per cent. ash, 31.9 per cent. volatile matters, 32.2 per cent. fixed carbon and no sulphur. The same coal dry showed 11,611 B.t.u., 7.7 per cent. ash, 45.9 per cent. volatile matter and 46.4 per cent. fixed carbon.

Under fair conditions one pound of this will evaporate 6.25 lb. of water from and at 212 deg. F. This is equal to evaporating 10.86 lb. of water from one pound of coal containing 14,000 B.t.u., but to obtain such efficiency from lignite the volatiles or gases must be ignited in the furnace during their course of travel over the bridge-wall and through the combustion chamber. Forced draft and a near balanced draft is required, but the force of the draft under the grate is the most essential point to be adjusted.

Mr. Kreisinger suggests a large air space for grates of the inclined type. The same idea appealed to me, but I had to reverse myself, and I am now constantly cutting down the air space; I am now burning lignite on a flat sawdust grate having only 11 per cent. air space, and by doing so can maintain a higher air pressure under the grate. Lignite does not require a large volume of air for its combustion—about 75 cu.ft. of air per pound of lignite is sufficient. The clinkers accumulating on the grate from a lignite containing little sulphur are porous, and air passes through them quite freely with high air pressure under the grate. By keeping a few inches of water in the ashpit, there is little fire below the grates. The first set of sawdust grates, installed 12 years ago, is still in service.

It is not advisable to fire a boiler above its rated capacity when efficiency is considered, and with a ratio of 1 sq.ft. of grate surface to 50 sq.ft. of heating surface 40 lb. of lignite can be burned economically per square foot of grate surface per hour. With such conditions a flue-gas temperature of about 450 deg. F. with an average of 12 per cent. CO_2 can be maintained. Boilers equipped with economizers may be forced to a great extent as the excess heat in flue gases would not all be wasted.

When burning lignite the combustion chamber fills up rapidly with small particles or sparks from the fuel on the grate, and it has been discovered that the highest efficiency is not obtained until there has accumulated a 3- to 4-in. coating of those slow-burning particles all through the combustion chamber and over the bridge-wall; therefore, when one receives a carload of lignite for a test and is not familiar with the characteristic of the fuel one generally gets disappointing impressions.

The cost of lignite f.o.b. the mines set by our Fuel Administrator is $2.50 per ton for screened lump, $2.25 for screened 6-in. coal, $2 for mine-run and $1.25 for screenings that have passed through a 2-in. screen. The screenings give the most suitable size of coal for boiler use, although they often contain a large amount of dirt. In mining our coal an undercutting machine is used, the cuttings from this machine go into the screenings and if the operator of the machine is not careful, he is liable to cut into the dirt or clay below the coal bed; this mixed with the coal makes it an unsatisfactory fuel. On the other hand, 6-in. coal is too large a lump for a steam coal; much of our lignite breaks up in slabs similar to sandstone, and such slabs lying flat on the burning coal smother the fire below them. Those familiar with burning lignite in stoves and heating furnaces will place those slabs up edgeways and pack the firepot full of it and get results. As this cannot be done under boilers, the coal must be broken or crushed to 3 in. and less to get efficiency.

In your editorial you speak of pulverizing lignite for use in the furnace. That process has been under much discussion through the columns of *Power*, and from what I learned from reading those columns there is no gain in burning a high-grade powdered coal when considering the cost of drying, pulverizing, maintaining the furnace walls and the excess air admitted to the fuel in the process of burning it. The cost to pulverize a pound of low-grade coal is practically the same as a pound of high-grade coal, and the moisture must also be disposed of before the lignite is pulverized.

Lignite will absorb moisture from the atmosphere after it has been dried; therefore, I doubt the possibility of burning it in that form. You also say that lignite in a natural state cannot be transported even short distances from the mines for the reason that the moisture evaporates, causing the substance to break up in small chunks and flakes and if subjected to much jarring it disintegrates into powder, all of which makes the fuel inconvenient to handle.

Lignite will slack to some extent when exposed to heat, but nobody here worries about that. We are now advised by our fuel administrator and governor to fill up our coal bins so the mines can be kept in full operation during the summer. We will then be able to send South Dakota and Minnesota lignite next winter.

Bismarck, N. D. C. P. Larsen.

Different Rate of Scale Formation

In the issue of Apr. 16, page 559, Mr. Lewis suggests that scale formation is greatest on the side of the boiler nearest the soot-blowing openings because there is less soot on the tubes on that side, etc.

We have trouble here with scale forming in nine tubes out of eighteen, and these nine tubes are not always those nearest the soot-blowing openings, while in the letter by Thomas Pascoe in the issue of Apr. 9, page 521, he states that it is always the tubes next to the soot-blowing openings that scale most. We use oil fuel, have three burners in each furnace, have the dampers exactly alike and run with the stop valves for the feed water full open on all drums, but there are always nine tubes with scale (of course that is the number for each drum), and always the same ones. It is not likely that burners in certain locations always give out much more or less heat than the others; besides, changing the position of burners is a common occurrence.

Anyox, B. C., Canada. J. B. Tait.

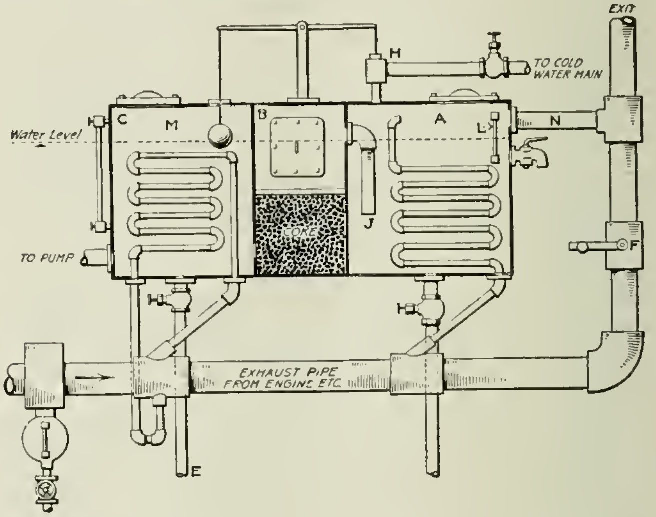
Plugged Holes in Piston

I recently had an experience with an engine that may be of interest. I first noticed a rather dull thumping in the cylinder as the piston came to the head end of the stroke. I realized that something was wrong, and at the first chance I removed the cylinder head and to my surprise found a hole in the piston about three-fourths of an inch in diameter with a crack extending on each side. I reamed out the hole and screwed in a 1¼-in. flush pipe plug and drilled a ⅛-in. hole at each end of the crack to prevent its extending further, and have had no trouble since. C. Richard Ward.

Willsboro, N. Y.

Feed-Water Heater and Filter

The illustration shows a heater and filter of my own design, which can be built of quarter-inch boiler plate or cast-iron plates and may be either round or square, although I prefer the latter. A live-steam connection, with a reliable pressure-reducing valve attached, supplies steam for heating the water when there is no exhaust steam. Traps discharging clean condensate from live steam can be connected into part *C*, but if the condensate contains any oil it should go to compartment *A*. There are manholes in each compartment for cleaning, and drains to the sewer are provided, also an overflow *M* to the sewer, in case the makeup cold-water supply control should get out of order. The back-pressure valve *F* is set at a pressure just enough to cause steam to circulate up through the coils into the tank. In the center compartment there is a deep bed of coke, on top of which are several thicknesses of burlap bags and over these about ten inches of excelsior.



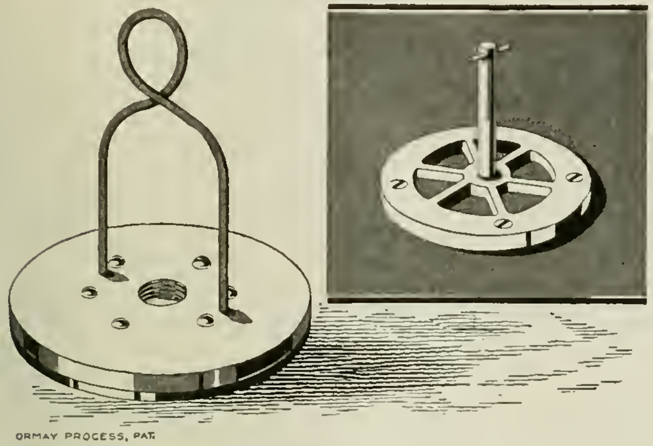
HOME-MADE FEED-WATER HEATER AND FILTER

The water supply enters compartment *A*, passes up pipe *J*, down through compartment *B* and into *C* at the bottom, thence to the pump. Most of the sediment will settle in *A* and the oil will float to the top, but if any does escape it will be collected in the filter. Part *A* will require cleaning quite often, but *B* only once in about three months and *C* once in six months. Pipe *N* acts as a relief to guard against an accumulation of pressure should the valve *F* be set too heavy.

Portsmouth, Ont., Canada. James E. Noble.

An Easily Made Draining Valve

The illustration shows a simple valve for draining tubs and tanks. The disk is cast iron with a ¼-in. cloth insertion rubber packing riveted to it, and the seat is similar to that of a pump, as shown, fastened to the bottom inside of the tank with screws countersunk flush with the surface of the seat. I have made a number of 4-in. valves of this type, and they were entirely satisfactory. The sheets of soft-rubber packing make a tight joint that will give, and close around any small object that may get under the disk.



OUTLET VALVE FOR BOTTOM OF TANK

New Bedford, Mass. H. K. Wilson.

Cleaning Condenser Tubes with Muriatic Acid

Regarding cleaning condenser tubes with muriatic acid, as noted by Mr. McKeehan on page 504 in the issue of Apr. 9, we have found here, in Grand Rapids, that the method is effective, economical and not injurious to the tubes.

The city is supplied with a lime-softened water averaging about six grains of scale-forming matter per cubic centimeter and, like all lime-softened waters under certain conditions of heat and pressure, tends to deposit a small amount of carbonate of lime, which in time becomes more or less serious on the surface of condenser tubes. At the city pumping station two of the pumps are equipped with condensers containing approximately 1400 one-inch tubes about seven feet long. In a year's time these tubes become so coated over as to drop the vacuum from about 28 to 24 in., a matter serious enough to require attention.

For the last two years the method of cleaning these tubes has been to disconnect the condensers and swing them clear of the suction connections, apply blind flanges to the inlet and outlet sides and fill them up with water to which has been added a first dose of 20 to 25 gal. of muriatic acid. Steam lines are connected in and this charge is boiled two hours or so till the acid has been used up, then more water and acid added, say five to seven gallons, till the tubes are boiled clean. Usually we have found about 55 gal. of acid sufficient, and boiling greatly hastens the work; a day is usually ample time to do a good job. This method has worked equally well in cleaning the oil-cooling tubes of our turbo-generators.

For the last three years an acid cleaning method has been used in the condensers at Columbus, Ohio, where the water supply is similar to that of Grand Rapids, and the type of the condensers does not readily admit of their being removed. In this case the acid is sprayed on with a force pump, a small fan being set up behind the men manipulating the spray to carry the fumes of the acid through to the other side and away. I understand that this method also works satisfactorily.

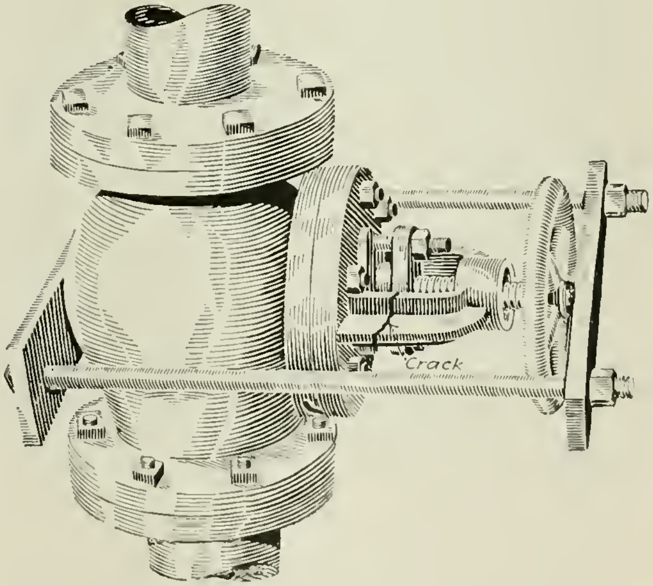
Grand Rapids, Mich. Walter A. Sperry.

Some Emergency Valve Repairs

In the plant where I am operating I recently had a little trouble with a 2½-in. throttle valve on a pump. The valve had broken at the yoke, due to water-hammer. As I did not care to use this pump as much as I did another one on the same line, I obtained two 2 x 4-in. pieces of iron and drilled holes through them, and placing one piece below the valve body and the other against the nut on the valve-wheel stem, the two were drawn together, and the cracked yoke back to place with the long bolts and nuts, as shown in the illustration.

A few days ago one of the pumps worked badly, becoming air-bound; when stopped, there was a continuous stream of water coming from the pump, which could not be stopped unless the glands were screwed up very tight. An examination showed that a 5-in. check valve was unseated, the bottom guide having been broken off and the top guide badly worn on one side. Not having another valve of that size in stock, I proceeded to repair the broken one as follows:

I took the top half of the valve to which the guide for the bottom is fastened, drilled a ½-in. hole through it, and then resurrected an old valve stem ½ in. diameter and cut it to the proper length and riveted it in the place of the one that had been broken off. The worn upper guide was cut off with a hacksaw and treated in the same manner as the lower guide. The valve was back in place in less than one-half hour, and it has worked as well as a new one ever since.



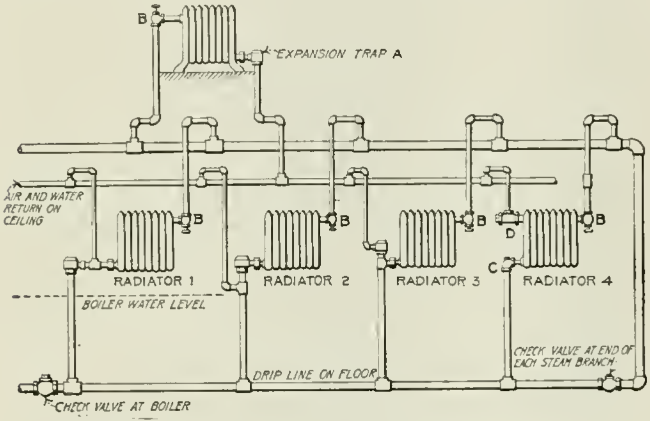
CRACKED YOKE DRAWN TOGETHER

Fort Apache, Ariz. Robert E. Leech.

Radiator Connections

One type of steam-heating system uses a small expansion trap on the outlet of each radiator, a return trap to put the water back into the boiler, and one air valve to let air out of the whole return system. The small traps on the radiators let air and water pass, but close against steam. The common air and water return must be above the water level of the boiler.

In one instance it was necessary to connect some wall-type radiators below this common return line, but still above the boiler-water level. They were first connected as radiator 1 shown in the illustration (the others being marked 2, 3 and 4). The air was expected to go to the air and water return and the water to go down through the radiator trap into the drain from the steam mains; but steam, blowing through these radiators and backing up to the radiators on the upper floors, shut the outlet traps and closed the air valve at the boiler, so the air could not clear from the system and the water would not return from the radiators—the system became steam- and air-bound.



RADIATOR CONNECTIONS TRIED OR SUGGESTED

The connections were then changed as shown in the next case (radiator 2), but on the first cold day the steam pressure forced the water out of the drip line, along the floor, and caused water-hammer. Connection 3 was considered as a remedy, but as the traps do not close against water unless it is near the boiling point, this plan was discarded and connection 4 adopted. As steam is lighter than air, it passes across the top of the radiator and closes the air valve while the lower half of the radiator is cold, but by letting the air valve blow a little steam, the radiator gradually clears of air and the small blow of steam does not interfere with the rest of the system. Discussion and any suggestions for improvement will be welcome.

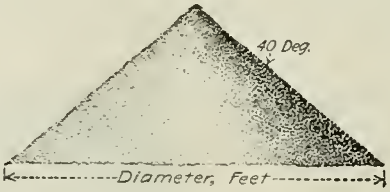
Washington, D. C. **MORRIS ELLISON.**

Weight of Ashes in Conical Pile

The angle of repose for ashes in a conical pile, that is, the angle made by the sloping side of the cone with the horizontal, as shown in the accompanying illustration, averages 40 deg. The average weight of ashes per cubic foot is 40 lb. Based on these two figures, it follows that a formula can be developed suitable for determining the weight of any conical pile of ashes. All that is necessary is to measure the diameter of the base. The formula is as follows:

$W = 4.4\,d^3$ = weight of conical pile of ashes in pounds. where d is the diameter of base pile in feet.

To illustrate: The diameter of a pile of ashes is 8 ft. Then $8^3 = (8 \times 8 \times 8) \times 4.4 = 2253$ lb. of ashes



AVERAGE ANGLE OF CONICAL ASH PILE

in a conical pile having a diameter at the base of 8 ft. The accompanying table gives the weight of ashes in conical piles from 1 up to 100 ft. in diameter, and any intermediate diameter of ash piles not shown in the table can be easily computed. **W. F. SCHAPHORST.**

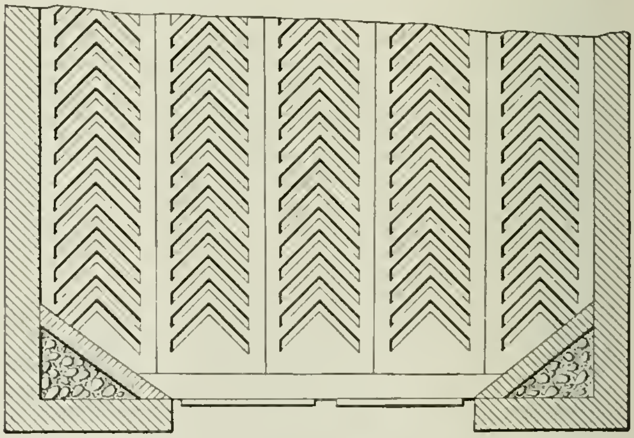
New York City.

WEIGHT OF ASHES IN CONICAL PILE

Diameter of Ash Pile, Feet	Weight of Ashes, Pounds	Diameter of Ash Pile, Feet	Weight of Ashes, Pounds
1	4.4	10	4,400
2	35	15	14,850
3	119	20	35,200
4	282	25	68,750
5	550	30	118,800
5.5	730	35	188,650
6	950	40	281,600
6.5	1,210	45	400,950
7	1,509	50	550,000
7.5	1,857	60	950,400
8	2,253	70	1,509,200
8.5	2,702	80	2,252,800
9	3,208	90	3,207,600
9.5	3,771	100	4,400,000

Boiler Firebox Improved

The illustration shows a top view of an improvement in the shape of the furnace under a return-tube boiler fitted with stationary grates. The bricks on the side wall and front were chipped out, and others were placed so as to cut off or fill in the sharp corners of the box, at the same time cutting off but little of the space. The object is to make it possible to clean the fire more quickly and to avoid the loss if these corners are neglected when cleaning or left uncovered when firing. The space behind the bricks was filled with pieces of brick and fireclay, and the top was sloped so that no coal or ashes can gather there.



BETTER RESULTS WITH CORNERS FILLED IN AS SHOWN

Flushing, N. Y. **WILLIAM F. WILLIAMSON.**

Inquiries of General Interest

Melting Point of Firebrick—What temperature will injure boiler-furnace firebrick? B. H.

When firebrick contains moisture or materials that have a higher coefficient of expansion than the binding material, the brick spawls and cracks with comparatively low temperatures. The melting point of ordinary commercial fireclay brick ranges from about 2700 deg. F. to 3200 deg. F., depending on the ingredients.

Pressure of Atmosphere from Height of Barometer—How may the pressure of the atmosphere be known in pounds per square inch from the height of the barometer? W. G.

At ordinary atmospheric temperatures the weight of a cubic inch of mercury may be taken as 0.491 lb. and the pressure of the atmosphere in pounds per square inch may be found by multiplying the height of the barometer in inches by 0.491.

Heat Required To Raise Temperature of Air—How many B.t.u. per hour would be required to heat 55 cu.ft. of air per min. from 62 to 300 deg. F.? J. C. E.

At 62 deg. F. there are 13.14 cu.ft. of air per pound. The specific heat of air is about 0.25, and to raise the temperature of a cubic foot from 62 deg. F. to 300 deg. F. would require $(300 - 62)\ 0.25 \div 13.14 = 4.52$ B.t.u., and for heating 55 cu.ft. per minute would require $4.52 \times 55 \times 60 = 14{,}916$ B.t.u. per hour.

Adding Heat to Constant Volume of Steam—If heat is added to steam in a closed vessel, would the temperature as well as the pressure rise? C. T. B.

The addition of heat would cause a rise of both temperature and pressure. The addition of sufficient heat would first convert any water present into dry saturated steam which would be of higher temperature and pressure than the original steam, and further addition of heat would still further raise its temperature and pressure to a superheated condition.

Iron Ball Pyrometer—How is the temperature of a boiler furnace obtained by heating a piece of cast iron in the furnace and afterward cooling it in water? G. R.

A piece of cast iron weighing 4 or 5 lb. and preferably of spherical or other compact form is allowed to remain in the furnace until it has attained the temperature of its surroundings. It is then suddenly plunged in a vessel containing a known weight and temperature of water and cooled while the water is being stirred rapidly until the piece of cast iron and the water attain the same temperature. The vessel may consist of a large bucket filled about three-fourths full of water and provided with a cover having a hole in it through which a perforated pipe extends to the bottom for the insertion of a thermometer. The hole in the cover may be large enough to use the pipe for stirring the water. If W = the weight of water, w = the weight of cast iron, t the original and T the final temperature of the water and S the specific heat of the cast iron, then the temperature of the piece of iron when placed in the water is found by the formula,

$$x = \frac{W(T - t)}{wS} + T$$

For example, if the weight of the piece of cast iron is 5 lb., the weight of the water 20 lb., the temperature of the water before the immersion 60 deg. F and after immersion 120 deg. F., and allowing the specific heat of cast iron at the furnace temperature to be 0.13, by substituting,

$$x = \frac{20(120 - 60)}{5 \times 0.13} + 120 = 1966\ deg.\ F.$$

Oil for Journal Bearings of Steam Dry Cans—In the textile-finishing business a machine is used that has steam-heated revolving cylinders called dry cans for which the steam used is conducted through the hollow journals on which the cans run. The bearings often attain a high temperature, and difficulty is experienced in keeping the bearings properly lubricated. What kind of oil would be suitable? O. M. W.

Most refiners of mineral oils are prepared to furnish lubricating oils suitable for use at ordinary temperatures of steam and, when informed of the pressure of steam supplied to the dry cans as an index of the temperature, would be enabled to select a product adapted to the conditions.

Testing Boiler-Feed Pump—How can a boiler-feed pump be tested to show that it is in fair working order? S. L. A.

Connect a steam-pressure gage to the steam-chest cover and a water-pressure gage with stop-cock on the delivery side of the pump. Then with a steam-chest pressure of about 50 lb. it should be possible to obtain a full bore of the delivery pipe when delivering against an equal water pressure. The pressure on the water-end gage is obtained by regulating the stop valve, and the discharge of water should be visible, and with equal steam and water pressure the water pressure gage should be reasonably steady. If the delivery of water stops while the pump is running, the fault will be due to leaky suction valves or piston slippage. Violent pulsations of the water-pressure gage usually will be an indication of leaky suction valves. When running slowly, if a piston travels suddenly to the end of the cylinder, the suction valve on that end will probably be the one that leaks most.

Determining Cylinder-Clearance Volume—How is the cylinder-clearance volume of an engine determined? H. N.

The cylinder-clearance volume is determined from the volume of water that can be contained by the clearance space when filled from the piston at the end of the stroke back to the valve seats. An opening needs to be provided at the top of each end of the cylinder for introducing the measuring water, or it may be introduced by the indicator connections provided suitable provision is made for the escape of air from the cylinder during the process of filling the cylinder with the measuring water. Place the engine on dead-center at the head end of the cylinder, and after removing the valves, cover each valve seat with a rubber gasket held down tight by a block of wood wedged or bolted in place. Remove the cylinder head and pack candlewicking around the piston to prevent excessive leakage of water past the piston.

Provide two vessels each filled with clean water and take the weight of each. With the cylinder head in place, the clearance space of the head end is to be filled from one vessel and a note made of the time required. As soon as the space is filled, the first vessel is to be set to one side for subsequently determining the weight of water thus used, and the clearance space is to be kept filled against leakage for five minutes by adding water from the second vessel. The vessels are then again weighed and the weight of water used from each determined.

The average rate of leakage while filling the space may be assumed to be one-half of the rate during the filling. If

W = Weight of water in pounds used to fill the clearance space,
t = Number of minutes required to fill the clearance space, and
w = The weight of water in pounds per minute necessary to keep the space filled against leakage,

then the leakage during filling is approximately $(W \times t) \div 2$, and the clearance space will contain $W - [(w \times t) \div 2]$ lb. of water and this multiplied by 0.036 will give the space in cubic inches. The clearance for the crank end of the cylinder is found in the same general manner.

[Correspondents sending us inquiries should sign their communications with full names and addresses.—Editor.]

The Storage of Bituminous Coal*

BY H. H. STOEK†

An unusually valuable paper on why coal should be stored; the practicability of storage and effect of storing on the coal; systems of storage employed; cost per ton, and precautions to be observed.

ALTHOUGH the storage of coal has become of unusual importance under war conditions, it should not be considered only as a war expedient, and plans for storage should be made by every householder and in connection with every industry that uses coal as one of the adjustments necessary to stabilize a fundamental industry of the country.

The demand for coal varies with the weather conditions and is largely a seasonal one, not only as regards domestic fuel, but in connection with fuel used for power purposes. As a result of the unequal requirements at different seasons of the year, and the failure to store coal during periods when small amounts are used, the mines of the United States operate only about 200 days per year and the demands upon the railroads for handling coal are unequally distributed, the greatest demand coming during the fall when railway equipment is needed for handling crops and during the winter months when operating expenses are greatest.

As a result of the reduced time of working of the mines, an extra daily wage must be paid the miner and other employees if they are to make a yearly living wage, and there must be also an excessive number of mines to take care of this peak load during a part of the year.

A reason often advanced against storage is the increased cost involved, but a suitable readjustment of mining and transportation conditions should mean a lower cost for mining and transportation that would, at least partly, offset the additional necessary cost for storage and should not increase the cost to the consumer much, if any.

STORAGE SHOULD ADD BUT LITTLE TO COST TO CONSUMER

The effect of storage upon coal may be considered under the heads of appearance, loss in heat value, difference in firing qualities of stored coal, change in coking properties, change in gas-making properties, and degradation, or the increase in the amount of fine coal and dust due to breakage from handling and the slacking or weathering due to exposure to the air.

With reference to appearance the exterior of a pile of certain kinds of coal frequently becomes covered with a white coating of sulphate of iron or it may be rusty and dirty in appearance. Usually, this change in appearance is only "skin-deep," and the interior is not changed in appearance to any extent, excepting with certain slack coals. Some coals have a much dirtier appearance in the piles after being in storage, and although the heating value is not reduced thereby the sale value may be decreased because, to the domestic user particularly, the appearance of the coal means much.

Loss in heat value, due to storage, is much less than is commonly thought. It varies with different coals and is greater for screenings than for screened coal. Experiments by Prof. S. W. Parr, University of Illinois, show a loss of only 3 to 3½ per cent. for screenings and also that coals vary in this respect. Those from southern Illinois show less change than those from central Illinois; also coals that show a small decrease at first continue to have only a small decrease as time goes on.

There is a general and widespread opinion that stored coal is dead when put on the fire and is often considered and condemned as being "no good." Although there is no great decrease in calorific power, it is quite probable that, due to the oxidation of the surfaces of the lumps of coal, they burn less freely, but experiments made at the University of Illinois on a stationary boiler showed that the stored coals tested had an equal evaporating power with the fresh coal, provided a thinner bed was carried and greater draft furnished.

SPONTANEOUS IGNITION OF STORED COAL

The greatest objection to storing coal is the liability to spontaneous combustion, which is due mainly to the oxidation of the carbon and other organic materials in the coal and to a less extent to the oxidation of the sulphur in the iron pyrites contained in most coals. Freshly mined coal has a tendency to oxidize and heat, and while this property varies with different coals, the general rule apparently holds for all coals. The finer the coal the greater the surface exposed to the air and the greater the tendency to oxidation and heating. Lump coal is not so likely to fire as fine coal, slack or run-of-mine. Any method of storage must either prevent or check the absorption of oxygen to such an extent that the generation of heat may not proceed so rapidly as to exceed the heat lost by radiation. The greater the time between mining and storing the less the liability to firing.

High-volatile matter does not increase the liability to spontaneous combustion, according to the experiments of Porter and Ovitz, of the Bureau of Mines. The high-volatile coals in the West are liable to spontaneous combustion, but Porter and Ovitz conclude that this is due more to the nature of the volatile than to its amount. Sulphur in coal assists in spontaneous combustion by oxidizing and breaking it up so as to produce greater fines, and also in its oxidation, heat is produced. In selecting a coal for storage a low-sulphur coal is to be preferred.

The effect of moisture on spontaneous combustion is an unsettled question, but it is undoubtedly safer practice not to wet coal for storage; if it can be avoided, do not store a layer of dry coal on a wet layer. The effect of water in helping to disintegrate high-sulphur coals is undisputed.

Data on the effect of storage on the coking properties of coal are scarce, but the general opinion is that unless the coal heats and thus changes in character, its coking properties are not materially influenced. According to the experiments of White, the gas-making qualities of Eastern coals are not decreased by storage.

There is often thought to be a loss in weight of stored coal, but this is more apparent than real and may be due to the evaporation of moisture.

NEARLY ALL COALS CAN BE STORED IF PROPERLY PILED

There is an erroneous, misleading but widespread opinion that the locality from which the coal comes determines whether or not it can be stored. One frequently hears such remarks as "Eastern coals" (meaning those from Pennsylvania and West Virginia) can be easily stored, but Western coals (meaning those from Illinois and Indiana) cannot be and they are much more liable to spontaneous combustion." Both parts of this statement are too broad, for scientific research and experience have shown that nearly any coal can be stored if it is properly piled and nearly any coal improperly stored will heat and may fire.

Coal should be stored preferably during the spring and summer so as to help the railroad and mining situations; labor costs are usually less. The disadvantage of summer storage is that the coal maintains this temperature for a long time.

The size, shape and depth of piles depend mainly upon the appliances used for storing. There is a great difference of opinion as to the height to which coal can be safely piled and stored. Many would limit the pile to 10 ft. in height,

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*Abstract of paper read before the Western Society of Engineers, Chicago, April 15, 1918.

†Professor of Mining Engineering, University of Illinois.

although many dock piles are 50 to 60 ft. high, and the chief objection to high piles is the difficulty in handling and moving the coal quickly in case the temperature rises and also the difficulty of testing for an increase in temperature. The idea that firing takes place at the bottom of the pile due to the pressure and crushing on account of the height is not borne out by the facts, as many fires seem to start near the top as near the bottom and near the outside as the inside of a pile. Since the weight of a cubic foot of broken coal is about 40 lb., a column 50 ft. high weighs only 2000 lb., which gives a weight of only about 14 lb. per sq. in. at the bottom of the pile. This is small compared with the crushing strength of most coal even when it is considered that the coal does not rest on a solid base, but is supported in many cases on the points of the pieces of coal. Heating due to pressure is certainly overestimated, probably also pressure due to the weight of the overlying coal.

It is generally accepted that if the air supply is shut off from the coal, as is the case with under-water storage, spontaneous combustion cannot occur, and also it is reasonable to assume that if ample ventilation can be furnished to carry off the heat and keep down the temperature in a coal pile, spontaneous combustion will not occur. It is the intermediate condition that is dangerous. On the other hand, run-of-mine coal often cannot be safely stored, because not only is there then present an excessive amount of fine coal that will oxidize readily, but the openings between the lumps contain considerable fine coal, which shuts off a free circulation of air.

This also explains why alternate stratification of coarse and fine coal is undesirable and why air passages due to large lumps rolling to the bottom of the pile should be avoided, because they form a duct or chimney for an amount of air to reach the fine material inside the pile, sufficient to promote oxidation but insufficient to keep down the temperature.

VENTILATING A COAL PILE

The practicability of properly ventilating a coal pile has been disputed, and while the consensus of opinion in the United States is against ventilation by pipes, it is probable that many of the opinions expressed are based upon unfavorable results secured through improperly installed and inadequate ventilation schemes. Many of the so-called pipe ventilation schemes have been little more than the occasional placing of a pipe into which a thermometer can be inserted to read temperatures. There are few records in the United States of a systematic and adequate ventilation scheme being installed, because such a scheme is expensive and it also undoubtedly interferes with the rapid handling of the coal. It is contended by many that closely packed coal is so poor a conductor of heat, fire can start very close to a ventilating pipe.

Several instances of successful ventilation have been cited to the writer in connection with railroad work in the United States and Canada. Dr. J. B. Porter, of McGill University, is convinced that the method of ventilation used by the Canadian Pacific R.R. and others in Canada is efficient and entirely practicable. It is questionable whether the cooler climate of Canada has anything to do with the effective ventilation noted by Dr. Porter. Data upon this subject for Illinois conditions are certainly not yet conclusive, and ventilation is a questionable experiment.

The common methods for testing heating coal piles are: Watching when the pile begins to steam, the odor which is either that of burning bituminous matter or burning sulphur; by means of an iron rod inserted into the pile and when drawn out tested by feeling with the hand; by means of the thermometer inserted into a pipe driven into the pile; and by spots of melted snow.

Opinions differ widely in regard to when the temperature reaches a critical or danger point. Parr says, "Bituminous coal can be stocked without appreciable loss of heat value provided the temperature is not allowed to rise above 180 deg. F." How close to this temperature a pile should be allowed to heat is largely a matter of judgment, for if the rise seems to be decreasing rather rapidly, it may be safe to allow it to approach the 180-deg. point; but if it is steady and regular, it is wise to load out the pile before the danger point is reached. This rise also depends upon the means available for loading out, for at a point equipped with large grab buckets and means for rapidly handling the coal, a higher temperature can be permitted than when considerable time may be required to load out the coal. A person in charge of a certain kind of coal under certain climate conditions will soon learn what is the danger point, and it is impossible to set any critical temperature that will apply to all coals under varying storage conditions. The only safe rule is to watch the temperature closely and get ready to load out when the temperature reaches 150 deg. and to move the coal if the temperature reaches 175 degrees.

WATER NOT EFFECTIVE IN PUTTING OUT FIRES

Water generally has not proved effective in putting out fires, probably because it cannot be applied or is not applied in sufficient quantities to thoroughly cool the entire mass. It is the general opinion that except for quite small piles which can be completely soaked, water will aggravate rather than put out a fire. Water frequently cannot reach the fire because of a layer of coke that has formed a protection about it. One large pile in Chicago was soaked as completely as possible with streams from river fire tugs, and while the fire was apparently out, within two or three days it was burning as fiercely as ever. If the coal can be spread out thinly and thoroughly saturated with water, the fire can be put out, but very often there is not sufficient ground available to permit proper spreading, for which reason most of the efforts to use water have been unsuccessful.

Inert gases, such as carbon dioxide, have been tried, but no successful results have been reported, because with an outdoor pile it is impossible to confine such gases, and even with inclosed piles where this has been tried, the same difficulty has been met with.

The author enumerated the points to be considered in the choice of a storage system and the requirements of an ideal plant. Following, brief descriptions were given of the principal methods of storing, such as hand storage, storage by means of a motor truck, trestle storage, storage with side-dump cars, side-hill storage, mast-and-gaff storage, locomotive-crane storage, circular storage, steeple storage, bridge storage and under-water storage. For more complete details reference was made to the speaker's paper on "Storage of Coal," Circular No. 6, Engineering Experiment Station, University of Illinois, Urbana.

LOCOMOTIVE CRANE STORAGE

Under the heading of "Locomotive Crane Storage," reference was made to the practice of the Commonwealth Edison Co., of Chicago, and the following conclusions by W. L. Abbott based upon storage of all varieties of Illinois coal over long periods:

"Nearly any coal that has gone over a 1½-in. screen can be stored. Coal of any size with duff left in it will heat.

"Pea coal (over ½-in. through ¾-in.) has been in storage for more than a year without heating. Coal with screenings removed has been kept in storage eight years without firing."

The coal is stored on the ground in continuous pyramidal piles 25 ft. high, each pile being between two pairs of railroad tracks.

Cost figures for storage and reclaiming from a number of different companies were presented. Some of the figures given include only labor and supplies, with no allowances for overhead, insurance, rental for the land, depreciation and interest on the investment. For hand storage the cost per ton varied from 15 to 64 cents; with the locomotive crane, from 5 to 50 cents; with the steam shovel, 20 cents; with bridge storage, 11 to 60 cents; and with under-water storage, 9 to 22.5 cents.

As the result of a rather detailed study of a number of storage plants and as a digest of the opinions expressed in answer to a questionnaire sent to a large number of those who have had extended experience in storing coal, the following have been decided upon as conclusions that are justified by present storage practice:

It is practicable, advisable and advantageous to store bituminous coal not only during war times, but also under normal conditions either at the mines, near the point where it is to be used, or at some intermediate point. It is well to store coal as near the point of consumption as possible to avoid rehandling.

The danger from spontaneous combustion is due more to improper piling of coal than it is to the kind of coal stored. Most varieties of bituminous coal can be stored in the air if of proper size and if free from fine coal and dust. The coal must be so handled that dust and small coal are not produced in excessive amounts during the storing, because spontaneous combustion is due mainly to the oxidation of the coal surface.

All varieties of bituminous coal can be stored under water, which excludes the air and prevents spontaneous combustion.

The danger of spontaneous combustion in storing the coal is greatly reduced if not entirely eliminated by storing only lump coal from which the dust and fine coal have been removed. Of two coals the less friable should be chosen for storage.

Spontaneous combustion may be guarded against by preventing air currents through the pile by means of a closely sealed wall built around the pile, and by closely packing the fine coal. Such a coal pile must be closely watched for heating. The only absolutely safe way to store slack or fine coal is under water.

Fine coal or slack has sometimes been successfully stored. Many varieties of mine-run coal cannot be stored safely because of fine coal and dust mixed with the lumps.

Coal exposed to the air for some time may become "seasoned" and thus may be less liable to spontaneous combustion, due to the oxidation of the surface of the lumps of coal, but opinions upon this point are not unanimous.

It is believed by many that damp coal stored on a damp base is peculiarly liable to spontaneous combustion, but the evidence is not conclusive.

Air Should Circulate Freely Through the Coal

To prevent spontaneous combustion coal should be so piled that air can circulate through it freely and thus carry off the heat due to oxidation of the carbon, or else it should be so closely piled that air cannot enter the pile and oxidize the fine coal.

Stratification or segregation of fine and lump coal should be avoided since an open stratum or a chimney of coarse lumps of coal gives a passage for air to enter and come in contact with fine coal and thus to oxidize it and start combustion.

If space permits, low piles are preferable.

Coal of different varieties should not be mixed in storage if this can be helped, for one coal more susceptible to spontaneous combustion than the other may jeopardize the safety of the pile.

The heating value of a coal is decreased little by storage, but the belief is widespread that storage coal burns less freely when fired in a furnace. Experiments indicate that much of this can be overcome by keeping a thinner bed on the grate than is kept with fresh coal and by regulating the draft.

Pieces of wood, greasy waste or other easily combustible material mixed in a coal pile may form a starting point for a fire, and every effort should be made to keep such material from the coal as it is being put in storage.

J. L. Hecht, mechanical engineer of the Public Service Co. of Northern Illinois, never had a fire in a storage pile of lump coal; that is, coal that had been screened. No attention had been paid to the height of the pile except from the standpoint of convenience of handling. The company never stored screenings, but had stored No. 3 nut coal for three or four years without signs of heating.

Screenings had been stored successfully at the University of Illinois by packing the fuel closely and excluding the air as much as possible. Coal from a truck was dumped on a former tennis court, which offered a hard foundation. When the fuel reached a certain height, it was smoothed over and pressed down into a compact mass by means of rollers. Plank roads were then laid on the pile so that the truck could distribute another layer of coal and this in turn was rolled down as before. To prevent air circulation from the sides, a board fence surrounded the pile. Heating developed in a couple of places where other coal had been mixed with the screenings, but otherwise this method was satisfactory. The cost for storing and reclaiming had averaged about 40c. per ton.

James Macdonald, president of the Macdonald Engineering Co., had developed, for a plant in Michigan, a vertical method of storage, which appeared to possess advantages over the various horizontal plans universally used. He was a firm believer in the exclusion of air and this was effected in the present case by storing the coal in two vertical reinforced-concrete tanks resembling the farm "silo." The tanks were 28 ft. diameter by 70 ft. deep. Depending upon the foundation, it was easy to vary the dimensions to suit the requirements. The storage was fireproof, occupied little space and was convenient to the power house. Slack coal had been stored so successfully that a duplicate installation was now being made. In case of heating, conveyors had been provided so that the bottom coal could be removed and transferred to the top and water pipes had been laid so that the tanks could be flooded. Neither of these precautions had to be used as the coal never fired.

Weights and Measures in Venezuela

The use of the metric system in all business transactions is not only legal but compulsory throughout Venezuela. The law of Feb. 13, 1857, prescribed that, beginning Jan. 1, 1858, the metric system should be used in all the government offices and for all public acts, and that a year later it should be used by all Venezuelans. Evidently the last-named proviso was not enforced for the old system of weights and measures continued in almost universal use among the people until the issuance of the decree of May 18, 1912, which was based on the old law and took rigorous steps to put it into effect. Under date of Feb. 13, 1914, the Federal Executive prescribed rules for the use and practice of the metric system. A pamphlet was published in Caracas in 1916 under government auspices and shows in detail the steps that have been taken to make the use of the metric system compulsory and to uproot the old methods which had survived.

The strict measures taken have compelled the adoption of the metric system for all business transactions of any importance. Not only is it illegal to use any other weights and measures, but a merchant is subject to punishment even for having them in his possession. The use of units indicating another system in addition to the metric is also illegal. The importation of weights and measures other than the legal is prohibited, and as the authorities have destroyed the old ones wherever possible, distinct progress toward the universal adoption of the new system has been made.

In spite of the stringency of the laws, the people at large, especially in the country, still cling to old units in their everyday life and talk and think in terms of them. This will only be finally remedied by the growing up of a new generation.

The units of weight and measurement formerly in use in Venezuela were varied as well as variable. Many of the measures differed according to the article and the locality. Thus the fanega, which was widely used, and for much the same purposes as in the bushel in the United States today, weighed from 110 to 864 lb., depending on the product measured and the locality concerned. The quintal of 100 Spanish pounds, equivalent to 101.4 English pounds, was formerly much employed in the sale of coffee, cocoa and other products; and this usage still survives, although the transactions are officially reported as "per 46 kilos," which is the equivalent of the quintal.

It is generally agreed here that the compulsory adoption of the metric system was a wise measure and that its use has simplified and facilitated the transaction of business.—*Commerce Reports.*

A little more care in cutting out gaskets from sheet packing will make a big saving in that commodity. It is time that more attention was paid to this important, if minor, detail.—*Marine Engineering.*

National Coal Conference

Under the auspices of the United States Railroad Administration and the United States Fuel Administration the International Railway Fuel Association held its tenth annual convention in Chicago on May 23 and 24. Hotel Sherman was headquarters for the convention, and the meetings were held at Cohen's Grand Opera House. Upward of 1500 attended, including mine operators, representatives of the mine workers, railway executives and employees, railroad and fuel administration representatives and heads of industries that make large demands on fuel and transportation. It was an enthusiastic meeting, held with a view of bettering the coal situation, to impress on each factor the necessity for maximum efforts and the need for coöperation. Those attending were pledged to carry home the spirit of the meeting and inspire the vast army of workers responsible for results. Nearly a million copies of the proceedings will be distributed to these men.

Expressing the sentiments of those addressing the convention, American miners must get out more and cleaner coal. American railroad men must furnish the locomotives and the cars to haul it, and in their use of fuel must make every pound count. The consumer can also do his part by ordering now to relieve the situation later on. It was made apparent that there was no lack of miners and that if they were employed full time as in other trades, there would be no coal deficiency.

In his opening address E. W. Pratt, president of the Association, summed up the railroad coal problem as one of hauling more coal with fewer cars. It was a question of doing the maximum amount of work with the facilities at hand. Regional Director Aishton, of the United States Railroad Administration, declared that the only thing that mattered for all of us now is the maintenance of that line "over there." He begged the miners and railway men of America to "strip to the waist" and do their utmost to help maintain that line. Trooper Scott, of the Anzacs, told how he pleaded with the coal miners to supply the fuel to win the war, and how when they realize what their work means, they go to it harder than ever to increase the output. His plea to the miners was, "Load all the coal you can and load it clean."

Thomas Britt, general fuel agent of the Canadian Pacific Ry., spoke for Canada, emphasizing the importance of coal loaded clean and free from slate, dirt or other nonburning substances. Troopships burning dirty coal are slowed down in the U-boat zone, doubling the danger of the thousands of soldiers carried to the front.

R. Quayle, general superintendent of motive power and car department of the Chicago & Northwestern Ry., urged that every man make it a personal matter to cut out waste of coal in railway operation. In a paper prepared by W. S. Carter, labor director of the United States Railroad Administration, and read by Eugene McAuliffe, it was stated that in the spring of 1919 American railroads must be ready to haul cargo and bunker coal for 8,000,000 tons of army shipping, supplying 2,000,000 American troops in France. This, in addition to the present great fuel demand, would necessitate that the eight-hour work day, desirable in peace, yield to the Nation's need, and that railway men must prepare to work as many hours as the job may call for up to the limit of their power. Better maintenance of locomotives as a means of saving coal was urged by Frank McManamy, director of the locomotive maintenance division of the United States Railroad Administration. It was estimated that defective and neglected motive power would cost the American railways this year $50,000,000 worth of coal, besides the great loss of efficiency.

On Thursday evening the feature was a motion picture dealing with the conservation of railway fuel. The picture had been prepared by and under the direction of the United States Fuel and Railroad Administrations and was viewed with a great deal of interest by those in attendance.

At the opening session Friday, P. B. Noyes, director conservation division, United States Fuel Administration, said that it was impossible for the railways, with their burden of war traffic, to haul the 200,000,000 tons of coal in excess of the requirements of 1914, that will be needed this year. Coal users must save the situation by saving coal, or the country would suffer a disastrous stoppage of industries. The Fuel Administration would try to keep the non-war industries supplied with coal, because these are the vital industries of peace, and their serious interruption would cause a nation-wide commercial panic. At least $20,000,000,000 of capital is invested in legitimate manufacturing enterprises not strictly needed for the war. Ten million men support their families from the work they do in these factories. Cutting off their fuel supplies would mean bankruptcy on a scale that would precipitate the greatest panic ever seen in the United States, and the sudden and forcible unemployment of at least 5,000,000 men. All responsible agents of the Government now realize that keeping labor reasonably employed and only taking it away from non-war work as fast as it can be employed on war work is nearly as important for success in this war as the manufacture of munitions and ships.

Peace in American coal fields for the duration of the war was pledged for miners and operators by John P. White, former president of the United Mine Workers of America, and now labor advisor for the United States Fuel Administration. He declared that 700,000 American coal miners were eager to work every day, Sundays and holidays, getting out the extra 200,000,000 tons of coal needed this year. It was a question of the railways furnishing the cars and the consumers placing their orders so that consecutive employment in the mines would be possible. Mr. White said that the 87,000 miners of Illinois alone, who work on the average only 160 days per year and mine 60,000,000 tons of coal, could get out 150,000,000 tons of coal this year if enabled to work full time. If the railroads would quit haggling over price and start buying their coal, everybody else would follow suit, production would rise and there would be no coal famine next winter. The one big mistake that had been made was in talking price instead of production.

H. N. Taylor, of Kansas City, a big coal operator, won hearty applause when he agreed with Mr. White that if the country had a coal shortage next winter, it would not be due to a wage war in the coal field. The mine operators have been hampered by loss of men and the wearing out of machinery which could not be replaced or repaired. They have to make the best efforts they can with what they have. The consumer has not wakened up to his responsibilities. Most of the coal mines in the Central West and the Southwest are working only half time, because the large buyers are holding back for a lower price. There is need of coöperation and coördination among the operators, the miners, the railway men and the consumers. Last year there was a shortage of 50,000,000 tons of bituminous coal. Even to keep even with last year, this much extra coal must be mined. The operators could produce it if the necessary cars were available. There are two ways of increasing the coal output: One is to produce more coal and the other to save coal. If maximum results are obtained from both there will be no coal shortage.

Eugene McAuliffe, manager of the fuel-conservation section of the United States Fuel Administration, intimated that the Government might find it necessary to take over the coal mines for the period of the war. According to Claxton E. Allen, deputy fuel administrator for Illinois, records of all coal sales are being kept, so that if necessary the administrator can take coal from those who have a surplus and allot it to others who have none.

"Fuel Oil and the War" was discussed in a paper sent by M. L. Requa, director of the oil division of the Fuel Administration. Diversion of all tankers from coastline to transatlantic army-supply service required the railways to haul an extra 100,000 bbl. of oil a day from Southwestern fields to the north Atlantic war industrial centers. Pipe-line deliveries are to be increased by 20,000 bbl. daily and the maximum number of tank cars have been placed in service. Fuel-oil users are urged to increase their storage capacity and lay in as much of their winter supply as possible before the summer is over.

The convention closed Friday afternoon with a business session at the Hotel Sherman, at which the following officers were elected: President, L. R. Pyle; vice presidents, C.

M. Butler, H. B. MacFarland and J. B. Hurley; members of executive committee for two years, B. Pemberton Phillippe, A. N. Willsie, T. Duff Smith and R. R. Hibben; members of executive committee for one year, H. B. Brown, L. J. Joffray and H. Woods.

Joint Meeting of the Chicago Section A. S. M. E. and W. S. E.

Officially, the last meeting of the season for the Chicago Section of the A. S. M. E. was held Friday evening, May 24. It was a joint dinner meeting with the Western Society of Engineers, held at the Hotel La Salle. Notwithstanding, another joint meeting will be held on June 17 at the rooms of the Western Society, the topics being "Modern Condensers" and "The Benefits To Be Obtained in the Power Plant from High-Pressure and High-Temperature Steam."

Preliminary to the paper of the evening, the question of training women for drafting work was brought up and resulted in arrangements for a meeting between educational sources and business men to see if such help was needed in this section and the possibility of introducing suitable courses. It developed that Armour Institute had already established a short intensive course to train women for drafting work.

Calvin W. Rice, national secretary, was a welcome visitor. His presence was explained as a continuation of the plan for the national officers to visit the local sections to relieve the impression that the organization is local to New York and not national in its interests. Mr. Rice had made an extended trip and had been impressed with the advance in thought among engineers. He had been particularly impressed by the motto of the new Engineers' Club at Dayton, Ohio. The speaker wanted to see coöperation between national and local bodies and between the various societies. Each engineer should do something altruistic and make the profession an instrument for the common good. He wanted to see engineers identified with the Board of Trade or similar bodies. They must be good citizens and help guide civic matters, but as a body should not take sides in politics. At the present all meeting topics should relate in some way to the war, so that in its winning, the services of the engineering societies would be preëminent.

In his retiring address President Bailey expressed the opinion that the best thing the executive committee of the section had arranged for during the past year was the joint meetings. They had proved a decided success and should be continued. The new officers elected were: Chairman, G. E. Lord; vice chairman, P. A. Poppenhusen; secretary, A. L. Rice; member of executive committee, J. J. Merrill.

John Ericson, city engineer, reviewed the construction of the Wilson Avenue tunnel and the Mayfair pumping station. The tunnel, which is eight miles long from the crib in the Lake to Mayfair pumping station, has been completed successfully and at a big saving by day labor. The finer sections of the stone removed from the tunnel were used in the concrete lining it. By the use of special screening and conveying machinery, the concrete was mixed in the tunnel, and it had not been necessary to follow the usual procedure of removing the stone from the tunnel and then taking it back again for the concrete. Excavation and lining were carried on simultaneously.

The design and erection of the intake crib, specially designed by the city, were discussed and the equipment of the station outlined. It was laid out for seven units, but only five have been contracted for. Three were designed for a head of 140 ft. and two for a head of 200 ft. The capacity of each of the former units is 25 million gallons and of the latter 17.5 million gallons per 24 hours. The pumping engines are of the Reidler triple-expansion type employed at the Lakeview Station. Six boilers equipped with underfeed stokers have been provided. The operating pressure is to be 190 lb. gage and the superheat 200 deg. Complete coal- and ash-handling facilities are being installed. It is the tenth large pumping station built for the City of Chicago. The estimated cost is $1,570,000, and that of the tunnel $3,856,000, so that the total cost of the system will approximate $5,426,000.

Price of Bituminous Coal Reduced

For a long time there has been a difference of opinion between the Fuel Administration and the Railroad Administration as to the price of coal to the railroads. By agreements with certain mines the railroads had been obtaining their coal at prices much lower than those to other consumers. The dispute has been settled conclusively by an order of the President, effective on May 25, 1918, by which the price of bituminous coal is reduced 10c. a ton and the railroads are forced to pay the Government price. The text of the order is as follows:

The United States Fuel Administration, acting under authority of an executive order of the President dated Aug. 23, 1917, appointing said Administrator, and of subsequent executive orders and in furtherance of said orders and of the act of Congress therein referred to and approved Aug. 10, 1917, hereby orders and directs that all prices for bituminous coal f.o.b. mines in the coal-producing districts throughout the United States fixed by the said executive order of the President, dated Aug. 21, 1917, and subsequent orders of the United States Fuel Administrator, and in effect at 7 a.m. on the 25th day of May, 1918, shall be and the same hereby are reduced as to all shipments made after 7 a.m. on the 25th day of May, 1918, by the sum of 10c. for each net ton of 2000 pounds.

This order shall in no way affect the increase contained in the executive order of the President dated Oct. 27, 1917, adding the sum of 45c. to the prices fixed for bituminous coal under the terms and provisions set forth in said last-mentioned order.

Regarding this order, the Fuel Administration has issued the following statement:

The reduction will mean an annual saving to consumers of a sum estimated by the Fuel Administration at $60,000,000. The President has directed that the railroads pay the Government price for coal. The increased cost of railroad fuel thereby occasioned is also estimated at $60,000,000 per annum. The reduction of 10c. per ton on all coal will, however, reduce the net increased cost to the railroads from $60,000,000 per annum to $45,000,000 per annum. Under the President's plan the railroads will furnish cars to all coal mines alike, without discrimination except as dictated by the prior requirements of the railroads for operating purposes and the needs of domestic consumers and of the war.

Under the present war demands the maximum output of every mine working at full time would still be insufficient to meet the country's coal needs. The principle of equal car supply has accordingly been adopted so as to make for as steady an operation as possible of all properties and for continuous employment of men, thus making for maximum output.

The introduction of the principle of even car supply will reduce the general average overhead of mine operation and thereby justifies the Administration in putting out a price reduction order. It is understood that the mine prices thus fixed will remain undisturbed until the United States Fuel Administrator has before him the cost returns for the twelve months ending Aug. 31, 1918.

The returns thus far in are being carefully studied by Fuel Administration accountants and engineers, with a view to making the utmost saving to the public that is consistent with a maximum production of coal.

The order issued tonight will have no effect on the price of anthracite, which forms the bulk of the domestic consumption fuel in the eastern part of the country.

Consumers of bituminous coal who have already entered their orders for the year's coal supply, but whose coal has not yet been delivered, will, of course, receive their supplies at the reduced price. This price applies to all coal which leaves the mines after 7 a. m., May 25, no matter how long the order for the delivery of the coal has been standing.

Coal delivered after 7 a. m., May 25, under contracts which have been entered into since Dec. 29, 1917, will be billed at the new price. Under the regulation of the Fuel Administration all such contracts call for the delivery of coal at the Government price effective at the time of delivery.

Organizing a Division of Inspection To Insure Clean Coal

To guard against the waste and serious loss resulting last winter from the shipments of dirty coal, which occupied car space and also seriously decreased industrial-plant efficiencies, the Fuel Administration has organized a division of inspection, with C. M. Means as manager. A chief inspector has been appointed in each of 21 representative districts, and where necessary assistant inspectors will be added. These inspectors will examine coal in the mines, also as dumped from mine to tipple, watch the picking tables and again inspect the coal as it is loaded in cars for shipment.

Standards will be established for insuring proper preparation according to use, so that all coal shipped must be of the quality required for its particular purpose. By condemning coal at the mine, a great improvement in the transportation situation should result in that the railroads will in effect be hauling heat units, not ash. Miners who get out dirty coal will be penalized, and a bonus system is being developed. Mines that cannot supply properly prepared coal will not be allowed to ship by rail.

Committee Studying Potomac River Power Project

A committee consisting of Brig. Gen. W. L. Marshall, chairman, Reclamation Service, Department of the Interior; Col. H. C. Newcomer, Corps of Engineers, War Department; A. L. Parsons, Bureau Yards and Docks, Navy Department, and Nelson S. Thompson, Supervising Architect's Office, Treasury Department, appointed several weeks ago, is making a study of the data at hand looking to the development of power from the Potomac River to supply electric current for various Federal and municipal uses. Two tentative plans have been prepared by Mr. Thompson. One involves building a large dam between the hills above Great Falls and conducting the water to a point near the Chain Bridge, where a fall of 180 ft. could be obtained. The estimated cost is about $40,000,000. The other plan—to build two smaller dams, one above Great Falls and another near Chain Bridge—would cost about half as much as the first plan, but would involve flooding considerable inhabited area and relocating the Chesapeake & Ohio Canal at this point.

Any plan must, however, take into consideration the water supply for the district, with its ever-increasing demands, taken from the Potomac at Great Falls. This was originally a gravity system built by and under the control of the War Department. The development of the city toward the northwest, higher ground, and the completion of a filtering system in recent years have made pumping necessary. A special report by Colonel Fiske, engineer in charge of the District water-supply system, points out the necessity for an increased water supply on account of the increased population and industrial activity. The problem therefore becomes more complicated than the usual water-power or water-supply project alone.

University of Illinois, Summer Session

The 1918 Summer Session of the University of Illinois will offer special advanced courses planned especially for instructors in mechanics in trade schools and technical schools, for chemists who wish to fit themselves to take positions involving the physical testing of materials, and for men who wish to fit themselves for positions in commercial or Government testing laboratories. Three special courses will be offered:

1. Advanced Mechanics of Materials. Advanced problems in strength of materials. A knowledge of elementary mechanics of materials is a prerequisite for this course.

2. The Properties of Engineering Materials. Lectures and assigned reading on the properties of iron, steel, other metals, wood, brick and concrete. A knowledge of elementary mechanics is a prerequisite for this course.

3. Laboratory Work in Testing Materials. Study of testing machines and strain-measuring apparatus; practice in standard methods of testing and tabulation of test results. A course in elementary mechanics of materials accompanied by work in the laboratory is a prerequisite for this course.

The extensive equipment of the materials testing laboratory of the university will be available for this work, which will be under the direct charge of H. F. Moore, research professor of engineering materials. Further information concerning the courses and expenses may be obtained from the Director of the Summer Session, University of Illinois, Urbana, Illinois.

Personals

W. V. Houck has tendered his resignation as works manager with the Sterling Engine Co. to accept a factory managership, and also an interest in the Buffalo Metal Goods Co.

Julius Alsberg has opened consulting engineering offices in the Tribune Building, 7 S. Dearborn St., Chicago. He is prepared to make investigations and reports on mechanical, industrial and chemical engineering problems, to design plants and to supervise their installation.

Robert L. Brunet, for the last five years public-service engineer of the City of Providence, R. I., and previously power engineer of the Essex Division, Public Service Corporation of New Jersey, has resigned from the former to become industrial and efficiency engineer of the Jenckes Spinning Co., Pawtucket, R. I.

Engineering Affairs

Universal Craftsmen, Council of Engineers, will hold its sixteenth annual convention at Detroit, Mich., August 5-10, with headquarters at the Statler Hotel. This is to correct error on page 642, April 30 issue.

New York State Convention N. A. S. E., will be held at Coney Island, Brooklyn, June 14-16, with headquarters and exhibits at the Shelbourne Hotel. Upwards of 60 booths have already been sold, and there is every promise of a successful meeting. Brothers McGowan, Casey, Downey and Cole are members of the hustling arrangement committee.

American Order of Steam Engineers will hold its annual meeting at Philadelphia, June 11-13. The meetings of the delegates will be held in the Parkway Building on Broad St. Because of the unsettled conditions, the display will be limited to a table exhibit. A large room has been provided for the get-together of the engineers and supplymen.

The National License Law Committee of the National Association of Stationary Engineers has had drafted and printed in pamphlet form a model state license law, as well as a set of instructions explaining and drafting a license measure. Information concerning these may be obtained by addressing the secretary of the Committee, F. W. Raven, at 417 So. Dearborn St., Chicago, Ill.

The Trustees of United Engineering Society at the regular meeting held May 23, elected the following men to the Engineering Foundation Board: Calvert Townley, of Westinghouse Electric and Manufacturing Co., New York, succeeding Gano Dunn. The following are additional members: Silas H. Woodard, Consulting Engineer, M. Am. Soc. C. E.; Dr. Joseph W. Richards, Professor of Metallurgy, Lehigh University, South Bethlehem, Penn.; Dr. David S. Jacobus, Advisory Engineer, Babcock & Wilcox Co., New York; H. Hobart Porter, of Sanderson & Porter, Consulting Engineers, New York.

The American Institute of Electrical Engineers at its annual meeting held in New York on Friday, May 17, elected the following officers for the administrative year beginning Aug 1, 1918: President, Prof. Comfort A. Adams, Harvard University, and Massachusetts Institute of Technology, Cambridge, Mass. Vice presidents, Allen H. Babcock, San Francisco, Calif.; William B. Jackson, Chicago, Ill.; Raymond S. Kelsch, Montreal, Quebec; F. B. Jewett, New York City; Harold Pender, Philadelphia, Penn.; John B. Taylor, Schenectady, N. Y. Managers, G. Faccioli, Pittsfield, Mass.; Frank D. Newbury, Pittsburgh, Penn.; Walter I. Slichter, New York City. Treasurer, George A. Hamilton, Elizabeth, N. J. These officers together with the following holdover members, will constitute the Board of Directors: E. W. Rice, Jr., Schenectady, N. Y.; H. W. Buck, New York City; C. E. Skinner, East Pittsburgh, Penn.; John B. Fisken, Spokane, Wash.; N. A. Carle, Newark, N. J.; Charles S. Ruffner, St. Louis, Mo.; Charles Robbins, East Pittsburgh, Penn.; E. H. Martindale, Cleveland, Ohio; Walter A. Hull, West Lynn, Mass.; William A. Del Mar, New York City and Wilfred Sykes, East Pittsburgh, Penn.

Miscellaneous News

Coal Production Slightly Increased—The report of the United States Geological Survey on coal production for the week ended May 11, shows the bituminous yield to have been 11,806,000 net tons, which was an increase over the preceding week of 252,000 tons, or 2.2 per cent. The anthracite production declined during the week more than 5 per cent. The shipments amounted to 38,314 carloads, as against 40,570 carloads during the previous week.

Big Turbine for New York City—The United Electric Light and Power Co., of New York City, has recently placed an order with The Westinghouse Electric and Manufacturing Co. for a 22,000-kw. turbo-generator set. The generator will be rated at 25,900 kv.-a., at 85 per cent. power factor, 8000 volts, three-phase 62½ cycles. It will be direct-connected to a Westinghouse 22,000 turbine. The order includes a 40,000-sq.ft. surface condenser and the usual auxiliaries.

Must Keep Oil Prices Steady—A communication just issued by the Oil Division of the United States Fuel Administration warns oil producers that the Government will not at this time view with approval any further advance in the price of crude oil. Competition in the form of payment of bonus is also to be restrained. By this it is not meant that varying prices should not be paid for oils of varying quality, but these differentials once established should not be further advanced.

The Penberthy Injector Co. is offering to stationary engineers' associations an artistically framed photograph showing the interior construction of their automatic injector, on which also is given a complete and concise explanation of its working. This should be of exceptional educational value and when hung in the association room it will be a permanent answer to the question, "Why does an injector work?" We suggest that the secretary of each association write at once to the Penberthy Injector Co., Detroit, Mich., for the photo, assuring them that it will be hung in the local rooms.

NEW CONSTRUCTION

N. Y., Black River—The Northern New York Utilities Co., 137 Arsenal St., Watertown, plans to build a plant on the Black River here, for the development of power. Estimated cost, $500,000. J. Brownell, Strickland Block, Carthage, Engr.

N. Y., Broadalbin—The Broadalbin Knitting Co. will soon receive bids for the erection of a 3-story, 75 x 100 ft. mill. Estimated cost, $65,000 Equipment, including electric motors, pumps, etc., will be installed. H. S. Moul, Gloversville. Arch.

N. Y., Fairport—A. S. Crocker, Engr., Mechanics Institute, Rochester, will receive bids until June 11, for the erection of a 2-story, 100 x 125 ft. factory and power plant here for the Douglas Packing Co., John St. Estimated cost, $25,000. Power equipment will be installed.

N. Y., Jamestown—The Art Metal Construction Co., Jones St. and G Ave., has had plans prepared by F. A. Shoemaker, Engr., Builders Ex., Buffalo, for remodeling and extending its boiler house.

N. Y., Olean—J. A. Coffey, Secy. Board of Armory Commission, 158 State St., Albany, will receive bids until June 12, for the installation of a complete heating system in its proposed 2-story, 52 x 110 ft. armory. Total cost, $100,000.

N. J., Gloucester City—The Pussy and Jones Co. plans to build a new electric power plant to supply power to several large shipbuilding plants.

N. J., Pompton Lakes—The City has had plans prepared by S. Firestone, Engr., Granite Bldg., Rochester, N. Y., for the erection of a hydro electric plant here. Estimated cost, $45,000. Noted May 7.

N. J., Trenton—The City plans to install 2 new pumps with generators for pumping station with 30,000,000 and 10,000,000 gal. capacity respectively. Estimated cost, $100,000. J. R. Fell, 134 North Clinton Ave., Engr.

N. J., Verona—The Board of Education will soon award the contract for the installation of a power and heating system in its proposed 4-story brick school on Laning Ave. Guilbert & Betell, 665 Broad St., Newark, Arch.

Penn., Greenville—Mercer Co. Commissioners are contemplating the erection of a brick power plant to be used for heating purposes. Plans include the installation of two 150-hp. boilers, a pump, etc.

Penn., Philadelphia—The United States Government has received bids for the erection of a 1-story, 57 x 154 ft. aircraft factory on League Island. A steam heating plant is to be installed in same. Estimated cost, $20,000. Noted May 28.

Md., Baltimore—The Maryland Creamery Co., 1726 East Pratt St., plans to build a 4-story, 50 x 90 ft., reinforced concrete, steel and brick ice manufacturing plant and cold storage building. Estimated cost, $55,000.

Va., Fieldale—The Caroline Cotton and Woolen Mill Co. is having plans prepared by F. P. Sheldon & Sons, Arch., Industrial Trust Bldg., Providence, R. I., for the erection of a weave shed and spinning mill. Motors, etc., will be installed.

Fla., Pompano—The Cypress Creek Lumber Co., Ft. Lauderdale, recently incorporated with $30,000 capital stock, plans to build a plant here. New machinery including power equipment, etc., will be installed.

Ohio, Cincinnati—The Dixie Terminal Co., 1st Natl. Bank Bldg., will purchase a battery of 200-hp. boilers for the main building to be constructed on 3rd St.

Ohio, Minster—The City will soon receive bids for the erection of a 1-story, 50 x 70 ft. power plant. Estimated cost, $50,000. V. I. Gray, 518 Nasby Bldg., Toledo, Engr.

Ind., Jeffersonville—The Quartermasters Dept., Wash., D. C., plans to appropriate $50,000 for a hospital, water pumping plant and an electric power plant here.

Ind., Maryland—The Evansville Tool Co., 9th Ave. and West Maryland St., Evansville, is having plans prepared by C. Brossman, Engr., 1618 Merchants Bank Bldg., Indianapolis, for the erection of a 1-story, 45 x 65 ft. power house. F. Lohoff, Evansville, Pres.

Wis., Depere—The Depere Manufacturing Co. has had plans prepared for the erection of an addition to its boiler works. Estimated cost, $35,000. E. S. Clark, Mgr.

Wis., Whitewater—The State Board of Normal Regents, Madison, plans to build a heating and power plant here. J. H. White, Madison, Engr.

Minn., Glen Lake—Sund & Dunham, Arch., 514 Essex Bldg., Minneapolis, will receive bids until May 31, for a built-in refrigerator and machinery for same at the Hennepin Co. tuberculosis sanitarium.

Minn., St. Paul—The State Board of Control will receive bids June 1, for the erection of a 2 story, 36 x 46 ft. power plant and laundry for the Home of Crippled Children, Phalen Park. Estimated cost, $40,000. New equipment will be installed. C. L. Pillsbury Co., 805 Metropolitan Life Bldg., Minneapolis, Engr.

N. D., Pembina—The Board of Education will receive bids until June 11, for the installation of a heating system, etc., in the grade and high school here. W. D. Gillespie, Fargo, Arch.

Mo., St. Louis—The S. S. Kresge Co., Detroit, Mich., has awarded the contract for the erection of a 3-story, 125 x 150 ft. store, to the G. A. Fuller Co., 540 Penobscot Bldg., Detroit, Mich. Estimated cost $350,000. A two pipe vacuum system will be installed by the owner.

Calif., Ontario—The Ontario Power Co. plans to build a new power house. Estimated cost, $60,000. G. D. Smith, Gen. Mgr.

Ont., Perth—The local hydro commission has been granted $35,000 for improvements to its distributing system. Work includes the installation of a transformer, erection of new lines, etc.

Sask., Gull Lake—The Canadian Pacific Railway plans to build a power house here, and will install equipment, etc. J. M. Cameron, Calgary, Alta., Gen. Mgr.

Alta., Lloydminster—W. and E. Johnson plan to build an electric lighting and power plant. Estimated cost, $60,000.

B. C., Cloverdale—The Whitlock Waterworks, Ltd., plans to transform its plant from gasoline to electric motive power. New equipment will be installed.

CONTRACTS AWARDED

R. I., Woonsocket—The Andrews Mills Co., Frankford, Philadelphia. Penn., has awarded the contract for the erection of a 2-story, 45 x 50 ft. boiler house, and a 1-story, 157 x 244 ft., weave shed, etc., to the C. I. Bigney Constr. Co., 898 Westminster St., Providence. Estimated cost, $120,000.

Conn., Thamesville (Norwich P. O.)—The Eastern Connecticut Power Co., care R. W. Péskins, Norwich, has awarded the contract for the erection of a 1-, 3- and 4-story 80 x 140 ft. power plant here, to F. T. Ley & Co., Inc., Springfield, Mass. Noted, Apr. 16.

N. Y., Gloversville—The Gloversville Knitting Co., Beaver St., has awarded the contract for the erection of a 2-story, 219 x 230 ft. knitting mill. Estimated cost, $150, 000. New equipment including pumps, motors, etc., will be installed.

N. J., Jersey City—Hudson Co. let contract wiring Passaic River bridge on Lincoln Highway, to W. J. Coleman, 29 Willow Court. Estimated cost, $6000.

N. J., Newark—Mass & Walstein, Inc., Ave. R., has awarded the contract for the erection of a boiler and nitrating room addition to its plant, to H. M. Doremus & Co. Noted Apr. 9.

Penn., Philadelphia—The Bellevue Worsted Mills, Wister and Reading Rds., has awarded the contract for the erection of a 1-story, 30 x 89 ft. brick power house at 16th and Huntington Park Ave., to W. E. S. Dyer, Land Title Bldg. Estimated cost, $10,000.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for the erection of a power house and 2 transformer houses to T. Riley, Philadelphia. Estimated cost, $130,078.

Md., St. Helena—The U. S. Shipping Board, Housing Division, Wash., D. C., has awarded the contract for the erection of a power house, bakery, etc., to the Consolidated Eng. Co., Calvert Bldg., Baltimore. Estimated cost, $800,000.

Ill., Chicago—The Fleischman Co., 427 Plum St., Cincinnati, Ohio, has awarded the contract for the erection of a 4-story, 62 x 85 ft. steel and brick factory. Estimated cost, $90,000. A new boiler and refrigerators are to be installed.

Ill., Chicago—Wilder & Co., 228 West Lake St., has awarded the contract for the erection of a 5-story, 50 x 125 ft. leather factory on Hawthorne St. Additions to the present steam heat and power plants will be built. Total cost, $75,000.

Que., Montford—The Montford Orphanage has awarded the contract for the erection of a hydro electric plant here, to Arsenault & Plamondon, 70 St. James St., Montreal. Estimated cost, $15,000.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania..	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.00	$4.35	$3.90
Barley	2.15	1.50	2.40	1.75
Buckwheat ..	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes...	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes...	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.65-3.00	$2.65-2.80	$2.30-2.40
2-in. lump	2.65-3.00	2.65-2.80	2.30-2.40
Steam egg....	2.65-2.80	2.35-2.50	2.30-2.40
Mine-run	2.45-2.60	2.45-2.60	2.00-2.15
No. 1 nut.....	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen....	2.15-2.40	2.15-2.40	1.50-1.65
No. 5 washed..	2.15-2.30	2.15-2.30	2.15-2.30

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba.	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T .fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			⅜-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
23.10c.	21.00c.	42.00c.	27.30c.	25.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T .P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	100
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$20.00
No. 16 cotton twisted	24.50
No. 18 cotton parallel	21.00
No. 16 cotton parallel	28.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	38.00
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No 18 cotton Canvasite cord	25.00
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid. Single Braid	Solid. Double Braid	Stranded. Double Braid	Duplex
14	$11.00	$12.50	$15.00	$24.25
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	56.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	223.60	....
000	....	....	271.24	....
0000	....	....	332.40	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$13.00	$15.00	$31.09	$11.00	$20.00	$31.50	$12.00	$17.40	$36.30
10	22.15	25.25	50.05	25.40	29.00	59.00	30.30	34.30	48.80
8	31.40	34.85	69.50	35.45	35.00	72.50	42.33	46.85	67.60
6	49.40	53.30	.....	.....	61.00	120.00	64.60	74.10	.....
4	71.30	76.15	.....	.....	86.00	.....	101.75	106.55	.....
2	108.00	113.65	.....	.....	130.00	.....	151.50	163.00	.....
1	140.40	147.85	.....	.....	176.00	.....	201.00	209.50	.....
0	176.85	176.85	.....	.....	222.00	.....	276.00	285.00	.....
00	......	239.45	.....	.....	270.00	.....	317.00	330.00	.....
000	......	293.15	.....	.....	330.00	.....	417.00	428.00	.....
0000	......	357 00	.....	.....	400 00	.....	508 00	516.00	.....

LOOM—Price per 100 ft., in coils:

	Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$66.56	$71.66	$0.1602	$0.1716	$0.059	$0.0632
¾	87.75	94.65	.2108	.2258	.0843	.0903
1	129.71	139.91	.3119	.3341	.1096	.1174
1¼	175.49	189.29	.4019	.4289	.1518	.162
1½	209.83	226.33	.5358	.5718	.1875	.2001
2	282.31	304.51	.9823	1.05	.25	.2668
2½	446.36	481.46	1.61	1.71	.3572	.3812
3	583.70	629.60	4.28	4.57	.5358	.5718
3½	729.56	784.76	9.47	10.10	.7144	.7624
4	886.17	951.57	10.93	11.67	.893	.953

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3 00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$65.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B—Watts	Plain	Frosted	No. in Package	Mazda C—Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

FANS—Following are prices of fans in New York:

DIRECT CURRENT

6 in.—Universal D. C. & A. C. Diehl	$ 6.00
9 " —110 volt D. C. S&T Diehl or Sprague	11.00
9 " —110 volt D. C. Osc. Diehl or Sprague	13.75
12 " —110 volt D. C. S&T Diehl or Sprague or Eck	14.50
12 " —110 volt D. C. Osc. Diehl or Sprague or Eck	18.55
16 " —110 volt D. C. S&T Diehl or Sprague or Eck	17.25
16 " —110 volt D. C. Osc. Eck or Sprague	21.25

ALTERNATING CURRENT

9 in.—110 volt 60 cycle A. C. S&T Diehl or Sprague	$11.00
9 " —110 volt 60 cycle A. C. Osc. Diehl or Sprague	14.00
12 " —110 volt 60 cycle A. C. S&T Diehl or Sprague	14 75
12 " —110 volt 60 cycle A. C. Osc. Diehl or Sprague	19.50
16 " —110 volt 60 cycle A. C. S&T Diehl or Sprague	18.25
16 " —110 volt 60 cycle A. C. Osc. Diehl or Sprague	22.50

For 220 volt Winding—$1.00 additional

Those prices are for fans 6 or more, less than this quantity add 10%.

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2⅝-in.	75c. per ft.
Common, 2½-in.	33⅓%

Air

	First Grado	Second Grade	Third Grade
¾-in. per ft.	$0.60	$0.35	$0.30

Steam—Discounts from list

First grade.... 25% Second grade.... 30% Third grade.... 40%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	40%	Best grade	15%
Standard	30%		

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	40%
Denver	35%	30%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.60
Duck and rubber for piston packing	1.00
Flax, regular	.90
Flax, waterproofed	1.10
Compressed abestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.90
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magaesia high pressure		5% off
For low-pressure heating and return lines	4-ply	58% off
	3-ply	60% off
	2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5¼	6.9	7½	10½
Fiber or sponge	8	6	7.4	7½	15
Transmission	7	6	7.4	7½	13
Axle	4½	4	3.6	4	5
Gear	4½	4½	7.0	4	6
Car jornal	22 (gal.)	3½	4.5	4	6

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	11.00 to 13.00	10.00 to 12.00	16.50	12.00 to 16.50
Colored mixed	8.50 to 12.00	10.00 to 12.00	13.00	11.50 to 14.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows.

	13¼ x 13¼	13¼ x 20½
Cleveland	$52.00	$58.00
Chicago	48.00	50.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw per barrel	$1.55*	$1.31	$1.65	$1.32	$1.65	$1.28
5-gal. cans	1.65*	1.41	1.80	1.42	1.75	1.33

* Nominal.

WHITE AND RED LEAD in 500-lb lots sell as follows in cents per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
25 and 50-lb. kegs	11.25	11.41	11.75	11.50	11.25	11.50
12½-lb. keg	11.47½	11.62	12.00	11.75	11.47½	11.75
100-lb. keg	11.02½	11.19	12.25	12.00	11.02½	12.00
5-lb. cans	11.82½	15.25	13.75	13.50	11.82½	13.50
1-lb. cans	13.72½	14.62½	.....	13.50	13.72½	.....

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel 7/16 and smaller	30%	40%	40%*
Tinned	30%	40%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York..$6.09½ Cleveland..$5.35 Chicago..$5.50 Pittsburgh..$4.65

Coneheads, same sizes:

New York..$6.19½ Cleveland..$5.45 Chicago..$5.60 Pittsburgh..$4.75

REFRACTORIES—Following prices are f.o.b. works, Pittsburgh:

Chrome brick	net ton	$175.00
Chrome cement	net ton	75.00
Clay brick, 1st quality fireclay	per 1000	50.00– 55.00
Clay brick, 2nd quality	per 1000	35.00– 40.00
Magnesite, raw	ton	30 00– 35.00
Magnesite, calcined	ton	32.00– 35.00
Magnesite, dead burned	net ton	32.00– 35.00
Magnesite brick, 9 x 4½ x 2½ in	net ton	110.00–125.00
Silica brick	per 1000	50.00– 60.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55; St. Louis grade, $40.
Birmingham—Fire clay, $55-60; silica, $55-60.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	125.00	70.00	118.00	74.00	110.00	65.00
Commercial	70.00	40.00	23.00	22.00	22.00	25.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$15.00	$13.00
Cleveland	15.00	12.00
Chicago	17.00	11.50

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft	7.40	6.60	6.60	5.80
7 in. by 35 ft	10.70	9.60	9.60	8.55
8 in. by 35 ft	12.20	10.90	10.90	9.65
7 in. by 40 ft	12.35	11.00	11.00	9.75
8 in. by 40 ft	13.75	12.15	12.15	10.65
8 in. by 45 ft	18.20	16.20	16.20	14.30
8 in. by 50 ft	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$ 9.00
12-in. butts, 6-in. tops, length 30-40 ft	11.50
12-in. butts, 6-in. tops, length 41-50 ft	12.50
14-in. butts, 6-in. tops, length 51-60 ft	21.00
14-in. butts, 6-in. tops, length 61-71 ft	23.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
¾ to 3	40%	35½%	¾ to 1½	33%	17%

LAP WELD

Inches	Black	Galvanized	Inches	Black	Galvanized
2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			

BUTT WELD, EXTRA STRONG PLAIN ENDS

Inches	Black	Galvanized	Inches	Black	Galvanized
¾ to 1½	47%	34½%	¾ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

Inches	Black	Galvanized	Inches	Black	Galvanized
2	40%	28½%	2	27%	14%
2¼ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

	Per Net Ton		Per Net Ton
1 in.	$340	1¾ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

POWER

Vol. 47 NEW YORK, JUNE 11, 1918 No. 24

Success—On Things in General, Personal and Otherwise

"I would like to study, but haven't the time." This is a familiar complaint. But consider the man who always has some educational literature with him, reading at spare moments, waiting for his dinner order, on train, trolley or ferry, homeward bound. Many possible moments exist for all of us; like the pennies, in the end they count and should be saved. One's time has a cash value.

Do you ridicule the man who studies up, saying "Work can be learned only by contact"? When he attains that position which you had thought to be yours simply by virtue of long service, do you complain and berate your luck? The man too valuable to longer occupy the lower position is given the one ahead; though not working at it, still he had acquired by study the fundamentals of the undertaking. He who does not progress surely goes backward.

Think not of the pleasures others have during social hours while yours is only study. Endurance wins. In games of skill a fair degree of proficiency is to be admired; beyond that, it is a waste of time, and no one cares to play with a professional.

Do not let personalities interfere with your progress. But some other fellow may. Study your own to avoid friction; no one advances on merit alone. Personality and temper control are gained by the preservation of health. One should not study to the detriment of health, but maintain that course compatible with progress which conserves the health necessary to enjoy the fruits of labor.

Money is not always a measure of success. Reasons of existence give each his part in the world's undertakings. Though you only have a ditch to dig and dig it well, success is yours; dig it better and a goal is defined for the other man. Branch out with success and extend it to all things, even to your leisure moments.

Is it impossible to advance? Are there necessary restrictions or limitations beyond which you may not go? This is your individual problem. Nothing is perfect; never complain; strive to make right, that is the purpose of your existence. Work cheerfully or choose an environment suited to your temperament; someone specially fitted may win in the place you vacate.

A fair appearance consistent with your position is commendable. Harmony, with utility in design, sells goods, so your good appearance impresses others, commanding respect and results.

You save for your employer a small amount and lift your head with pride, little realizing that your salary is his investment—you the instrument of service to economize for him. Equal results could be obtained by others; your salary should be the small percentage of your economies, otherwise you have lost where there is no reasonable return upon the investment.

Command the attention of those above, but not in a spectacular manner, advertising your ability in a modest way. Work well, even if not appreciated; others are watching, and even those in minor positions may at some future time recommend or employ.

Contributed by T. W. Reynolds

Soot and Soot Blowers

Nature of soot and its effect on heat transfer through boiler heating surface. Relative steam consumption of mechanically operated soot blowers versus hand cleaning. Effect on the coal pile, labor required and maintenance cost of mechanical blower as given by a number of users.

DURING recent years the boiler room has gradually emerged from a position of secondary importance to a primary element in the cost of power generation. Boilers have been growing in size, combustion rates have increased, and greater loads per unit of steam-making surface are being carried. With the operating conditions becoming more severe and fuel cost high above the normal level of years past, closer scrutiny is being given all factors affecting economy.

Of all the preventable losses, that caused by the formation of soot on the fire surfaces of the boiler is perhaps the most troublesome. Cracks in the setting may be detected, and the leakage of air into the setting may be stopped. Proper insulation will reduce radiation, and scale on the water surfaces may be eliminated to a large extent by the use of pure or softened water. The formation of soot and ash, however, is universal and continuous as long as there is an active fire under the boiler. Depending upon the degree of combustion and arrangement of the setting, the quantity of soot varies and its character differs with the fuel, but there is no stopping of its formation. Even if conditions were ideal and combustion complete, a heat-insulating coating composed largely of ash would form on the tube surface.

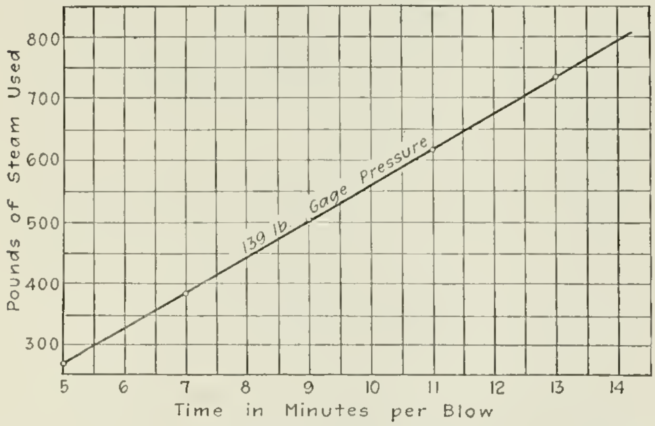


FIG. 1. TOTAL STEAM REQUIRED FOR PERIODS BLOWER IS IN OPERATION

As a rule the soot found in boilers is not pure soot or carbon. It contains a varying proportion of ash, so that the color may be light gray, red, brown or, where conditions are particularly unfavorable to good combustion, black. In coming from the furnace, the soot particles are more or less plastic and readily adhere to the metal surface of the tubes. Unless the deposit is quickly removed, the carbon on the tubes near the fire will burn out in part, fusing the various ingredients into a hard coating, which increases rapidly as the gas temperature rises due to the insulation of the tubes. In water-tube boilers it is not uncommon to find on the heating surface near the fire hard clinker-like formation in some cases bridging the tubes. Even with efficient and frequent cleaning it is practically impossible to keep the lower tubes near the fire entirely free of this slag-like formation. Farther back the soot does not contain so large a percentage of ash. It is usually darker in color, and the formation is not cemented together. Loose deposits rest on all retaining surfaces, such as the upper portions of the tubes.

With all kinds of fuel then there is formation of soot. Anthracite contains a low percentage of volatile matter, but may run high in ash, so that the deposit is largely the latter constituent and is usually of a light powdery character. With bituminous coal, high in both volatile and ash, there is a large percentage of carbon in the soot, particularly if the furnace conditions are not favorable to good combustion. In waste-heat boilers deposits of fine powdered dust carried along with the gas are to be found, and even with oil fuel there is some formation of soot. Due to excellent combustion the quantity is small, but as the deposit is pure soot of high insulating value, its removal is important from an efficiency standpoint. The soot evil also extends to the economizer, the deposits resembling the boiler soots. Due to the lower temperatures the formation is more profuse and its interference with heat transmission relatively greater as the difference in temperature between gas and water is less.

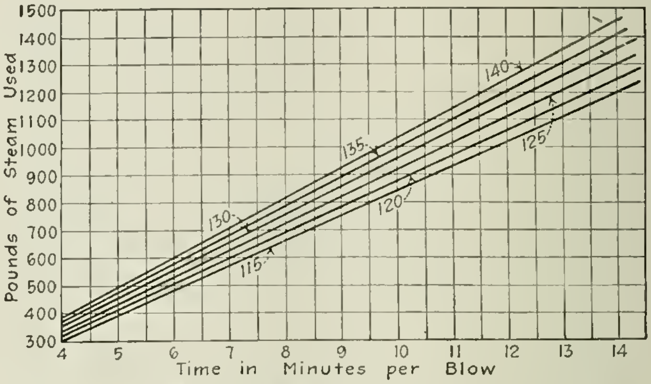


FIG. 2. STEAM CONSUMPTION OF 2-IN. BLOWER FOR VARIOUS PRESSURES

It has been commonly stated that next to loose wool, loose lampblack or soot is the best insulator known. In this capacity it is ahead of hair felt, and is more than five times as effective as fine asbestos. All this may be true, but boiler soot is not all lampblack. The varying percentages of ash and the density and structure of the deposit will naturally affect the insulating properties. Besides, the coating is not evenly distributed so that part of the surface at least will be comparatively clean. If the maximum heat transfer through the boiler tubes is to be maintained, however, all the heating surface must be kept clean, and this is particularly true where boilers are forced over normal rating, as is the practice in modern plants. If the soot is allowed to remain, another bad feature is the formation of carbonic and sulphuric acids, which act on the metal of the boiler, causing leaky tubes and general deterioration that will shorten the useful life of the boiler. It is quite evident, then, that soot must be removed if the best results are to be obtained, and the question at issue is the easiest and most efficient method of doing it.

For the purpose there are the hand lance and the mechanical blower. The former, consisting of a rubber hose and nozzle, was the first device to be used. It is of course simple and the initial cost is small. Two men are required to operate it: one at the boiler to handle the nozzle and the other at the steam valve. The work is naturally hot, dirty and disagreeable and on a medium-sized boiler takes from twenty to thirty minutes. Usually there is not more than one and at most two blowings per day of twenty-four hours. The lance is inserted through dusting doors in the setting, and there is no opportunity for the operator to see the result of his work. Unless he is conscientious beyond the average, the surface may be poorly cleaned and some sections are neglected entirely. Usually, the lance does not reach all the heating surface, the area covered being determined by the kind of dusting doors, the width of alley space at the side of the boiler and the range of the lance due to the angle of the dusting door. Another objection commonly advanced against hand-blowing is the fact that when soot is blown across the tops of the tubes it strikes the battery wall and tends to pile up on the far tubes, contrary to the argument that the draft will carry it off.

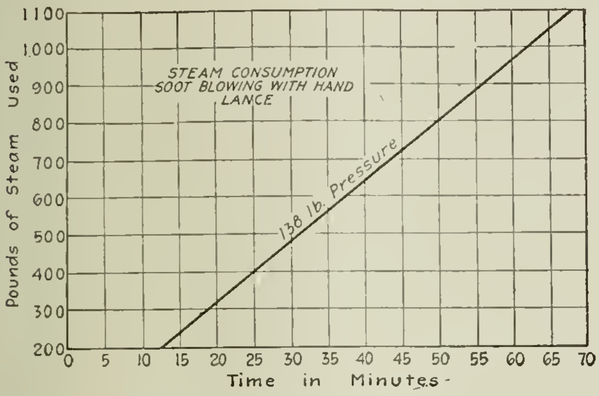


FIG. 3. STEAM CONSUMPTION WITH HAND LANCE

There is the additional objection of large quantities of cold air being drawn into the setting during the period the steam lance is in operation. This means less efficient combustion. As expressed by A. W. Conklin, in *Power*, July 13, 1915, the time required to clean a boiler with a steam or air lance is about three times that necessary with a mechanical blower, and the results obtained are about one-third as good. In a series of comparative tests in soot blowing, it was found that the amount of steam required for one operation of the mechanical blower was about the same as that used in blowing the boiler by hand. In other words, the amount of steam used by the blower in 6 minutes, the time required to clean the boiler, was nearly the same as that used by the steam lance in 25 minutes for the same operation. The mechanical blower, however, showed a saving of 5 per cent. over hand-blowing, because the heating surfaces were more thoroughly cleaned. This figure appears to be conservative and when in average practice neglect or less frequent cleaning are factors, the saving may easily be more.

Continuing with the results obtained by Mr. Conklin, Fig. 1 shows the steam consumption of a soot blower equipped with 1½-in. piping to the blowing elements. The steam pressure was 139 lb. gage and the superheat about 20 deg. Between the main steam header and the nozzle plugs there was a drop of about 10 lb. pressure when the blower was in operation. The test was made on a 300-hp. water-tube boiler vertically baffled for three passes. Two blowing elements in each pass cleaned the tubes. In addition an element served the superheater and another was placed in the rear combustion chamber. Fig. 2 shows the steam consumption of a 2-in. blower at different steam pressures and 20 deg. superheat on a 500-hp. boiler of the same type served by the same number of blowing elements. Fig. 3 gives the steam consumption of a hand lance on the smaller boiler. With the latter the superheater tubes were not blown, nor was the rear combustion chamber cleaned, but the steam consumption was about the same as that required for one blow with the mechanical blower. The blower required 29 min. and the steam at 138 lb. pressure was used 25 min. at the rate of 16 lb. per min. Temperature readings taken at the top row of tubes, third pass, showed that the gases from the mechanically cleaned boilers were anywhere from 80 to 100 deg. lower, say 520 deg., as compared to 620 deg. for the hand-cleaned boiler. This corresponds to a saving of from 4 to 5 per cent. made possible by more efficient and more frequent cleaning.

Drop in Uptake Temperature

From general observations and figures from various tests a general rule has been figured out that for every 20 deg. drop in the uptake temperature due to the removal of soot from the heating surface, there is a saving of approximately 1 per cent. in fuel. It is well to bear in mind that a drop in flue-gas temperature may mean better absorption of heat or it may mean a temporary cooling of the surface by the blowing steam. The time element in the return of the temperature to that before blowing is the deciding factor. A rapid recovery indicates cooling while a slow gradual rise in the temperature shows efficient cleaning. Fig. 4 is an example of the latter condition. The curve is a plot of flue tem-

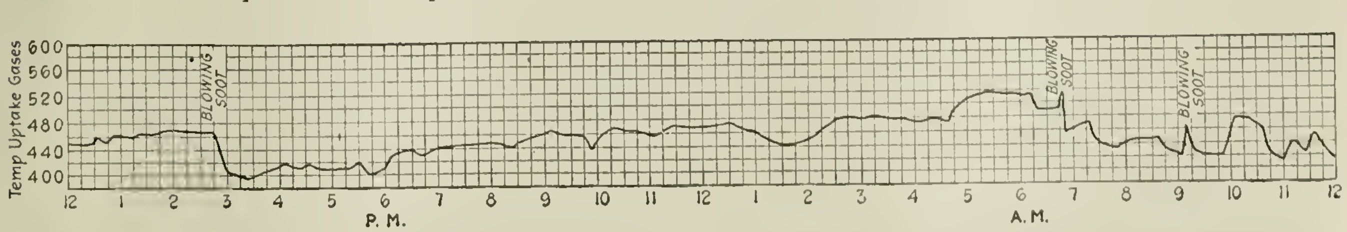


FIG. 4. EFFECT OF SOOT BLOWING ON FLUE TEMPERATURE IN A HORIZONTAL VERTICALLY BAFFLED BOILER

peratures in a horizontal vertically baffled water-tube boiler burning Illinois coal in an underfeed stoker. After the blowing at 2:45 p.m. there is a sudden drop in temperature of 70 deg. The succeeding rise in temperature is gradual, as the curve does not reach the original level until midnight, about nine hours later.

Labor is another item entering into the comparison. The mechanical blower required but one man and the time of blowing is, say, one-fourth as long, so that the ratio in this case was 8 to 1, and with very large boilers it may be considerably higher. Local conditions, size of plant, etc., determine whether the saving in time will be sufficient to dispense with the services of employees retained for this work.

Objections offered to the mechanical blower are initial cost, running from 5 to 10 per cent. of the cost of the boiler, the burning out of the elements exposed to the hottest gases direct from the furnace, and warping. The objection last named, warping, has always been a serious problem. It is a well-known fact that metal begins to warp long before it reaches a temperature that will cause corrosion or burning of the metal. For that reason it is necessary to construct the element so that it will have strength to resist the warping, for as soon as this action begins, the element will be thrown out of line, it will bind in the bearings and the operator will be unable to turn it.

INITIAL COST SMALL

The initial cost is comparatively small when compared to a 5 per cent. saving in the fuel bill, the reduction in labor and the convenience of operation. Destruction of the elements near the fire has been obviated to some extent by the use of special metal having high heat-resisting qualities, and by so placing the elements that they are protected from the direct heat of the furnace when in the nonoperating position. Corrosion, due to back suction of the boiler gases into the blowing elements, has been reduced by the use of special air valves, and special precautions have been taken to drain the piping system of the blower to prevent condensation being forced out onto the heating surface to interfere with soot removal and to corrode the metal. These various improvements, better placing of the elements and nozzles of improved design have so perfected the mechanical blower that, according to reports from numerous users, the services rendered are excellent and the maintenance charges are comparatively small.

While users of the mechanical soot blowers realize that they are getting better heat transfer, that the flue gases are lower in temperature and that the boiler efficiency has been improved, there is a lamentable lack of specific data showing the saving actually effected and the average cost of maintenance. The blowers have been installed. They are giving satisfaction. The boilers will carry more load, and it is known that the flue temperatures are considerably lower than previous to the installation. During the first two or three years of use repair parts are required occasionally. Depending upon the service the average life of the blower is at least five or six years. The labor of blowing has been reduced, and as the work is less arduous, it is performed more frequently and with better results.

Such was the gist of replies from a large number of power-plant owners and engineers to whom inquiries had been sent by the writer concerning the saving in fuel and labor effected by the installation of mechanical blowers, the cost of maintenance and the degree of satisfaction the blowers gave in service. The substance of some of the replies, more specific than others, are presented in the following:

The Iowa Falls Electric Co. had equipped three Edge Moor water-tube boilers of the four-pass type with soot blowers. Two of the boilers were rated at 410 hp. and the other at 550. The boilers had previously been blown by hand, and the work required the full time of one man at a cost of $850 per year. In their opinion it took a remarkably good man to stand up beside a hot boiler and blow every tube. Frequently some of the tubes were missed, and the result was a reduction in efficiency. Besides, a man could not hold a hose carrying 175-lb. steam pressure. It had taken the company two months to get all the old scale off the tubes, caused by blowing them with wet, low-pressure steam. The principal advantages of the mechanical blower in their estimation was the fact that full boiler pressure could be used and that better results were obtained. Since the installation of the blowers the services of the man previously mentioned had been dispensed with, and the firemen were blowing the tubes twice on every shift. The saving in coal was placed at 15 per cent. The blowers had been in service one year, and the maintenance expense had been the cost of one pint of oil to lubricate the swing joints.

MAKE A SAVING

The Iowa Railway and Light Co., of Cedar Rapids, had installed mechanical soot blowers on 29 Edge Moor water-tube boilers during a period extending from 1909 to 1918. The company knew that the blowers were a great help both in labor and economy, but could give no definite figures. It had been found that the blowers would not keep clinkers off the first row of tubes. There was a chance for improvement here.

In the plant of the Indianapolis Light and Heat Co. 14 boilers, ranging in size from 500 to 800 hp., were equipped with mechanical blowers. If properly operated, the blowers saved approximately 15 per cent. in fuel and labor. About 12½ per cent. of this saving was attributed to higher boiler efficiency and 2½ per cent. to a reduction in labor cost. The maintenance had been approximately $5 per installation per month.

The Richmond Light and Railroad Co. had blowers on ten 606-hp. B. & W. boilers equipped with stokers. The maintenance on the blowers, which had been installed from one to two years, had been practically nothing. The company had no accurate data to show the saving in coal and labor, but was satisfied that the blowers were a good investment.

The Edison Electric Illuminating Co. of Brooklyn had in use blowers on 17 B. & W. boilers averaging 650 hp., and 45 additional units were being installed. Installation work had begun in November, 1916, and no definite figures as to fuel saving were available, as the majority of the boilers were still blown by hand. In the opinion of the operating engineer there was no question that the boilers were much cleaner by the use of the mechanical soot blowers, and that a saving in fuel must result. When all the soot blowers were installed, the labor saving would eliminate the services of five men and would amount to about $13 per day.

Soot blowers on 4900 hp. of Stirling boilers are in use at the plant of the Indiana Railways and Light Co., of Kokomo, Ind. No tests had been made to determine the percentage of saving. Cleaner tubes so clearly indicated a saving that the question had not been analyzed. It had been their experience that the soot blower complete had to be removed in from five to six years.

Four 750-hp. Bigelow-Hornsby boilers in the plant of the Salem Electric Lighting Co., of Salem, Mass., had been equipped with soot blowers in 1915; five blowers were installed on 280-hp. Heine boilers in the plant of the Rockland Light and Power Co., of Nyack, N. Y., in 1914, and in the same year a 600-hp. B. & W. boiler of the Malden Electric Co., of Malden, Mass., was equipped with a blower. In the plant first mentioned the saving in labor was $675 per year; in the second plant $411 per year, and in the Malden plant the labor saving was undetermined. Blower repairs in the three plants had been negligible. In the opinion of the engineering manager controlling the three properties, there was no question but that there had been a saving in fuel on all the boilers equipped with mechanical soot blowers, as it was possible to clean the tubes twice in twenty-four hours so that the heating surface was maintained in much better condition. No exact data were available.

BETTER THAN AIR BLOWERS

The Central Hudson Gas and Electric Co., of Poughkeepsie, N. Y., had equipped six of eight Stirling boilers with mechanical blowers. These blowers were much more effective than the compressed air they had previously used, and there was a considerable reduction in labor.

Installation of soot blowers on two 400-hp. Heine water-tube boilers in the plant of the Chester Valley Electric Co., of Coatesville, Penn., in the year 1911, had resulted in a saving in the operation of the plant roughly estimated at 5 per cent. This figure was considered conservative and was divided into 1 per cent. in labor and 4 per cent. in fuel. The maintenance charges, which had been small, were placed at $100 in seven years.

With blower installations on two 350-hp. Heine boilers and two Stirling boilers for several years, the Texas Power and Light Co. placed the cost of upkeep at $5 per blower per year, and over hand-blowing estimated a saving in fuel of approximately 10 per cent.

The public lighting plant of the City of Detroit had installed soot blowers on two 685-hp. Stirling boilers Apr. 21, 1916. To clean the soot from two 400-hp. Stirling boilers by means of a steam hose from ladders required the labor of two men for about three hours. With the mechanical blowers the battery of two 685-hp. boilers was cleaned by one man in one-half hour, the ratio being 12 to 1 in favor of the mechanical blower. So far there has been no expense for maintenance.

One of the large central station companies of the country has equipped 55 boilers with mechanical soot blowers. These are of competitive types, and a few of home manufacture. Fifteen of the installations have been made on Stirling boilers rated at 2365 hp. that operate between bank and about 200 per cent. of rating. On overload the temperatures are high and the conditions severe, so that it has been found necessary to assist in the further development of the blowers. To clean one of the large boilers by hand requires twelve to fourteen hours' time with two men operating. These men receive 38 cents per hour, so that the labor cost for hand-blowing averages about twenty-six hours of 38-cent time, or just under $10 per 2500 boiler horsepower per twenty-four hours.

With soot blowers installed two men blow a boiler in about one hour. They blow each boiler three times a day so that the total labor cost approximates $2.30 per 2500 boiler horsepower per twenty-four hours. Thus the labor item is reduced to less than one-fourth, and the boiler has the advantage of three cleanings a day. The job is much better done, and no useless air is admitted through open doors. The effect of this factor will be appreciated when it is noticed that it takes from twelve to fourteen hours to blow one of the boilers by hand.

To clean one of the big boilers with a mechanical blower required about 3500 lb. of steam per blow. Three operations per day would require about 10,500 lb. of steam per 2500 boiler horsepower every twenty-four hours.

The maintenance charges on soot blowers had not been separated from certain other somewhat similar costs, but it was estimated that soot blowers properly installed could be kept in good operating condition with a maintenance expenditure of not over $200 per 2500 boiler horsepower per year. The average charge had been higher than this, but it was due to the fact that certain parts as originally designed and installed had given out frequently and had to be replaced. Because of imperfect methods used for measuring flue-gas temperatures, accurate data were not available to indicate the thermal advantage obtained from the use of soot blowers. It was believed safe to assume, however, that mechanical soot blowing maintained a flue-gas temperature about 30 to 40 deg. lower than could be maintained with hand-blowing, and unless the latter operation was completely and conscientiously done, the difference would be more nearly of the order of 80 to 100 deg. less.

Loss of Flowage Rights

Under the laws of New York, right to dam a stream, when acquired and held under an express deed or grant, cannot be lost by mere nonuse unless the disuse has continued for at least twenty years. And when a dam has been maintained at a given height for that period or longer, a prescriptive right is acquired, irrespective of any express grant. Where there has been no relinquishment of an acquired right to flood lands, through express relinquishment or continued nonuse for twenty years, the owner of the dam is entitled to reconstruct it at such height as to overflow upper lands to the full extent permitted under the original grant of right. Hence, the fact that an old dam may have leaked for many years, less than twenty, will not affect the right of the owner to repair the leaks, or reconstruct the dam, so long as no more land is overflowed than was overflowed in the original enjoyment of the right. (New York Supreme Court, Ulster County; Geiger vs. Divine, 167 New York Supplement, 263.)

Augustine Rotary Two-Cycle Super-Induction Gas Engine

ONE of the most widely used engines for airplane work is the revolving air-cooled motor, of which there are several designs, operating on the four-stroke cycle. The distinguishing feature of this type of engine is that the crankshaft and cranks are stationary and the cylinders revolve about this shaft. This produces the same relative motion of the piston to the cylinder as if the cylinder were stationary and the crank revolved, as in the case of an ordinary reciprocating engine. These engines are generally made with 5, 7, 9 or 14 cylinders and range from about 50 to 100 hp. each.

A new design of rotary gas motor is the Augustine rotary two-cycle super-induction air-cooled engine, Fig. 1, which has been developed by the Augustine Automatic Rotary Engine Co., 1862 Elmwood Ave., Buffalo, N. Y.

Figs. 2 and 3 illustrate the general design of this engine; the former is a sectional view through the motor in a plane at right angles to the axis of the driving shaft and centrally through the cylinders, also showing the relative positions of the pistons in the radial cylinders and the stationary shaft, bearings and connecting-rods. Fig. 3 is a sectional view in the plane of the axis of both the stationary and driving shafts, showing the assembled parts and how the lubricating oil is carried in copper tubes to the bearings and how the oil is kept cold by the incoming charge of gas.

The fuel gas is drawn from the carburetor through the hollow shaft *A*, Fig. 3, by the pumping action of the piston and is delivered to the crank casing, where it is put under slight compression, the degree of compression being controlled by the throttled condition of the carburetor. The passage of the fuel gas is from the hollow shaft *A* through the stationary controlling valve *B* and intake pipe *C* to the space *D* in the cylinder between the piston and the cylinder head, as shown by the arrows. As the sleeve valve *E* has closed the exhaust ports when the piston is at the compression position, the gas in the space *D* is forced back through the pipes *C* and *F*, past the valve *B* and into the crank casing of the engine when the piston begins its outward stroke, the valve *B* having moved to permit of its passage and so has cut off the supply of gas from the carburetor from the cylinder that has reached the compression stroke.

Fig. 4 is a sectional view of the stationary controlling disk valve showing the alternately intaking and discharging pipes that lead to the different cylinders. It also shows by the arrows the intaking of the charge from the carburetor and the discharging of the gas charge into the inner chamber by positive cutoffs above and below, the engine rotating in the direction of the curved arrow. As shown, the gas passes to the chamber *D*, Fig. 3, at the same time and is being forced into the crank casing from two opposite cylinders during the same period.

The fuel gas passes directly from the crank casing to the cylinders, entering through the intake ports *G*, Fig. 3, which are at the inner ends of the cylinders. A separate view of the piston, ports and cylinder is shown in Fig. 5, which also shows how the super-induction is effected, the sleeve *E*, Figs. 3 and 5, having closed the exhaust ports and the full pressure of the inner chamber being admitted into the cylinder before cutoff and compression begin.

With the piston at the inner end of the cylinder, Fig. 6, and the exhaust ports closed, the cylinder is filled with fuel gas drawn from the carburetor through the hollow shaft and intake pipe leading to the outer end of the cylinder. The greater piston area on the pump side is responsible for the super-charge that is brought in and then transferred to the inner chamber as the piston reaches the other end of the stroke. Compression is effected between the inner face of the piston and the inner end of the cylinder before exploding and expanding, and the spark plug *H* is located in the center of the charge. The screen on the intake ports *I* is to prevent backfiring.

After the explosion in any one of the six cylinders takes place, the burnt gases are expelled through the exhaust ports *J*, Fig. 3, at the outer end of the cylinders. These exhaust ports are controlled by a sleeve which is positively moved by the cams and push-rods *K* and *L*, the movement of the sleeve being so timed as to close the exhaust ports prior to the closing of the intake ports *G*. By this super-induction, brought about through the closing of the exhaust ports and the pumping capacity of the piston, which can deliver a large volume of gas to the cylinders, a very high volumetric efficiency is obtained, even at high altitudes in airplane service where low atmospheric pressures are encountered.

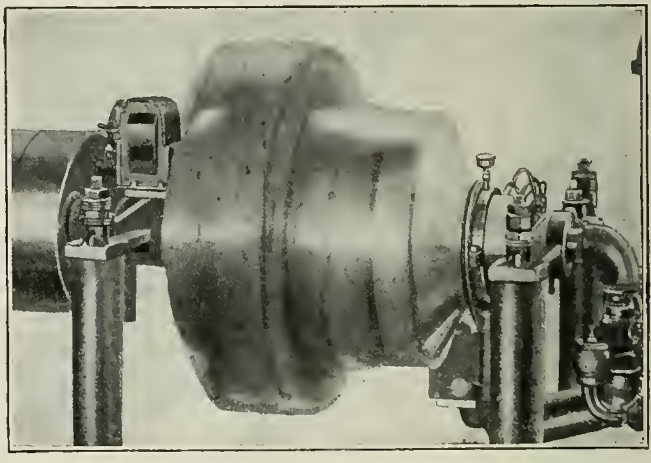


FIG. I. THE AUGUSTINE ROTARY ENGINE RUNNING AT HIGH SPEED

An idea of the action of the gases in each cylinder may be obtained from an examination of Figs. 7 and 8. The former shows the piston position just as the exhaust gases are released by the piston uncovering the ports and thereby relieving any pressure before the inlet ports are open. Fig. 8 is a similar view, showing the intake ports open and the cylinder fully scavenged of the burnt gases and the sleeve at the point of closing the exhaust ports. It also illustrates how the spark plugs *H* have a complete scavenge with the new, clean charge of dry gas, insuring easy ignition. As the exhaust ports are at the outer end of the cylinder and the inlet ports at the inner end of the piston cylinder, this prevents cycloning of the inrushing gases and causes natural scavenging, owing to a "uniflow" of the gases.

In Fig. 9 is shown a partial view through the upper portion of a cylinder at one side, with the piston just closing the exhaust ports and the sleeve for the closing of the exhaust ports about to move and uncover them. At this position of the piston there is no pressure on the sleeve, therefore it is moved practically without friction. Fig. 10 is a similar view showing the exhaust ports uncovered by the sleeve and the piston just reaching the ports, which it also uncovers and thereby effects the exhaust. After the compressed charge has been exploded and the piston has moved to its outer stroke, the sleeve valve *E*, Figs. 3, 9 and 10, uncovers the ports *J* and the incoming charge of fresh gas from the crank casing forces the burnt gases out through the ports *J* into the exhaust pipes *U*, Figs. 2 and 3. This cycle of events takes place in each cylinder in rotation.

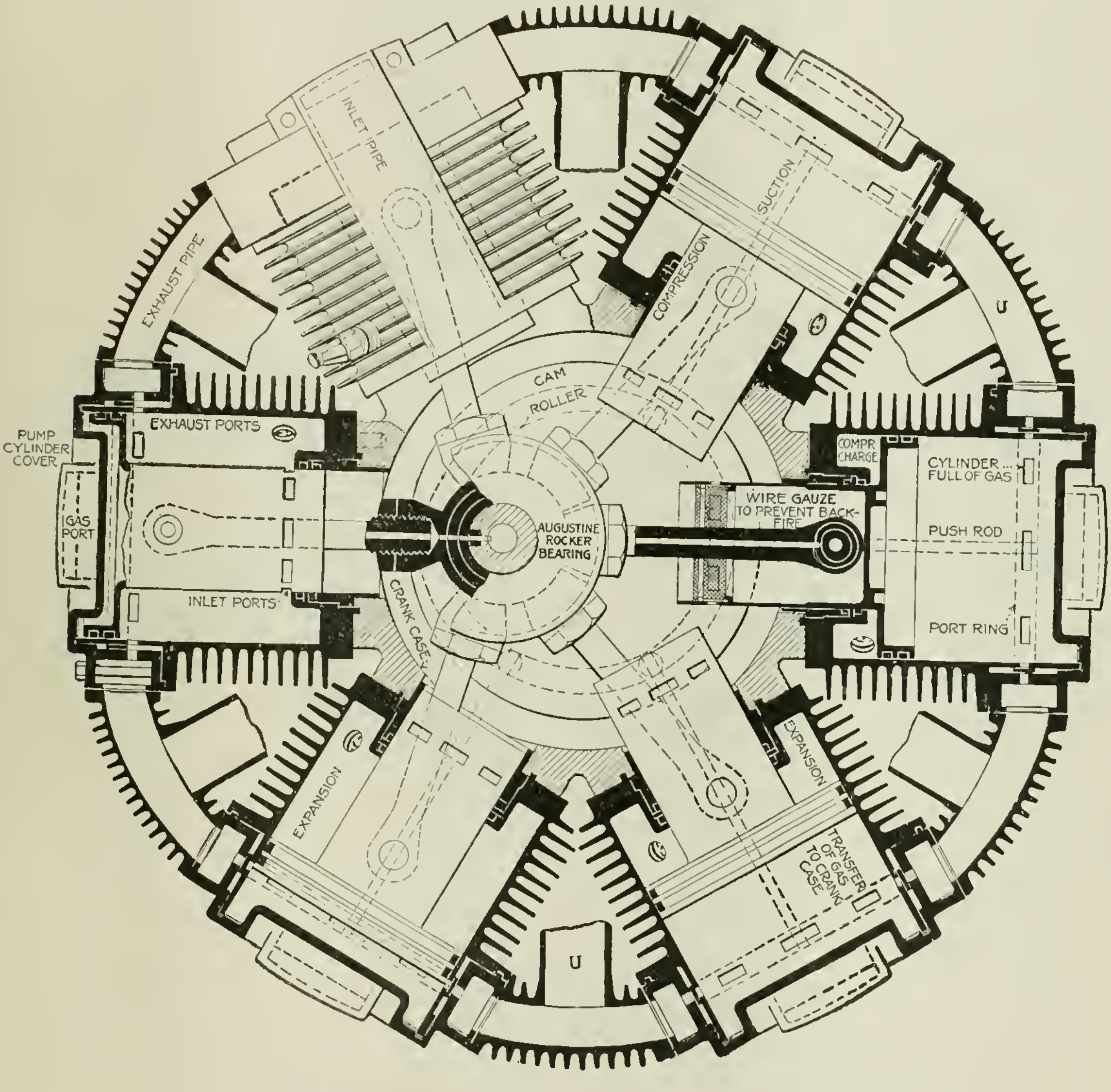


FIG. 2. END SECTIONAL VIEW THROUGH THE AUGUSTINE ENGINE

In the operation of the rotary type of engine centrifugal force has to be contended with, and this becomes an enormous factor in a high-speed engine. The Augustine engine overcomes this difficulty by arranging the expansion and compression chambers for the fuel gases so that the expanding gases work against the inner space of the piston, forcing it outward and pulling on the fixed crank to turn the engine rather than thrusting against the crank. The expanding force of the gas against the piston operates in the same direction as the centrifugal force and is added thereto, and does not destroy the balance of one piston against the other. In this connection another advantage is accomplished in that the thrust of the expanding gases against the cylinder forces the cylinder against the crank casing, so that the only necessary connection between the cylinder and the crank casing is to overcome the centrifugal action on the cylinder. Records show that many accidents have occurred by the cylinder breaking loose through the tremendous pressure of the expanding gases combined with centrifugal effect, which tends to force the cylinder outward. In this engine, however, this is overcome because the pressure of the expanding gases against the inner end of the cylinder tends to hold it seated against the crank casing.

An essential feature in an airplane engine is extremely light weight. In this engine each cylinder is divided by the piston into a pumping chamber and an expansion and compression chamber for the fuel gases, as already mentioned. The gases are pumped by the same piston that is acted upon by the expanding gases, thus making the piston double-acting. By using the one cylinder both for pumping gases and for the expansion of the gases in turning the engine, the latter may be made very light, because the expansion of the gases is against the inner end of the cylinder and the crank casing, and the outer end of the cylinder is only subjected to the suction and the discharge of the gases. In other words, the force of the expanding gases is practically taken up by the piston head and the crank casing itself. As the sleeve that controls the gas ports is also timed to cover the exhaust ports when the outer end of the cylinder operates as a pumping chamber, this not only obviates the loss of fuel gases being pumped, but also prevents the burnt gases from being thrown back into the pumping chamber.

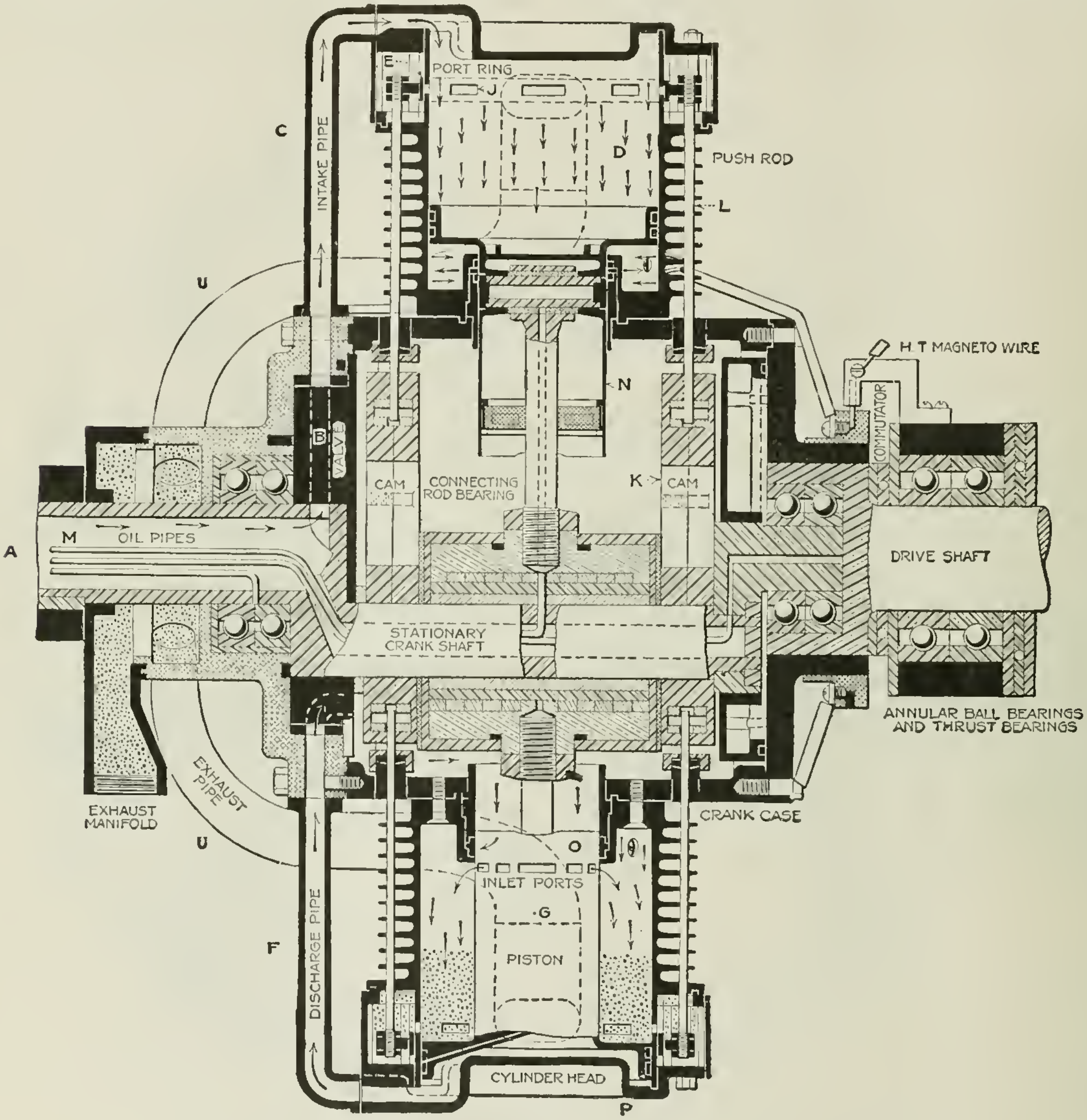


FIG. 3. SIDE SECTIONAL VIEW THROUGH THE TWO-CYCLE ROTARY ENGINE

The cylindrical projection *N*, Fig. 3, extends inwardly from the piston head and from the housing from the piston-rod connection and also contains the intake port. This cylindrical projection is opened to the crank casing so that the cooled fuel gases pass up into them and the moist gases, particularly, are carried by centrifugal force into the cylindrical projection, which becomes in a way a vaporizer for gasifying the fuel. As the intake ports are at the extreme inner end of the cylindrical portion carried by the piston, the moist gases are carried by the centrifugal force past the intake ports and gasified, and only dried gas passes through the intake ports to the cylinder. Furthermore, the fuel gases come in contact with the inner central portion of the piston head, and at the same time the fuel gases in the pumping chamber come in contact with the outer face of the piston head. This tends to keep the piston head cool while the heat units tending to accumulate therein are utilized for gasifying the fuel.

The piston with its cylindrical projection has a two-point bearing, one at each end of the expansion chamber. As the piston travels, the connecting-rod assumes a position at an angle to the longitudinal center line of the cylinder, and this has caused considerable difficulty in previous engines, owing to the side thrust or twist of the piston wearing the cylinder wall. By this construction, however, where the piston has a two-point bearing, as at *O* and *P*, Fig. 3, this side thrust or lateral twist in the piston is taken care of with little or no wear of the piston on the cylinder wall. Furthermore, by this two-point bearing the extent of the contact surface between the piston and the cylinder wall is reduced to a minimum and the friction incident to the travel of the piston is thereby reduced.

The exhaust ports are large and are disposed about the end of the cylinder. The intake ports are disposed about the cylindrical portion carried by the piston and are in line with the exhaust ports. As a result, when the exhaust ports are open and the intake ports uncovered, the gases rush through the latter and force the burnt gases out of the former, thus scavenging the cylinder. As already stated, the central portion projecting from the piston prevents cycloning of the inrushing gases and intermixing with the burnt gases.

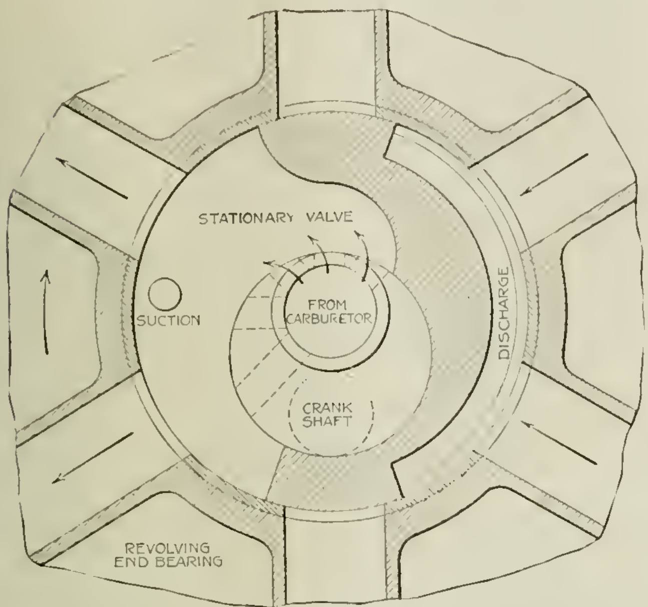


FIG. 4. SECTION THROUGH THE STATIONARY CONTROLLING DISK VALVE

Each piston rod is connected to a pair of rings, and these rings are nested and engage two floating sleeves mounted on a fixed crank. By having a pair of rings, all side thrust on the piston rod is avoided. The end cups surround the ends of the connecting bars carrying the rings. A compression ring is slipped over the connecting bars and engages the groove therein. This compression ring also engages the inner surface of the cups and thereby forms in each cup a lubricating pocket. The oil for lubricating the crank is carried by a copper tube through the hollow fixed shaft as at *M*, Fig. 3, and passes out through oil grooves in and about the floating sleeve into the end cups and also out through the connecting-rod to the wristpin and to oil ducts leading to the cylinder walls. This arrangement gives lubrication for every desired part of the engine, and also insures that the fuel gases are free from the lubricating oil.

A side elevation through the center of the self-aligning bearing is given in Fig. 11, in which the two inner sleeves and the oil channels are shown, also the end cap bearings that inclose the outer section of the bearing. The two expansion rings on the inner ends of the caps are for retaining the oil film. Fig. 12 is an end view showing the various sections of the self-aligning bearing and the oil ducts leading up through the connecting-rods to the wristpin, through which the oil is equally distributed by centrifugal force through all parts while the engine is in operation. The ensemble of this self-aligning bearing insures alignment of the piston rods between the crank and the wristpin centers and at the same time constitutes the center along which all pistons and their rods revolve in a balanced centrifugal condition, with no reversal of direction of pull on the connecting-rods. Fig. 13 is a perspective view of two of the self-aligning bars with annular rings, which, when assembled, are mounted on inner creeping sleeves.

As the engine is of the two-stroke cycle type, the cylinders are fired in rotation one after the other. This gives a constant torque and permits of the use of a very simple ignition device; for example, in a six-cylinder engine a two-point magneto may be used, driven at a speed of three to one with a single wire leading to a brush-holder coöperating with spaced contacts connected to the respective spark plugs in each cylinder. The brush engages these contacts in rotation. The spark plugs are directly in front of the incoming gas, which assures perfect scavenging and allows the motor to be throttled to a very low speed and at the same time insures that the spark plug shall be in the region of the fresh fuel gas. A diagram showing the inlet and exhaust cycles of the motor and the section of the box cam that closes the exhaust ports in each revolution is shown in Fig. 14.

Following are given data of the more essential features of this engine: Number of cylinders, 6, having six double-acting pistons utilized both as power pistons and pumps; bore of working cylinder, equivalent in area to a 4⅝-in. conventional piston; stroke, 4 in.; area of piston, 16.7 sq.in.; area of pump, 23.76 sq.in.; connecting-rod crank ratio, 4 to 1; bore of crank case, 10¼ in.; over-all diameter of motor, 26 in.; over-all length of motor, 24 in.: two-spark magneto, driven 3 to 1, giving six sparks per revolution; approximate weight of motor, 2 lb. per hp.; compression, from 90 to 100 lb. per sq.in.; positive system of force-feed lubrication.

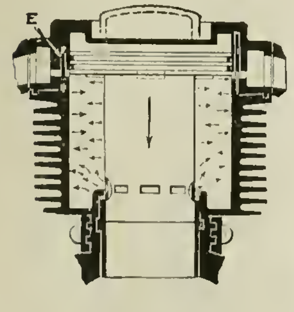


FIG. 5. PISTON PORTS AND CYLINDER

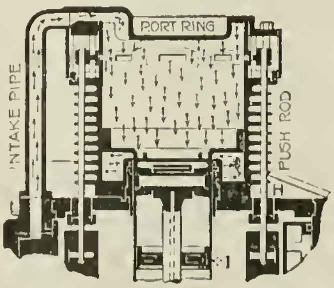


FIG. 6. PISTON AT INNER END OF CYLINDER

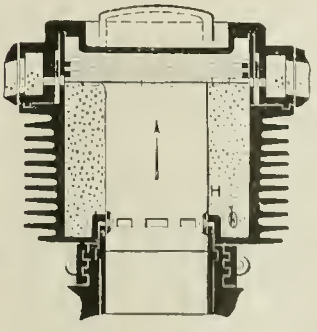


FIG. 7. PISTON AT EXHAUST AND RELEASE

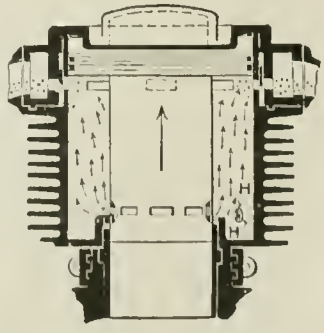
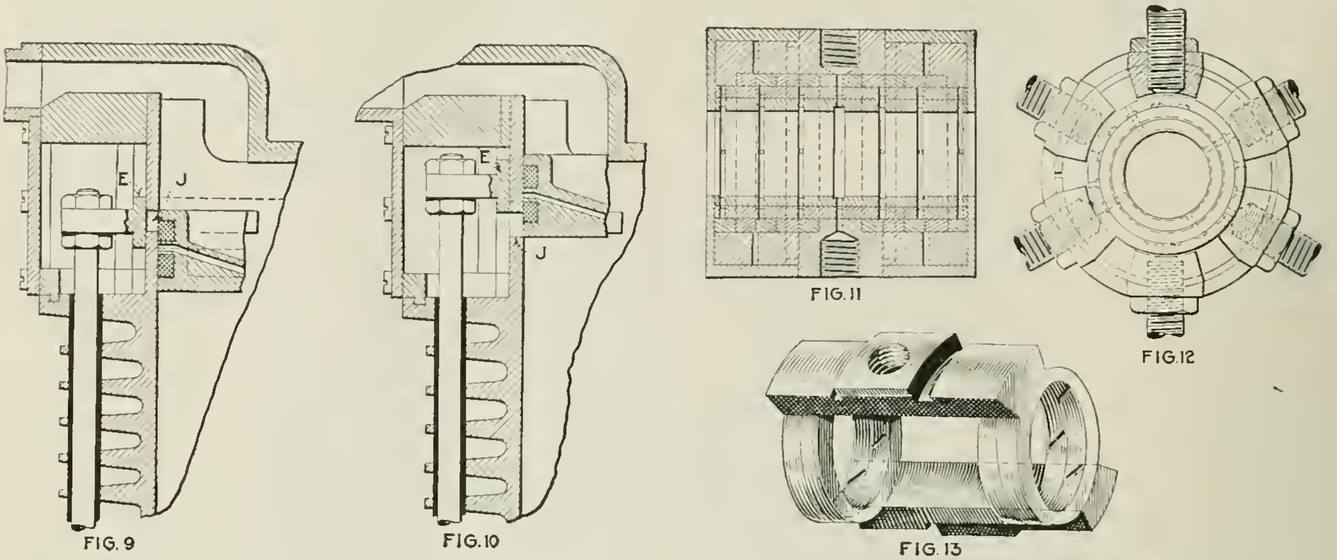


FIG. 8. INTAKE PORTS OPEN

The engine is started by turning the switch of the magneto and pressing the button of the self-starter. When the engine is stopped by turning off the switch all the cylinders are charged with fresh fuel from the inner chamber and are ready for the next operation. The engine can be started with a coil and battery if desired. It is made reversible by simply adding a sleeve to reverse the inlet and transfer ports. The engine is practically fool proof for the reason that there are no adjustments to be made.



FIGS. 9 TO 13. SECTION OF CYLINDER, PISTON, SLEEVE VALVE AND SELF-ALIGNING BEARING

Fig. 9—Piston just closing exhaust ports. Fig. 10—Exhaust ports uncovered by sleeve ring. Fig. 11—Section through self-aligning bearing. Fig. 12—End view of bearing. Fig. 13—Two of the self-aligning bars

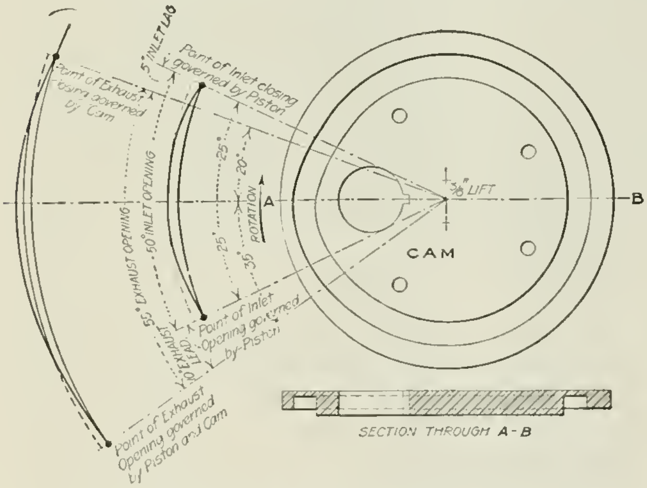


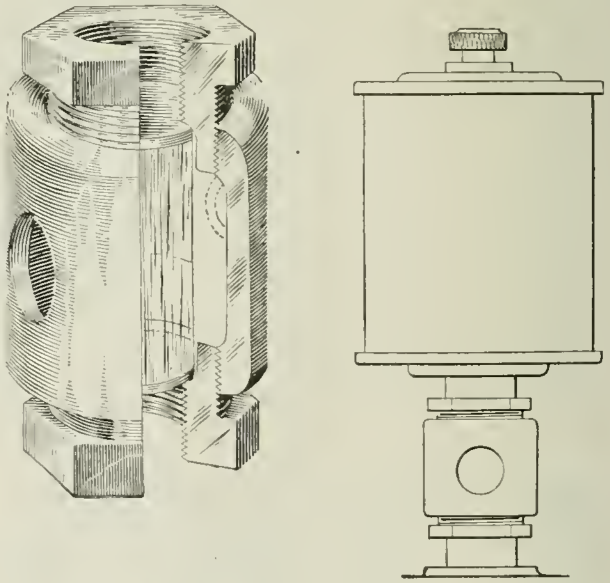
FIG. 14. DIAGRAM OF INLET AND EXHAUST CYCLE, ALSO A SECTION OF THE BOX CAM

Sight Feed for Oil Cups

By F. W. Bentley, Jr.

The lower, or sight-feed, portion of heavy oil cups is frequently broken, due to lightness in the constructtion of the average frame holding the glass—heavy enough, of course, to support the lubricator under ordinary circumstances, yet too easily broken in case of accident. The lower end of the oil cup or lubricator can in most cases be retapped and fitted again to give service, but the sight-feed glass retainer or receptacle is a hard thing to repair and it is difficult to get something to work as a substitute.

The illustration shows how a sight-feed arrangement can be made out of two pipe-reducing bushings, a coupling and a piece of tubular glass. Most reducing bushings have an unthreaded recess on the inside, the threads not extending entirely through, which affords an excellent shoulder for retaining the glass at both ends. A hole is drilled through the coupling of approximately the same size as the outside diameter of the glass. The two bushings can be screwed firmly down into the coupling and the distance measured, which will give the necessary length for the glass. The glass can be set with cement or putty.



OIL-CUP SIGHT FEED MADE OF PIPE FITTINGS

Where a new fitting cannot be secured or a cup having no sight feed is used, this little kink can be resorted to and will afford a strong and easily constructed sight feed. The one shown is of a ¾-in. coupling for ½-in. connections, a short piece of ¾-in lubricator glass being set in place with cement.

Operation and Maintenance of Elevators—Care and Lubrication

BY R. H. WHITEHEAD

Attention is called to the fact that elevator machinery, like any other equipment, must be given proper care. Certain important features in the maintenance, care and lubrication of modern drum-type elevator machines are pointed out.

EVERY operating engineer knows the necessity of careful maintenance of machinery to avoid trouble and get the proper results. The writer finds that elevator machinery is very likely to be neglected. Sometimes this is because the elevator is cared for only when there is nothing else to do and this happens at infrequent intervals, and in other cases it is due to lack of familiarity with the equipment. The only proper way to maintain an elevator is to make thorough inspections of the various parts of the installation at regular intervals. Several elevator manufacturers furnish just such service on what is termed a "Maintenance Contract." In the following, attention is called to certain features in the maintenance and care of the drum type of elevators.

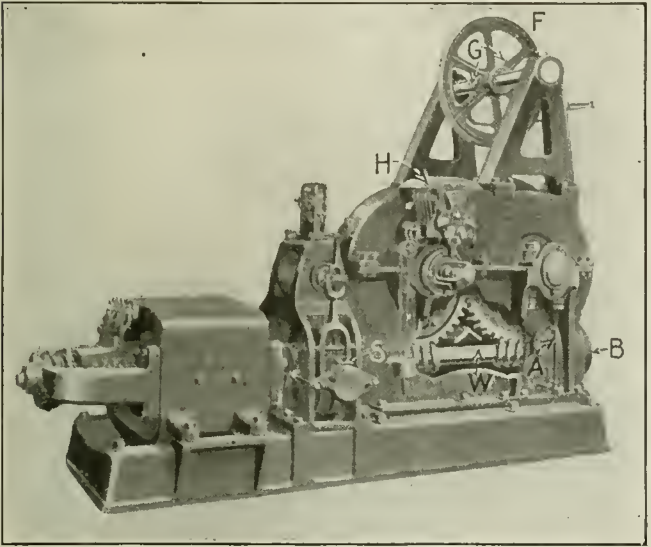


FIG. 1. DOUBLE-GEARED ELEVATOR MACHINE

1. Open the main-line switch and take care that no one closes it, so as to prevent accidents when preparing to clean, oil or repair any part of the machinery. Keep all parts of the machine and controlling device, motor room and pit clean; a pair of hand-bellows should be used to blow the dust from the motor, controller and other parts of the apparatus that cannot be conveniently reached. Where possible, the parts should be wiped clean, and cement and brick dust not allowed to get on the machinery and into the lubricants.

2. Self-oiling motor bearings have rings, which should always turn freely, and the oil chambers must be kept sufficiently full of motor-bearing oil to insure the oil rings dipping into it. Attention should be given the rings while the machine is running to see that they carry the lubricant from the oil well to the top of the shaft.

3. Use only worm-gear lubricant for the worm and gear and keep the gear case filled to a point just above the top of the wormshaft *W*, Fig. 1; the standpipe *A* on the side of the gear case should be used to determine the height of the oil. To remove sediment and grit, drain the oil from the gear case three or four times a year and refill with fresh lubricant. If the oil gets below the wormshaft level, the bearings will seize and expensive repairs will be necessitated. Do not use dirty or poor lubricant, as the worm and wormwheel will wear quickly, and for that reason it is poor economy.

4. The wormshaft bearings *B* and *B*, Figs. 1 and 2, are automatically oiled from the gear case, and oil should be allowed to drip slowly through the wormshaft gland *C*, Fig. 2, to insure perfect lubrication of the inboard bearing. Use a pan to catch the oil, but do not use the oil again without straining and then only once.

5. The wormshaft stuffing-box *D*, Fig. 2, must be kept packed with square-braided flax packing. The gland-adjusting nuts *E* must be tightened evenly to prevent binding of the wormshaft, but not tight enough to prevent the drip of oil.

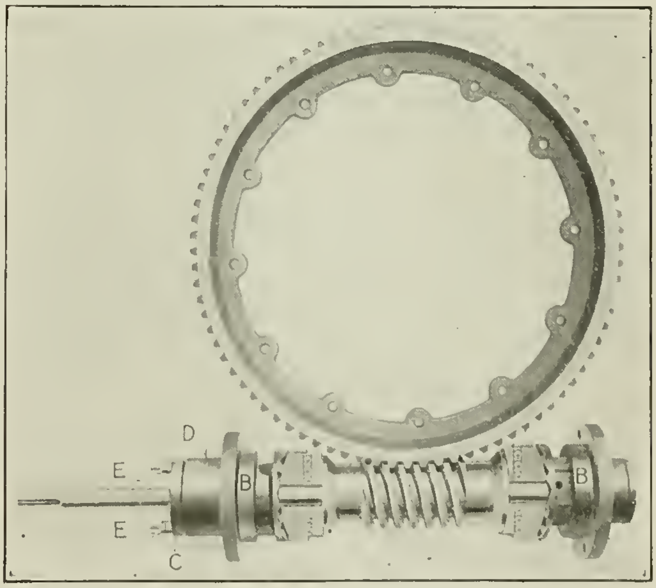


FIG. 2. SINGLE WORM AND GEAR SHOWING BALL THRUST BEARING

6. Drumshaft bearings should be lubricated every day or be provided with automatic grease cups or lubricators.

7. All parts of the governor must be kept well lubricated so that they work freely and easily, and this includes the tension sheave in the pit.

8. Vibrator sheaves *F*, Fig. 1, should be lubricated by means of grease cups *G* filled with compression-cup grease and sufficiently compressed to properly feed the lubricant. If automatic grease cups are used, be sure

that the cups feed. Remove the entire cup occasionally and see that grease feeds slowly through its nipple.

9. Overhead-sheave bearing boxes should always be packed with compression-cup grease. The grease must be pushed against the shaft once or twice a week, as sufficient heat is not generated in the bearings to cause the grease to run as in the case of continuously operated machinery.

10. Ropes should occasionally be coated with elevator-rope compound to preserve them and prevent rusting. This may conveniently be applied with a brush.

11. Safety devices on the car frame and safety plank under the car should be examined at frequent intervals and all working parts kept clean, well lubricated and free from rust.

12. On the guides use guide lubricant and occasionally clean down the guides with kerosene to remove grit. If lubricators are used, see that they are kept clean and filled.

13. Adjust the brake springs *S*, Fig. 1, to properly hold the car under maximum load and to give a smooth stop. Set the brake shoes so that they just clear the brake drum when released. If a piece of thin paper can be passed between the shoes and brake drum, the clearance is sufficient. In case the clearance of the brake shoes is too great, they should be reset to give the proper lift. The brake drum and brake shoes must be kept dry and clean. Under no circumstances allow oil on the brake drum or brake-shoe lining. In the case of an alternating-current machine the brake-magnet case must be kept well filled with brake-magnet oil. When necessary to remove the brake shoes for cleaning or repairs, the empty car should be left at the top landing with the counterweights securely blocked up in the pit. Oil the brake-lever pins frequently where oil holes are provided.

14. On direct-current machines, to prevent sparking at the commutator, when adjusting or renewing the brushes, fit them to a full bearing with a strip of fine sandpaper—never use emery cloth. This may be done by placing the paper between the commutator and the brush (sand side against the carbons) and drawing it back and forth by hand, at the same time keeping the smooth side against the surface of the commutator. The carbons must always project beyond the holder so that the latter will not bear on the commutator. Brushes should be staggered to distribute wear evenly on the commutator. In case the commutator becomes rough, it may be made smooth by holding a piece of fine sandpaper—never emery cloth—against the surface while the machine is running, after which it should be wiped clean. A canvas pad—never use waste—should always be used for cleaning the commutator. Sandpapering the commutator should be avoided as much as possible. Polishing when new with canvas, after being sure that the brushes do not spark and are bearing properly on the commutator, brings about the burnished finish which renders the commutator less liable to damage.

It is most essential to keep the commutator free from dirt and oils. This applies to the head of the commutator and the mica insulating ring at the base of the bars, as well as to the surface of a commutator.

On alternating-current machines keep the collector rings on the motor clean and free from dirt and oil and see that all brushes have a good even bearing on rings.

15. The contacts of the slack-rope switch and of the hatchway-limit switches should be frequently cleaned.

16. The car should be frequently tried on the atuomatic stop to see if it is properly adjusted, as the automatic is thrown out of adjustment through the stretching of the ropes. Frequently remove the cover *H*, Fig. 1, of the automatic switch on the machine and clean the contacts thoroughly and oil its mechanism.

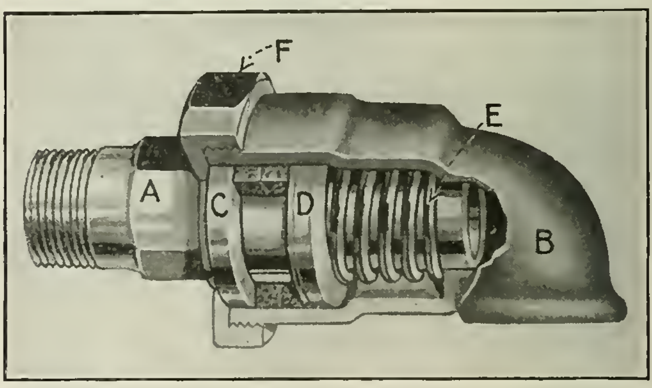
17. The ropes should be shortened as may become necessary and never allowed to lengthen to such an extent that the car will not open the hoistway-limit switch at the top of the hoistway before the counterweights bottom in the pit.

18. Controller parts should be kept clean and well lubricated so that they work freely. Keep the metal and carbon contacts on the controller clean and free from pits and blisters. They should be frequently dressed with sandpaper and have a good even bearing when in contact.

Although the foregoing was written as applying to Otis Elevator Co.'s machines, nevertheless the major portion of it applies to elevator machinery in general.

Tuxeda Swing Joint

Swing joints are made in various types, but to be really serviceable it is necessary that they be leakproof. A swing joint with this quality appears to have been found in the Tuxeda, manufactured by Franklin Williams, 39 Cortlandt St., New York City. The joint is made with a male and a female member, *A* and *B*.



SEMI-INTERIOR VIEW OF TUXEDA SWING JOINT

The male member has a collar *C* against which the packing is forced by the pressure exerted upon the loose collar *D* by the compressed spring *E*, as shown in the illustration. The joint is held together by a shoulder nut *F*, which screws on the outside of the *B* member. The spring *E* automatically compensates for wear of the packing and keeps the joint tight. When worn out, the packing is easily removed and replaced. This joint is made in standard sizes from $\frac{1}{8}$ to 3 in., but larger sizes are available.

Water Commissioner George C. Andrews of Buffalo, N. Y., reports that during the month of April, water pumpage was reduced millions of gallons with a saving of 415 tons of coal, worth $1850. Pitometer experts have been at work searching for underground leaks which do not show on the surface of the streets. Several large leaks have been located and repaired.

Pipe-Line Transportation of Coal

Some of the chief features of a proposed plan for increasing the transportation facilities of the United States, preventing fuel famines, and saving a billion dollars a year.

THE pressing necessity for an ample supply of coal to meet the greatly augmented demands of the war industries and at the same time provide for all normal requirements in the matter of heating, lighting and power has focused an extraordinary amount of attention on the present-day methods of distributing and utilizing fuel. As a result, numerous schemes have been suggested with a view to eliminating wasted effort and thus ameliorating the difficulties that at present confront the coal consumer.

One of the most ambitious of these plans is that proposed by Farley G. Clark, of Niagara Falls, N. Y. Although it relates specifically to bituminous coal, its application would save both hard and soft coal and would relieve the railroad situation, at the same time producing a stupendous saving of money. The plan contemplates:

1. The preparation of bituminous coal at the mines by pulverizing and the removal of a large part of the impurities by washing.
2. The transportation of the prepared coal mixed with water through pipes laid along railroad lines.
3. The storage of such coal in quantity, properly protected against deterioration, near the centers where it is to be used.
4. The utilization of pulverized coal in locomotives, for steam generation and for general use.
5. The manufacture of byproduct coke and gas at or near large metropolitan districts, the coke to be used in metallurgical processes and mixed with pulverized coal and tar as briquets to replace anthracite, and the gas to replace soft coal, water gas and anthracite.

USE OF WATER TO FLUSH COAL THROUGH PIPES

The chief feature of this scheme is the pumping of the prepared coal through pipe lines from the mines to centers of distribution. Water is used as the vehicle for carrying the coal, because it is cheap and abundant. The coal as it comes from the mine is sent through crushers, in which it is reduced to ¾-in. lumps, and then passes by gravity to the pulverizers, in which it is reduced to such a fineness that all of it will pass through 100-mesh and 50 per cent. through 200-mesh.

Magnetic and gravity separators remove impurities and the coal is then run into jiggers, in which it is thoroughly agitated with water, resulting in the dissolving of most of the sulphur and some of the other impurities. Centrifugal separators then remove most of the water, and the fairly dry coal is washed and delivered to wet grinders, from which it issues as a slime. The slime passes over concentrating tables, where it is divided into two grades, one to be sent to the boiler room for immediate use and the other to be sent to the pipe-line pumps.

The slime to be pumped is mixed with fresh water in agitating tanks, from which it is drawn by centrifugal pumps and forced through the pipe lines. The mixture in the pipes consists of from 30 to 40 per cent. of water and from 57 to 67 per cent. of coal, the remainder being ash and other foreign matter. The entire cost of this preparation will not increase the cost of the coal more than $1 a ton in extreme cases, and in some cases only about 25c. a ton.

The pipe lines are run along the rights-of-way of the railroads and are placed underground wherever possible. The main lines are supplied by branch feeders from the producing centers and branch distributors lead off to the distribution centers. A network of such pipe lines, with suitable storage reservoirs, coke ovens and briquetting plants would handle 70 per cent. of all the bituminous coal mined.

PUMPING STATIONS AND STORAGE RESERVOIRS

Pumping stations at intervals of 12 miles or more would need to be provided on the main pipe lines, and at each station an emergency reservoir would have to be supplied to allow the pipe line to be drained to prevent freezing or to make repairs. At the distribution plants it would be necessary to have large storage reservoirs, one for each grade of coal pumped. These accumulations would tide over any reasonable emergency that might arise and would enable a demand for a certain grade to be met immediately.

At or near the distributing plants the byproduct coke ovens or coal-gas plants would be erected. These would convert the coal sludge into coke and gas and recover the usual byproducts. The gas would be piped through mains to supply the district. The coke would be shipped to foundries and furnaces, while the breeze could be mixed with pulverized coal and briquetted.

It is estimated that the cost of pumping the coal would be comparatively low. A pipe line 20 in. in diameter would handle 25,000 tons per day at a cost of 50c. per 1000 ton-miles of actual coal transported, this figure including operation, maintenance and 10 per cent. interest on investment. The present rate for transporting coal by car is more than $4 per 1000 ton-miles.

Mr. Clark's plan does not contemplate the immediate changing over of all boiler plants so as to use dry pulverized coal. That is considered as a possibility to be reached eventually. For the present the pipe-line coal would be used in boiler furnaces as they exist or as they could readily be adjusted without seriously disturbing industries. The coal would be deprived of moisture to 10 per cent. or less by centrifugal driers and spread over the grate by suitable devices; or, it may be burned by the existing types of underfeed and chain-grate stokers. The moisture remaining in the coal will hold the fine particles together until the volatile matter is driven off and the coke remains. As there is very little ash or impurity in the fine coal, the tendency to clinker will be practically eliminated. The ash in pipe-line coal would never exceed 3 per cent. and the average would be much lower.

The railroads distribute over 80 per cent. of all coal and this constitutes 35 per cent. of the total freight handled. The pipe-line distribution of coal would reduce the freight congestion on the railroads by relieving them of at least one-fourth of their present burden, thus enabling the equipment to be used for other commodities.

The greater part of the domestic coal consumed is anthracite. Under the pipe-line system, heating and cooking would be carried on largely by the use of gas from coke ovens and gas plants burning pulverized coal, supplemented by the use of briquets and anthracite, with a resultant enormous saving.

The estimated saving in tons of coal in various lines is given in Table I, and the value of the saving is given in Table II.

TABLE I. ESTIMATE OF COAL SAVING

	Used in 1917 Millions of Tons			Possible Saving Millions of Tons		
	Bit.	Antb.	Total	Bit.	Anth.	Total
Railroad	180	5	185	100	3	103
Steam	195	20	215	20	15	35
Coke	75		75	—45		—45
Domestic	25	45	70	20	35	55
Export	25	5	30	5		5
Bunker	20		20			
Miscellaneous	20	5	25	5		5
Totals	540	80	620	105	53	158
Per cent. saved				17.4	66.2	25.4

TABLE II. VALUE OF COAL SAVING

Bituminous railroad coal, 100 million tons at $4	$400,000,000
Bituminous general-use coal, 5 million tons at $6	30,000,000
Anthracite railroad coal, 3 million tons at $3⅓	10,000,000
Anthracite general-use coal, 50 million tons at $8	400,000,000
Total	$840,000,000
Substituting $6 coal for oil at $4 per bbl., saving $2 per bbl., on 20 million bbl	40,000,000
Substituting byproduct for coal and water gas, saving 25c. per 1,000 cu.ft. on 800 billion cu.ft.	200,000,000
Total value of saving per year	$1,080,000,000

This saving of over a billion dollars a year is necessarily only an estimate, but it is based on conditions with regard to which reasonable predictions can be made. Moreover, it does not take into account the relief to the railroads and to industry in general, while the value of storage at the points of consumption cannot be reduced to dollars.

In developing his idea, Mr. Clark has counted on objections from various quarters. For example, mine workers and owners may find fault with some provisions of the scheme, particularly those that relate to the recovery of a greater percentage of the coal from the earth, even at the risk of including more dirt, since the subsequent washing and grinding removes the impurities.

OBJECTIONS FROM RAILROADS AND OTHERS

The railroads may be expected to object to a change that would remove a large part of their freight business; but with the increased demand for transportation of other materials than coal, it would seem as though the net result would be to the advantage rather than the disadvantage of the railroads.

The coke industry might interpose some objections, because the Clark plan contemplates the use of byproduct ovens only, and the obliteration of the beehive type. Some engineering objections might be raised in connection with the utilization of pipe-line coal, but it is believed that there are no obstacles of an engineering character that cannot be overcome.

Of course, the complete adoption of a plan of this magnitude would cause considerable change in the methods of utilizing coal, and expense would be incurred; but for the sake of so great a saving, it would be proper to go to considerable initial outlay. The fuel problem must be settled sooner or later, for it grows more acute each year, and such plans as the one proposed by Mr. Clark indicate a healthy interest in the solution of this important matter.

Superheat in Forced-Draft Stoker Installations

By H. R. Greene

In designing boiler plants, as in the case of all engineering installations, there must be taken into consideration by the engineer, the relation between the first cost of the various apparatus and their performances. Coal is much more expensive than formerly and, unquestionably, in this country within a short period of time we shall be compelled to select all the component apparatus with a view to the highest efficiency in the production of power in the complete installation. This being the case, it is axiomatic that the economical performance of various apparatus is, except in extreme cases of excessive cost and where certain predetermined performances must result regardless of economical operation, the determining factor in the decision as to selection.

In the competitive-sales problem of multiple-retort stokers, the economical operation of the necessary auxiliaries is of the greatest importance in determining the advisability of selection in comparison with natural-draft stokers. This is necessary to justify the high first cost of the former and also the excessive additional expense of the forced-draft equipment to supply air for predetermined results exclusive of the higher combined efficiencies obtained and the net economical results of the boiler-stoker combination. In the large power stations where great fluctuations of load occur, the forced-draft system of air supply must always prevail, on account of the elasticity required, but in manufacturing plants operating under nonvariable loads, the sales problem becomes one of comparative efficiency, all things being taken into consideration.

Here is where superheating is of value. We may compare the steam necessary for stoker driving as about equal between the forced- and natural-draft systems; but all the steam necessary for the forced-draft equipment must be charged against the efficiency of the stoker requiring it. Superheating is, of course, raising the heat of saturated steam above the temperature normal to its pressure. We then have a gaseous element, following the laws of perfect gases, and no moisture can exist while superheat remains; thus pipe and cylinder condensation losses are eliminated.

The problems of proper packing and lubrication in reciprocating engines have been largely solved, and with turbines lubrication is not necessary and packing complications have been satisfactorily overcome.

As we use both turbines and simple engines for fan prime movers and the latter for stoker driving also, it is interesting to note that the saving in the former at 100 deg. F. superheat would reach approximately 8 to 10 per cent. and in the latter over 12 per cent. The importance of such savings in water rates can readily be realized in computing comparative net efficiencies with natural-draft stokers in competition.

Useful Kinks for Engineers

By Frank R. Williams

The so-called self-marking paper for indicator diagrams and other uses is a plain chemically coated paper that is easily marked by the touch of a plain brass or aluminum point. It is much used for taking indicator diagrams instead of the common paper card and lead pencil, which are often troublesome and unsatisfactory. The paper can be bought in large sheets or it may be prepared easily and cheaply at home as wanted, by taking ordinary zinc white, which can be bought at any drug store or paint shop, and mixing with common thin mucilage into a thin paint and lightly coating the paper with it. When dry it may be used as ordinary indicator-card paper, using a brass or aluminum point instead of a lead pencil.

It is often desirable to make holes in glass, but few persons know how to do this. It may be done easily and conveniently without special appliances in the following manner: For small holes take an ordinary three-cornered file, such as is used for sharpening saws, and grind all flat sides to a three-cornered sharp point. Then put some spirits of turpentine on the glass and rotate the drill with a moderate pressure. One will be surprised at the slow but satisfactory progress that will be made through the glass. The cutting edge of the drill should be kept wet with turpentine while cutting. The old receipt says add camphor dissolved in spirits of turpentine; but I find that the drill works well without the camphor.

To make large holes, take a copper tube the size desired and rotate it upon the glass with moderate pressure, and keep it wet with fine emery and oil. It is best to cut from both sides, meeting in the center, but one should be careful to keep the drills rotating freely and easily, as any pinch or jam may break the glass. Finish the hole with a half-round file wet with spirits of turpentine.

An ordinary twist drill can be used to drill glass, but it must be ground with considerable clearance, both on the cutting edge and on the circumference, as the least pinch will break the glass. Keep the drill wet with spirits of turpentine.

Engineers do more or less soldering, and a strong solder can be had by using pure tin. It will be about twice as strong as common tin and lead solder and never turns black or disintegrates. I have used it exclusively, where greater strength is required than is obtained with ordinary solder and where brazing or silver solder would not do because of the high temperature.

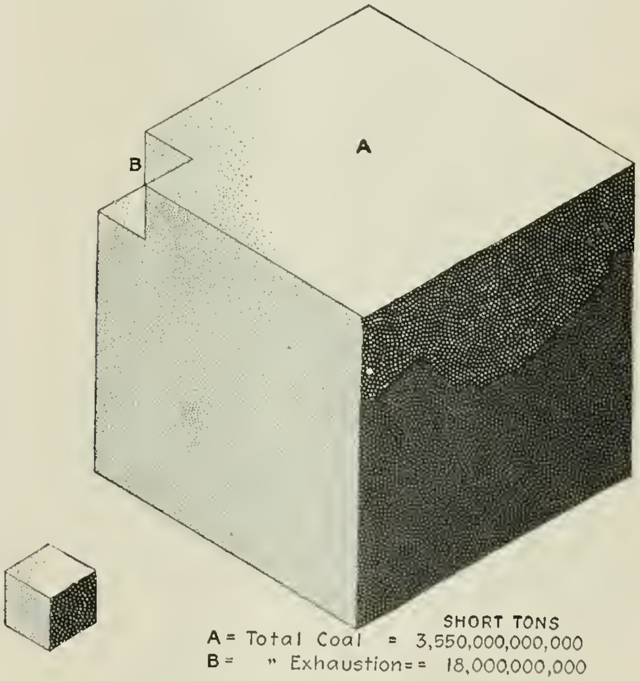
A safe liquid flux for electrical soldering is made by dissolving rosin in alcohol. A similar paste flux is made by taking chloride of zinc, which can be bought at any drug store, and rubbing it into a thick paste with common vaseline or petrolatum.

Worn or warped rubber valves may be refaced and made to do additional duty by tacking a sheet of sandpaper on a smooth board and, with the hands holding the valve flat and steady on the sandpaper with gentle pressure, rubbing the valve back and forth. This will gradually cut down the rubber so as to make a true face.

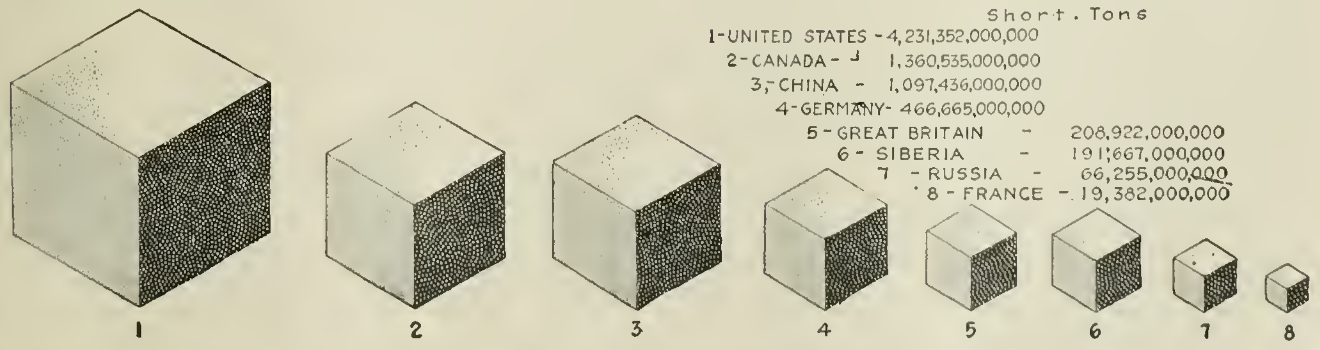
To remove broken taps or drills, wet for a few hours with ordinary muriatic acid which will slightly dissolve the steel and make the broken tool smaller, thus making it more easily removable.

The Coal Supply

The illustrations below are from a paper by R. H. Fernald before the Engineers' Club of Philadelphia. With their aid one is able to visualize the coal supply of the world and to get a good conception of the coal available in the United States compared with what has been used up to date.



TOTAL AVAILABLE COAL IN UNITED STATES AND EXHAUSTION TO CLOSE OF 1917



COAL RESERVES OF THE WORLD AND THEIR DISTRIBUTION

Plastic Refractory Boiler Baffles

The principal loss of heat from a boiler furnace is in the flue gases, and is measured by the product of their weight, specific heat and excess of temperature over atmospheric. High temperature of gases may be due to their coming in contact with too little heating surface, to coatings of soot or scale on the heating surface which prevent the absorption of heat from the gases, but most commonly it is caused by defects in the baffling.

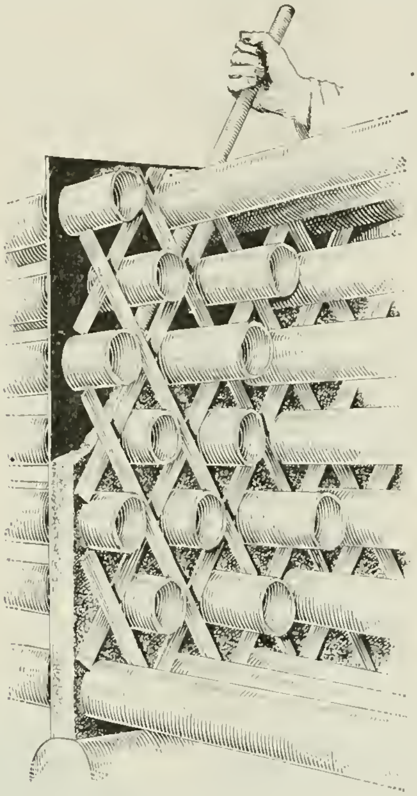


FIG. 1. PLACING THE MATERIAL BACK OF CRISSCROSS SLATS

Baffles may be improperly located, producing dead spaces where the gases do not circulate in the tube banks of water-tube boilers, or the baffling may not provide for a sufficiently high velocity and long path of the gases of combustion.

Defective baffling is the most common cause of high chimney temperatures. The baffles may have fallen down, or bricks or blocks may have slipped out from between the boiler tubes, allowing the short-circuiting of a large amount of gas.

Baffles for water-tube boilers have in the past consisted of tile, bricks or blocks of refractory material fitted in between the tubes. In cross-baffled boilers these tiles are introduced between the tubes by springing the latter, and naturally do not always form tight joints with one another or with the tubes, especially after the latter have warped or sprung, as they invariably do in service. It is also difficult to insure that blocks will remain where they are placed and will not slip or fall, leaving large openings. Owing to the manner in which baffles are inserted in boilers, it is almost impossible to cement them together; moreover, the difference in expansion and contraction of the boiler and baffling would break the joints apart.

The illustrations show how jointless, gas-tight baffles can be made by the use of a refractory known as plastic firebrick and manufactured by the Betson Plastic Fire Brick Co., of Rome, N. Y. This material is compounded of refractory substances so prepared as to practically eliminate expansion and contraction with changes in temperature.

In forming a cross-baffle for a water-tube boiler of the B. & W. type, the ordinary cast-iron baffle plate is used as one side of the mold, while the other is made by thrusting slats in through the diagonals between the tubes, as shown in Fig. 1. The plastic material is then poked down through the diagonals to fill the space between the cast-iron baffle plate and these slats. It is sufficiently plastic so that it can be forced out sidewise around the tubes, fitting the latter snugly.

When this work has been completed, the boiler is fired up slowly, the crisscross of slats burns out, and the plastic material is dried and vitrified in place. This operation occupies only a few hours, after which the full load may be put upon the boiler. Inasmuch as the boiler comes up to full steam pressure before the material is thoroughly set, the expansion of the metal pushes away the soft material to the position it should occupy when the boiler is hot, and while the boiler will draw away from the material in cooling off again, the baffles will fit tightly when the boiler is under steam.

In forming a longitudinal baffle, Fig. 2, blocks of wood are placed in between the tubes, above and below the space which it is desired that the baffle shall occupy, thus confining the plastic material, which is shoved in from the side in the case of baffles in the middle of the tube bank or from underneath or overhead in the case of the baffles at the bottom or top of the tube bank.

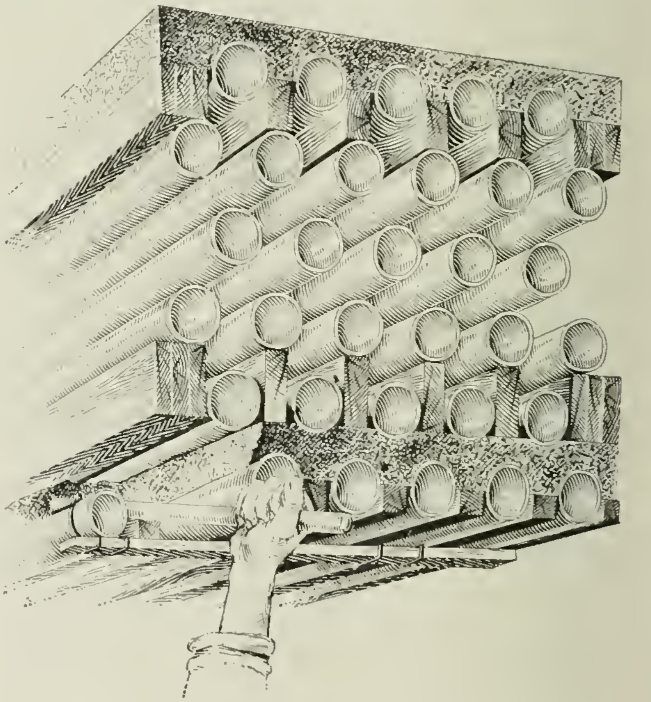


FIG. 2. HOW MATERIAL IS PLACED FOR HORIZONTAL BAFFLES

Where this material is used, there is no restriction upon the shape or size of the baffle, and the latter can therefore be arranged in any form desired. In cross-baffled boilers, for example, it is becoming the practice to slope or incline the baffles so that the gas passage will contract progressively from the point where the gases enter the tube to the point where they leave, in order to maintain a uniform gas velocity, in spite of the shrinkage of gas volume with cooling. This is easily accomplished with the plastic material.

This material also finds use as a substitute for special forms of bricks or blocks; as for example, where the front headers of horizontal water-tube boilers rest upon the front arch. It is used for lining furnace and combustion chambers, including front arch, side walls, bridge-wall, rear arch, etc.

Refinite Water Softener

When boiler-feed water contains a scale-forming element, two conditions must be met—the boiler shell and tubes will have to be cleaned of scale at intervals, according to the quantity of scale formed, and if the formation is to be prevented the water must be treated before it goes into the boiler.

Numerous systems of water-softening plants are employed for boiler-feed water, some being installations of considerable size, and are generally used with steam plants of medium and large capacity. A system designed for both small- and large-capacity power plants is manufactured by the Refinite Co., Omaha, Neb., and is known as the Refinite water softener.

The illustration shows a 60-in. water-softener system, consisting of a closed tank in which the softening mineral bed of filter gravel is placed. Raw water enters the softener tank through the pipes *A* and *B* and, striking a baffle plate, is sprayed over the mineral softening bed. The treated water leaves the softener through the pipe and meter *C* after it has passed through the Refinite mineral bed.

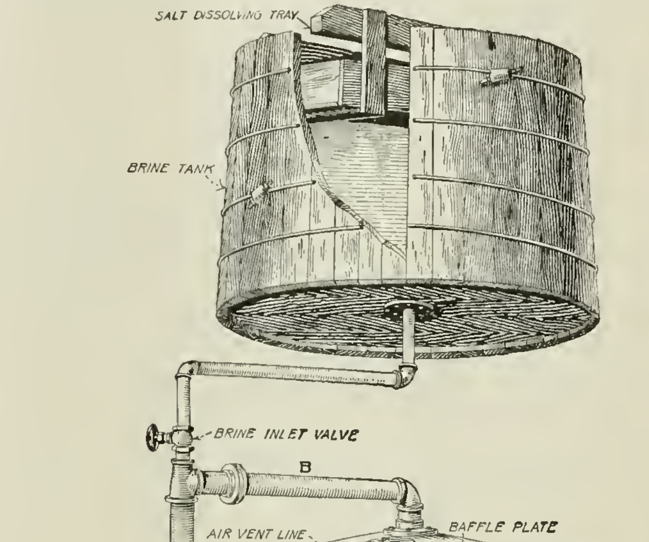
The operation of the system depends upon this mineral bed, which is composed of a clay product having zeolite properties. It is put out in a form suitable for the commercial use of softening water, and the mineral is furnished with the apparatus, which, as shown, is constructed much the same as the ordinary pressure filter. The mechanical operation of softening water is one of simple filtration, or just passing the water through the mineral bed, the same as water is passed through a sand filter. After a time all the original sodium in the Refinite will have been given up in this exchange. When this occurs, the softening action ceases, but it is not necessary to replace the mineral or to remove it from the softener container.

By a reverse action, called regeneration, in which ordinary salt is the reagent, the softening action of the Refinite may be restored. Common salt, sodium chloride, is dissolved in water in a tank, and the brine run into the softener and allowed to stand therein for a few hours, after which the softener is ready for the next run.

Hardening salts in water vary considerably, and can be actually determined and weighed. A pound of Refinite mineral has the ability to take up a certain amount of these hardening salts by actual weight. Therefore, the capacity of one pound of the mineral in gallons would depend on the weight of the hardening salts in the total quantity of water handled.

One pound of Refinite mineral has the ability to take up 54 grains of hardness. If the water contains 18 grains per gallon, one pound of Refinite mineral will handle three gallons, and the time required for the action is ten hours. From three-fourths of a pound to one pound of salt is required to eliminate each grain of hardness in a thousand gallons of water by the Refinite process. If the water contains 18 grains of hardness, for instance, 18 lb. of salt would be required to treat 1000 gal. The average cost of the salt used is about a half-cent per pound.

Thus the capacity of any sized softener in which a stipulated amount of mineral is used, depends on the hardness of the water treated. If the water is 18 grains hard, a certain number of gallons can be handled. If the water is only 9 grains hard, twice the amount can be handled, and the capacity in any case is inversely proportional to the hardness in the water.



SEMISECTIONAL VIEW OF THE REFINITE WATER SOFTENER

It is necessary, therefore, to regenerate after each capacity of softening has been run. If the machine is designed to handle 10,000 gal. in 10 hours, it is regenerated after each 10-hour run, and the time required for regeneration is usually from 8 to 10 hours. The operation takes place at night while the softener is not in operation.

Questionnaire Which Owners of Power Plants Will

Questionnaire for Power Plants. General Information To Be Supplied by the Owners. Not to Be Used for the Rating of Plant

Date of Report..............

Name of company, concern or owner................

Address of Central Office..........................

Name and location of plant inspected................

Character of product or service.......................

STATIONARY BOILERS

WATER-TUBE BOILERS

		Kind of Draft			How Fired			
Number	Hp.	Nat'l	Forced	Induced	Stoker	Hand	Total Hp.	Remarks

FIRE-TUBE BOILERS

		Kind of Draft			How Fired			
Number	Hp.	Nat'l	Forced	Induced	Stoker	Hand	Total Hp.	Remarks

MOVABLE BOILERS*

Number	Hp	Type	Remarks

Kind of coal	....	Bituminous	Semibituminous	Anthracite
Size.......	....	..	.. ..	....

Tons of coal of 2000 lb. used during twelve months ending May 1, 1918...................

Months of operation of plant during the same year......... .....

Approximately what percentage of live steam is used for:

	Winter Per Cent.	Summer Per Cent.
(*a*) Making power ...		
(*b*) Heating building		
(*c*) Process work..		

Is purchased electric power used? ....

If so, how many kilowatt-hours consumed during twelve months ending May 1, 1918? ....

RECORDS

Are records kept to show any of the following information? Answer "Yes" or "No" in table.

	By Shift	Daily	Weekly	Monthly
Water evaporated by boilers..				
Coal consumed by boilers........				
Flue-gas analysis ...				
Electrical output or consumption kw.-hr				

ENGINE EQUIPMENT

STEAM UNITS—ENGINES, TURBINES, PUMPS

			Rating				
Type	No.	Initial Pressure	Hp.	Kw. or Gal. Per Min.	Condensing	Noncondensing	Type of Valve Gear
Simple.......							
Compound ..							
Turbine							
Steam Pumps							

What changes have you in progress which are expected to reduce your fuel consumption?

....

When will they be in effect?

....

Further remarks by owner:

....

Note to Owner: If sufficient space is not available in the questionnaire, please attach an extra sheet with the additional information.

RECOMMENDATIONS BY THE FUEL ADMINISTRATION

That provision be made for weighing and recording of the fuel used each shift or day.

That feed water be heated and measured.

That provision be made for an adequate supply of air to the fuel and convenient means provided for the measurement and control of the draft.

That provision be made to keep boiler surfaces clean inside and out.

That the grates be in good repair, that settings, breeching and access doors be free from air leakage, and that boiler surfaces wasting heat be covered with insulation.

That the surfaces of steam piping, drums and feed-water heaters which waste heat or steam by radiation be properly covered with insulating material.

That exhaust steam be utilized wherever possible, to the exclusion of direct steam from the boilers. The plant should be so designed that no more exhaust steam will be produced than can be efficiently utilized in heating or process work.

That a competent man in the plant be detailed for the work of fuel conservation in the boiler and engine rooms.

That a competent man or committee be detailed for the work of fuel conservation in the building or shop outside of the power plant.

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* In the rating of the plant movable boilers will be considered separately. The questionnaire does not call for information regarding movable boilers except as per above table. The influence of movable boilers on the rating of the plant will be left to the judgment of the Administrative Engineer.

Be Asked by the Fuel Administration to Fill Out

Outline of Standard Questionnaire Covering Operation of Steam-Power Plants. Questions to Be Marked to Form Basis of Rating of Plant

(a) FUEL: Value of question, 9. Mark rec'd......

Question 1. What provision is made for weighing fuel used each shift or day?

Question 2. What records are made of fuel used each shift or day?

Question 3. What grate surface is in use each shift, exclusive of banked fires?

Question 4. Total coal used each shift exclusive of banked fires?

(b) WATER: Value of question, 15. Mark rec'd.....

Question 1. What provision is made for heating and continuous measuring of feed water (check answer in table below)?

Heating	Means Used for Measuring
Open feed-water heater...........	....
Closed feed-water heater	....
Exhaust steam	....
Direct steam	....
Waste heat economizer...........	....

(c) AIR SUPPLY: Value of question, 12. Mark received ....

Question 1. Are means provided for measuring the draft over the fire?

Question 2. Are means provided for determining the excess air by flue-gas analysis?

Question 3. Are dampers provided for equalizing the draft in the furnaces?

Question 4. Is there a convenient means for regulating the draft by main or uptake damper?

Question 5. Is there an automatic damper regulator in working order?

(d) CLEAN HEATING SURFACES: Value of question, 12. Mark received ....

Question 1. What provision is made for keeping soot and ashes from boiler-heating surfaces (mark answer in table below)?

Steam lance for blowing soot by hand......
Mechanical soot blower ....
Brushes or scrapers.. ....

Question 2. How often are the soot and ash cleaned from the boiler-heating surface?

Question 3. What provision is made for keeping scale and sediment out of the boiler (check answer in table below)?

Chemical treatment of feed water in the boiler.... ....
Chemical treatment of feed water outside of boiler.... ....
Filtration of feed water in open feed-water heater .. ..
Filtration by means of feed-water pressure filter. ... .
Other means............. ....
Water is free from scale or sediment without treatment ....

Question 4. What means are used for removing scale from the boiler?

Hand .... Mechanical ....

(e) BOILER AND FURNACE SETTING: Value of question, 20. Mark received..............

Question 1. Are the grates warped, broken or otherwise defective?

Question 2. Check air leaks observed, as follows:

Leaks in boiler setting
Openings between boiler and setting ......
Badly warped fire-doors.. ....
Badly warped cleaning or access doors ......
Leaks around blowoff piping ....

(f) INSULATION: Value of question, 7. Mark received ....

Check any of the following items where saving could be made by covering surfaces with insulation:

Exposed drums of boilers ......
Exposed shells of boilers ......
Steam piping in boiler room ......
Steam piping in engine room ......
Feed-water heater ......
Exhaust-steam piping where fuel could be conserved by covering..
Feed lines ....

(g) ENGINE-ROOM AND HEATING SYSTEMS: Value of question, 15. Mark received..........

Question 1. Is exhaust steam used: Entirely...... partly......not used?......

Question 2. State service for which this steam is employed: Heating......Cooking..... Dry room......Tank heating......Low-pressure turbines...... Other purposes ....

Question 3. Is there an excess of exhaust over requirements?

	Day	Night
Winter	....	..
Summer....	......	....

Question 4. Is there any low-pressure live steam used in the plant?......At what pressure? ....lb. gage. For what purpose?...... Heating...... Cooking......Dry room ...... Tank heating...... Other purposes.......

(h) SUPERVISION: Value of question, 10. Mark received ....

Question 1. Has the owner detailed a competent employee to supervise the work of fuel conservation in the boiler and engine plants with directions to report weekly on measures for economy and progress in conservation of fuel? Name and title of this employee

....
....
....

Question 2. Has the owner appointed a man in charge of the work of fuel conservation outside of the boiler and engine rooms described under Recommendations? Name and title of this employee

....
....
....

Let's "Can" the Bellyache*

This country—your country, our country—is at war. Let's cut out the bellyache.

We are at war with a powerful, relentless foe—a foe lusting for dominion. We are at war to save our own "hide"—our own individual hides.

By "making the world safe for democracy," we are making it "a decent place to live in"—for you and yours and me and mine. We are at war to perpetuate those things that stand for *our own* daily happiness. Let's not forget that. We're in this thing in self-defense. So, let's "can" the bellyache.

There are a few people who think this war isn't worth while, and most of them are keeping their mouths discreetly shut. But there are a host of flyspeckers, calamity howlers, and woe-betiders that are barnacles on the Ship of State. At heart most of them are loyal, good American citizens, but their tongues are loose. If you think this war is worth while, then join a movement to stop the mouths of those sobbers. Let's "can" the bellyache.

Our sympathy goes out to the man whose business has been hit a hard wallop by this war. We are sorry for the man who can't get cars; can't borrow money; can't ship goods, or can't make 'em. We are sincerely sorry to see a man suffer, even when his suffering may be necessary to further the chief business in which we are all engaged—the business of winning the war.

Let's "can" the bellyache.

If our public servants are sometimes wrong; if they misjudge conditions, men, measures, then those who suffer unjustly—while the nation trains off its fat and girds itself for war—let those with a common grievance get together, do some constructive thinking and planning and show our public servants, not with sobs and whines, but constructively, how things should be done. Let's cut out the fault-finding. "Can" the bellyache.

There are four things worth having in mind all the time:

1. The seriousness of the war—the necessity that it be prosecuted as the chief activity of the nation, at the cost of individual needs and preferences.
2. The fallibility of all men and, therefore, all public servants; the unescapable fact that no man or body of men could run even a *little* war and please everybody—and this war is the biggest war the world has ever seen.
3. The fact that our Government recognizes the necessity that business proceed so that the difference between income and outgo shall be as great as possible on the credit side—so that there may be profits and savings out of which to pay for the war.
4. The fact that in times like these the individual is of small consequence; the private need or preference is swallowed up in the public necessity—to the end that private needs and preferences and individual freedom may *eventually* survive.

We give up individualism to the end that we shall ultimately retain it. We shall not dare to clutch at our private wants or they must be torn from us. We give them up so that we may gratify them tomorrow.

We grasp the hand of the man whose business goes to ballyhack—we are sorry. But this is war. It is inevitable that the activities of peace shall be disarranged. Let us all help by silence and reproach to "can" the bellyache.

Let's organize, as we must, to criticize constructively; do the best we can, but mostly let's drive the dam machine of war until our enemies have had enough. Let's "can" the bellyache; stop the footless chatter of the street, the cheap mouthings of the malcontents. *We* are not overrun by the Hun. *Our* country is not devastated. Its people are not outraged nor its homes made desolate. The only sobs our country has an ear for are the sobs of those whose *hearts* are torn, those who have seen the war come to *their* homes, to demand the supreme sacrifice.

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*An editorial written by Harvey Whipple and printed in "Concrete," Detroit, Mich., May, 1918.

Providing Ample Clearance Space

By M. A. Saller

A very important factor in the satisfactory operation of power-plant equipment, and one frequently overlooked by the designing engineer, is the matter of providing sufficient space around the equipment to permit the replacement of worn parts. Every operating engineer at some time has been confronted with the necessity of knocking a hole in the wall in order to remove the tubes from a boiler, or has had to move some auxiliary apparatus or piping in order to obtain sufficient clearance to remove and replace tubes in a condenser. Another common mistake is to so locate motors or engines that when occasion arises, for changing the pulley even, it is necessary to remove the machine from the foundation to secure the necessary clearance space.

PROVIDING SPACE TO MAKE REPAIRS

An easy way to minimize trouble from this source would be for the manufacturer to place on all standard drawings a notation as to the clearance space that should be provided about a machine or outline the space graphically on the drawing. Being thus noted, the point would receive attention by the designing engineer who would probably avoid the common error. This is done by a few manufacturers whose example could be followed to advantage by all.

Editorials

For the Duration of the War

ONE of the most striking things in a war replete with amazing happenings has been the remarkable adaptability displayed by the peoples of all nations. Under the pressure of great necessity and the urge of patriotic impulse they have voluntarily subjected themselves to conditions that before the war were undreamed.

In our own country, where the individual has been accorded freedom of action and opportunity such as no other nation can boast, we have imposed rules, regulations and restrictions that often savor of autocracy rather than democracy. But though in so doing we have shattered scores of precedents, our people have responded instantly and whole-heartedly to every change, convinced that no demand is too unreasonable to be met if it promotes the one great task of the present moment—the winning of the war.

In the name of efficiency and conservation we have turned over the railroads to the management of the Government, arbitrarily restricted the use of certain coals to certain prescribed localities, fixed the prices of fuel and food products, conferred upon the President the power to commandeer any public or private resource for the use of the nation in the conflict, set a guard armed with blue-pencils at the doors of the public press and in a hundred other ways limited and proscribed the operations of public and private enterprises.

Only the absolute need for coördinated effort and the wisest use of our resources could have brought about so radical a change in our methods of conducting affairs, and there are many who believe that when the pressure of necessity is removed, there will be a general reversion to pre-war conditions and modes of doing business.

Piffle and poppycock! Likewise fudge and fiddlesticks! The human race is not a crab. It does not progress backward. The war has thrown the spotlight, as nothing else could have done so effectively, on our criminal wastefulness and our unnecessary duplication of effort. We have realized that we have been working largely at cross-purposes, spending energy lavishly and to no good purpose. No reasonable person will deliberately return to a practice that he has found to be inefficient or contrary to the public welfare.

If the war has forced us to adopt plans that have resulted in better service at decreased cost, with smaller drains upon material and labor, there is going to be no retracing of steps when the war is over. Whatever has been found to be productive of the greatest good for the greatest number will be retained as a part of our system. Any individual or group of individuals who for selfish purposes would attempt to restore obsolete and slipshod methods must be regarded as an enemy of the public. If this war is accomplishing anything at all, it is teaching the gospel of teamwork and wiping out the heresy of self-interest.

Once they have proved their value and have been properly appreciated, economic policies will become a part of the habits of thought and action of the people. "For the duration of the war" is a refrain sung by selfish interests to revive their hopes and reinforce their courage. It is like the quavering whistle of the small boy who passes a cemetery at dead of night.

Celebrate Flag Day

IN 1775, two years before the Stars and Stripes came into use as our National Flag, George Washington wrote, "Please fix on some flag by which our vessels may know each other." Two years later, June 14, 1777, Congress met in Old Independence Hall in Philadelphia and adopted the following resolution:

> Resolved, that the flag of the thirteen United States be thirteen stripes, alternate red and white; that the union be thirteen stars, white in a blue field, representing a new constellation. The stars to be arranged in a circle.

Since that time the number of stars has been increased as the number of states has increased, until today there are 48. June 14 has come to be known as the Flag's Birthday, and it is this date that we celebrate as Flag Day.

We have thrown this country open to millions of emigrants from practically every nation of the world, to come and live within our borders, saying this is a land of freedom and equal opportunity, without teaching the meaning of these terms. For years we have gone along in our peace-loving, idealistic way without giving very serious consideration to what the Stars and Stripes really mean to us, what a precious thing this liberty is, which we have held up as symbolical of our national attitude. Too long have we been doing this, therefore is it no wonder that many whom we have invited to our shores have been inclined to take the duties of citizenship here lightly and in many cases have entirely neglected to assume these responsibilities.

Flag Day offers to every employer in this country the opportunity to bring home to his foreign-born employees what it means to be an American; how that the Stars and Stripes have greater significance to them than ever before, since for the first time in our history men of all nations who have adopted America as their country are fighting under the American Flag on the great battlefronts of France to make the world a safe place for freedom, right and equal opportunity, to enjoy which they came to our shores. There are thousands of foreign-born workers in our industries that have those near and dear to them in our military and naval forces, who would welcome the opportunity to join with the American-born to pledge their loyalty to the Flag and to the great cause we are fighting for, and it is the patriotic duty of every employer in this country to see to it that his employees have the opportunity on June 14 to get together for a flag raising.

This is a timely occasion for the employer to get the idea across to his employees that they are working for their country and for the boys at the front. This idea, when once instilled, will make strikes, sabotage and restricted output a thing of the past and develop a loyal spirit among native- and foreign-born employees by making them realize that America is the land of the square deal and equal opportunity.

The employer, in addition to producing the materials essential to winning the war, must also help develop a new American spirit. This was very eloquently expressed recently by Secretary of the Interior Franklin K. Lane, in an address before an educational conference in Washington, D. C.

> And we who are not permitted to fight, what shall be our part? Let it be our resolution that when our sons return they shall find a new spirit in America, a deeper insight into the problems of a striving people, a stronger, firmer, more positive and purposeful sense of nationality. We shall make America better worth while to Americans and of higher service to the world.

Flag Day offers an opportunity to help make this resolution a reality.

Cent-a-Gallon Gasoline a Dream

WHILE we are waiting for the report of the five internationally known scientists, who we understand have been appointed by Garabed T. K. Giragossian and approved by the Secretary of the Interior, to investigate the former's sources of free energy and learn whether the said Giragossian is to be a great benefactor to humanity or whether his claims are just plain buncombe, the story of the doings of Louis Enricht, of Farmingdale, L. I., and his "Cent-a-Gallon Gasoline," published in the New York *Tribune*, May 5, an abstract of which appears on page 854 of this issue, will help in provide fuel for our speculative imaginations.

Gasoline at one cent per gallon, if such a thing were possible, would seem to be about the equivalent to tapping the inexhaustible reservoir of energy in the atmosphere. However, as far as we know, the T. K. Giragossian free-energy motor, or "Garabed," as he calls it, exists only in the would-be inventor's imagination, while Louis Enricht has managed to put his mysterious something across in such a way as to interest Henry Ford, B. F. Yoakum and, according to his own statements, the governments of two or three countries, without revealing his method of doing it.

No doubt many of our readers have speculated upon what would be the results if all this was a reality and not a dream or a hoax; how some day all the millions invested in pipe lines, oil-refining and oil-pumping equipment would cease to earn dividends; how gasoline, which is becoming one of the most expensive and essential fuels, would some day be one of the cheapest and most commonplace; how the fortunes of the millionaires of the oil industry would fade away—but you need not speculate any longer, for, according to Louis Enricht's own words, he has had to abandon the idea of his "Cent-a-Gallon Gasoline," and, on account of the great increase in the cost of chemicals during the last two years, his mysterious motor fuel will now cost the public "twelve cents per gallon." When it comes to war profiteering, Louis Enricht appears to be a joy rider.

However, this would-be "green-fluid wizard" seems to be a sort of a generous creature after all, for according to his own statements he has had a conference with Secretary Baker and Attorney General Gregory, and this Government wants his secret for war use only, while he wants the Government to protect him after the war and license him to manufacture his compound and make it illegal for anyone else to produce it. On this plan he will sell his fuel to the Government at ten cents a gallon, and the extra two cents charged the public he is willing to pay the Government as a tax. This, according to his estimate, would enrich the Government by seventy million dollars per year, which is equivalent to a two-cent tax on three and a half billion gallons. Louis must expect to do some business when he gets started, since the total gasoline production in the United States in 1917 was only about two and a half billion gallons.

Like Giragossian, Enricht has always held up the difficulty of protecting his idea as a reason for not revealing his secret, if he has one; and by this subterfuge he has managed to cover himself at every turn from his first public demonstrations in 1916 to what he claims to be his latest offer for his fuel from the Government.

Now that "Cent-a-Gallon Gasoline" has increased to twelve cents in the last two years, it should be enough to convince the trusting public that whatever Enricht may have is a hoax, and that it is only one more of the something-for-nothing schemes breathing its last and about to pass into oblivion. Is it not about time that at least those who are supposed to be familiar with the laws of physics, chemistry and engineering cease to lend their attention to schemes that are so far removed from all laws of reason?

Soot-Blower Data Solicited

ON OTHER pages of this issue is an article dealing with mechanical soot blowers, giving experience from a number of plants as to the saving effected in coal and labor and the character of the service rendered. As far as they go the various reports are favorable, but for the most part they lack definite data to back up the assertions made. Those published are only a few of the responses received. The others merely state that no data on the subject are available.

A loss that may account for two to eight per cent. of the fuel is surely worth analyzing. It would be interesting to know the amount of steam required to blow different sizes and types of boilers, the relative efficiencies of mechanical and hand cleaning and the cost of maintenance in various plants. With these points in view it should not be difficult to obtain data sufficiently accurate for the purpose in hand. We would welcome other contributions to the subject. A general knowledge that a thing is good is not sufficient. Those interested in a device of this character should know how good and at what expense.

There are few engineers and technical men who do not view the move to abolish the study of German language in the schools as a piece of downright foolishness.

Correspondence

Texas Also Needs a License Law

The account in the issue of Apr. 2, pages 463-4, of a boiler explosion in a laundry at Providence, R. I., resulting in the death of three men, and the editorial comment, "Does Rhode Island Need a License Law?" recall an incident that I observed a few years ago in this state.

I stopped overnight in a small town in central Texas and next morning before train time, I decided to walk around and see some of the plants. The first one I came to was a small laundry. The boiler room opened on the sidewalk, so I stepped in to have a chat with the engineer, but there was no one in sight. The boiler was of the horizontal-tubular type, about 35 hp., and judging from its general appearance, it was of a "very indefinite age." The steam gage registered 85 lb., and glancing at the water column, I saw that there was no water in the glass. I had a feeling that as an engineer it was my duty to "stick around." While I was looking the outfit over a boy came into the boiler room from the laundry, and I asked for the engineer.

He said, "Why, the boss generally looks after the engine, but he's gone up town and told me to 'sorter' look out for her until he got back." "Well," I said, "someone had better be 'looking out for her' pretty soon, as your boiler don't seem to have any too much water in it." He blew the column and only dry steam came out. He became very much excited and asked what I thought he had better do. I looked in the furnace and saw that he had very little fire (lignite was being used as fuel) but plenty of ashes. So I told him I thought the best thing to do would be to cover his fire with a few shovels of wet ashes, let the steam drop back, shut everything down and wait for the boss.

I left him shoveling ashes on the fire and have often wondered what the boss had to say when he finished his "political argument" up at the post office and returned to "generally look after" the boiler. This is only one of many instances where the boss "generally looks after the boiler" in small isolated plants, and it shows that Texas as well as Rhode Island needs an engineer's license law. S. F. FARLEY.

Galveston, Tex.

Greater Efficiency in Internal Combustion

Your editorial in the issue of April 16 on "Internal-Combustion Economy" is timely and I trust will bring out some comparative efficiencies between engines of this type working under the average and best conditions. While a hot cylinder wall is conducive to a minimum jacket loss, the greatest field for improving thermal efficiency is found in expanding the working charge to a greater degree.

The power stroke is now of shorter duration than the compression stroke, but if the working stroke were prolonged until the terminal pressure approached the initial pressure of compression, a larger amount of heat would be converted into work before release. The indicated work with such expansion is from 23 to 26 per cent. greater for the same amount of fuel, but like a single-cylinder steam engine, there is a limit to the terminal pressure, as nothing is gained by expanding steam lower than 18 to 19 lb. absolute because the mean effective pressure of further expansion is less than that required to overcome the mechanical friction of the moving parts; so in an internal-combustion engine, ordinarily twice as heavy per unit of output, it has been found that there is a net increase in fuel consumption with expansion before release to about 23 lb. absolute. The pressure of release at full load is usually 25 to 30 lb. absolute, or above the pressure of initial compression, and the temperature is about 1500 deg. F., while an expansion reducing this pressure to 23 lb. absolute will reduce the temperature of release about 1000 deg. and will increase the total efficiency 12 to 16 per cent.

Of course, an engine with a long stroke has more friction than one with less piston displacement, but a compound noncondensing steam engine has in many cases double the friction of a simple engine of the same output, yet the saving in cylinder condensation exceeds the frictional losses, and noncondensing compound steam engines are commercially successful.

If there were no cylinder condensation of the working medium in a steam engine, the same number of expansions in a single cylinder would show a greater efficiency than when carried out in two or more cylinders. It is the writer's opinion that in its ultimate development the internal-combustion engine will have a working stroke of longer duration than the compression or induction stroke. C. E. SARGENT.

Indianapolis, Ind.

Excessive Compression Lifted Valve

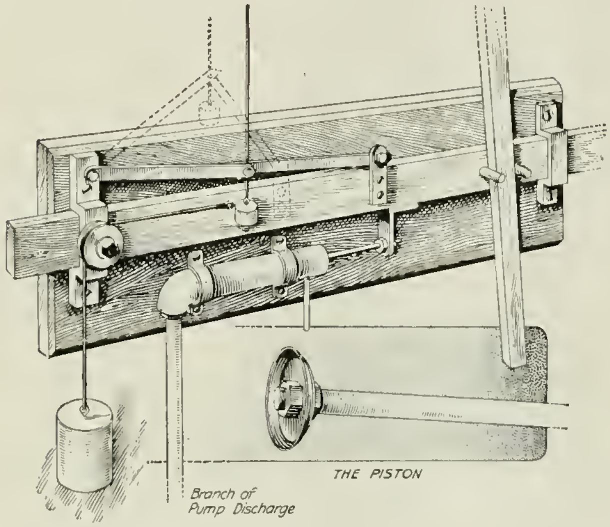
We had a distressing experience for a couple of days after putting a new piston rod in a 20 by 32-in. mill engine. Whenever the throttle was closed, there would be a terrible clattering racket set up inside of the valve chest, continuing as long as the engine was in motion. If, however, some steam was allowed to enter while the engine was slowing down, the noise was not nearly so bad.

The cause was found to be that the new rod was slightly longer than the old one, so that the piston traveled up close to the head end, causing enough compression to lift the balanced slide valve off its seat, but as soon as the valve lifted, the pressure was released and the springs slammed the valve back against the seat.

New York City. J. LEWIS.

Automatic Control for Belt-Driven Pump

A plant of which I once had charge used large quantities of water pumped from a well into an overhead tank to be heated. The duplex belt-driven power pump with hand control proved unsatisfactory as the tank was often either empty or overflowing and wasting hot water, and to overcome this difficulty I made the control automatic by the following means: I extended the belt shifter along the wall back of the pump with two supports for it to slide in. The pump discharge line had a balanced valve, operated by a float in the tank, so that when the tank was full this valve closed and of course the pressure would build up in the pipe line. I connected a branch to this line and led it back of the pump to where the shifter was and connected to it a cylinder made of 1½-in. brass pipe. The piston rod was made of ½-in. iron rod with a cup leather washer on the end to fit into the cylinder; the other end was connected to the belt shifter, which was counterweighted, as shown in the illustration.



BELT SHIFTED BY HYDRAULIC PRESSURE

When the tank filled and the valve closed, the extra pressure would force the piston and rod outward and shift the belt to the loose pulley, stopping the pump. When the float valve opened and the pressure was released, the belt was thrown on the tight pulley by the counterweight. This arrangement was an improvement over hand control, but it was too sensitive, for the pump would start too often, sometimes making less than one revolution before stopping again. To overcome this, I arranged a jointed brace, as shown, so that when the shifter moved to the off position, the jointed part would drop a little past a straight line, "toggle locking" the shipper until the toggle was tripped again. This was done by a second float in the tank, connected to the toggle and a small weight by a wire. When the water level dropped eight or ten inches the float would trip the toggle, allowing the pump to start and fill the tank, after which it would stop and be locked in the off position again. The pump starts and stops pretty often, but it receives no attention for months at a time beyond an occasional oiling.

New Bedford, Mass. H. K. Wilson.

Removing Piston-Rod Packing

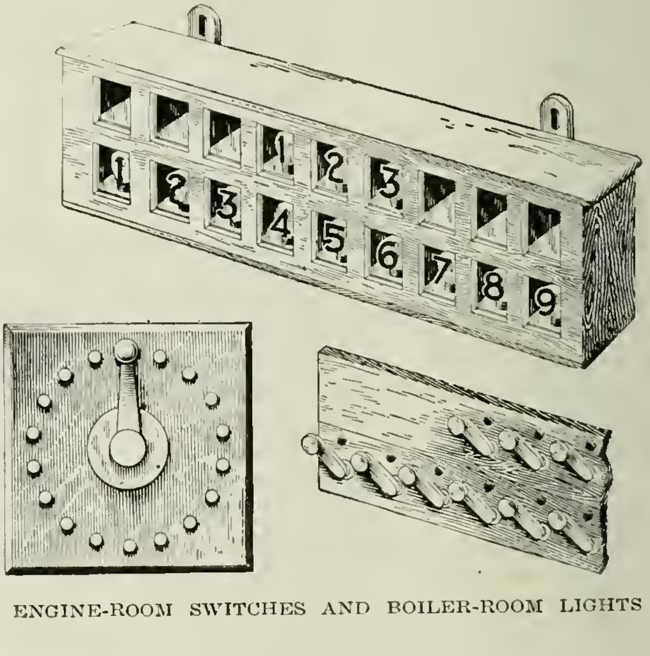
I have a way of my own of removing packing from piston rods of engines, which may be new to some engineers. Place the engine on the center toward the cylinder, remove the nuts which hold the gland in the stuffing-box, open the cylinder cock at the head end and close the one at the crank end, then give the engine a quick turn of about half a revolution and the air compressed in the cylinder will blow the packing out.

This of course applies only to engines that are smal' enough to be turned over by hand, but it is preferable to blowing the packing out with steam, as it leaves the cylinder cool to repack and there is no danger of breaking the gland as when using steam. Care must be taken, however, not to let the engine turn a complete revolution or the gland may be jammed or broken.

Binghamton, N. Y. Edward J. Dowd.

Fireroom Load Telegraph

It is convenient for the firemen to know what load is being carried in the engine room, but sometimes rather inconvenient to keep them informed. Various devices are employed for this purpose. The one shown was used in a power plant where I once worked. A box with numbers from 1 to 3 and 1 to 9 painted on its glass front, with a small lamp back of each number, was placed in plain view of the firemen in the boiler room, and a bank of twelve single-pole switches, each one corresponding to a number on the board in the boiler room, was placed handy to the engine-room operator, the upper row to show the load in thousands and the lower row, in hundreds. As the switches were turned on, the corresponding lamps lit up, informing the firemen of the load carried.



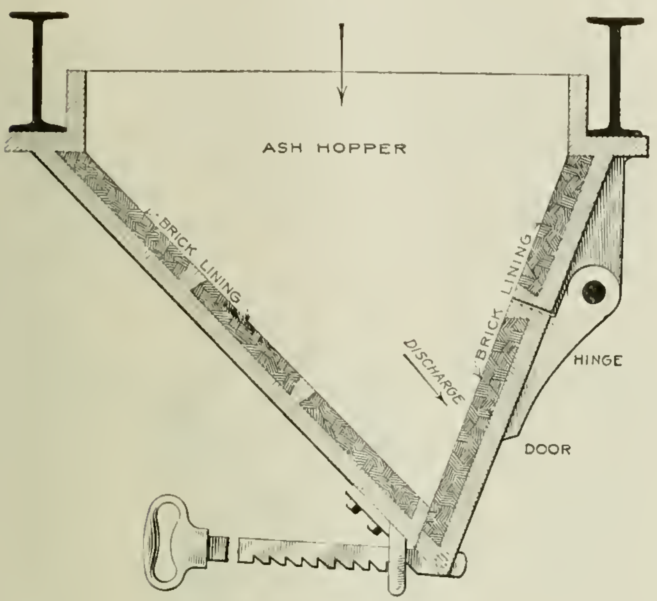
ENGINE-ROOM SWITCHES AND BOILER-ROOM LIGHTS

A handy bank of switches may be made out of an old rheostat with a lamp connected to each contact button and to a common return wire at the lamp bank. There are enough contact points so that the numbers can progress all the way by hundreds. D. R. Hibbs.

New York City.

Brick-Lined Ash Hopper

In some automatic stokers the ashes from the fire fall into a receiver or hopper below. These ashes may be left in the hopper two or three hours before being removed and carted away. The hopper is made of cast-iron plates which, if not insulated, come in direct contact with the hot ashes and become warped and are soon put out of commission. The illustration shows an ash hopper fitted with a firebrick lining built according to the writer's own ideas and used in a local plant.



BRICK-LINED ASH HOPPER

M. E. Duggan.

Kenosha, Wis.

Induced-Draft Fan Puzzle

I once had an interesting experience in connection with an induced-draft fan placed on the roof of a large hotel and used in connection with two marine-type boilers. The construction of the building prevented placing the fan near the base of the stack, and the only available space was on the roof within 20 ft. of the top of the stack; the flue had a great many crooks and turns and was divided into two parts, one from the boilers and the other evidently a ventilating flue.

When tested, it was found that there was no apparent increase in draft over the fires, and the fan was taking considerably more power than was originally figured on. The temperature readings at the boilers and at the fan inlet showed a large drop, which would seem to indicate that the fan was handling a lot of cold air from somewhere. This was puzzling, but it was decided that the flue had a great many small leaks.

In order to determine if there were any large openings between the stack and ventilating flue, a newspaper was torn into small pieces and thrown into the ventilating flue while the fan was running. A few seconds after they went in they came flying out from the outlet of the fan, proving in a very striking manner that there was a hole somewhere in the stack and that the fan was drawing air through it and consequently handling nearly all cold air. This, of course, accounted also for the wide difference in temperature and for the fan taking an excessive amount of power. A hole 12 in. in diameter was found about one-third the way up the stack. Before its discovery the owner of the building was positive there was no hole in the stack, so to square himself the check in payment for the installation was sent at once.

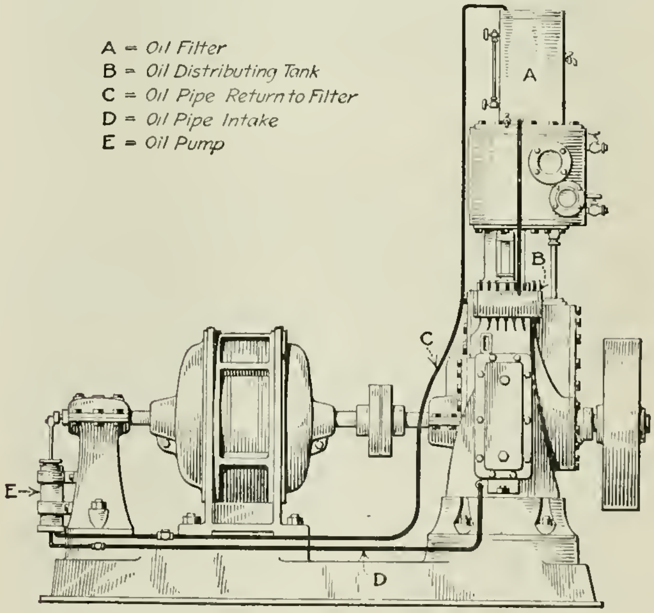
G. C. Derry.

New York City.

Engine-Oiling System

The illustration shows the general plan of an automatic engine-oiling system of the "home-grown variety" somewhat on the order of the one described by Mr. Morrison on page 60 in the issue of Jan. 8, 1918. Oil from the crank case was originally discharged into a pail, but by the new arrangement the pipe was extended to the end of the bedplate supporting the outboard pedestal bearing, and connected to a home-made pump, from which the oil is discharged to a reservoir and filter located above the engine and drains by gravity to the regular distributing tank on the engine. All of which is "according to Hoyle," but the construction of the pump might be described as something "fearful and wonderful, to wit:

The pump body was a nondescript piece of brass threaded inside at one end for a stuffing-box and outside at the other end for the oil-pipe connections. A 1-in. drill was run through from end to end, forming a working barrel. The piston, piston rod and pump head were originally the stem, disk-holder and bonnet of a bath cock fitted to the size and thread of their respective new mates. Motion is imparted from a 7/8-in. capscrew tapped into the shaft center with a steel pin located 3/8-in. off center, making a 3/4-in. stroke crank. The pump body is attached to a cast-iron plate with U-bolts, and that in turn is fastened to the outboard bearing pedestal with studs.



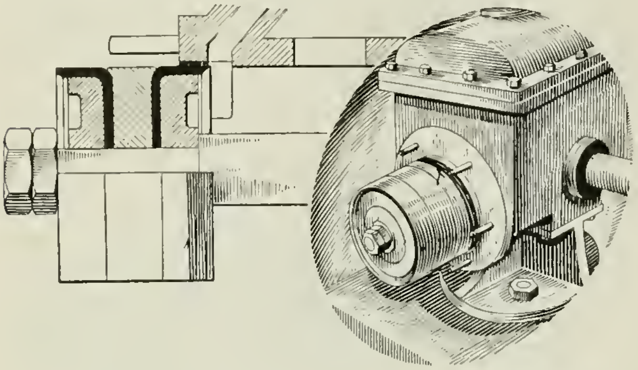
AUTOMATIC OIL FILTER AND RETURN SYSTEM

The description may read like that of the remains of a steam calliope, but the pump does the work just as well as one bought for the purpose and the "automatic oiling system" saves a lot of time and attention.

Ray Brook, N. Y. J. J. Brewer

Entering Leather Pump Cups

We had considerable difficulty replacing the plunger in a Davidson pump, with a set of new leathers on it. Using sheet iron proved of no avail, but we finally succeeded in the following manner: The edges of the cups were very tightly wound with strong thread and smeared with grease. The plunger then entered easily. Of course after a few strokes the thread was worn off, leaving the cup "lips" to serve their proper function.



STRONG THREAD WRAPPED ON LIP OF LEATHER CUP

Another good stunt pulled off lately was as follows: We have only one brine pump, and when one of the round notched packing gland nuts on a steam piston rod broke one day, it meant shutting down the entire refrigerating system unless it was repaired promptly. The engineer on watch found that a 2½ x 1¼-in. reducing sleeve would take the place of the packing nut, so he put it on and had the plant running again in an hour. R. J. DALTON.

Woodhaven, L. I.

Water-Heating System

In a silk mill where there was a heavy demand for hot water for boiling the silk, they used to draw cold water into the tubs and bring it to a boiling temperature with live steam through a "full-open" 1¼-in. pipe. To boil 250 gal. it took 15 to 20 minutes. With ten tubs in operation there was a noticeable extra demand on the boilers and the coal pile. After considerable argument I was allowed to put in the following equipment.

The boiler room had a monitor extending along the middle of the roof, below which ran the exhaust pipe of the main engine. In this I built a 1200-gal. tank and put in a closed feed-water heater with 6-in. steam connections and connected the water side to a centrifugal pump with 1½-in. connections from the bottom of the tank to the pump, then to the bottom of the heater. From the top of the heater another pipe discharged into the tank to circulate the water from the tank through the heater and back to the tank. With the centrifugal circulating pump in operation the water was soon heated and kept at from 150 to 212 deg. F.

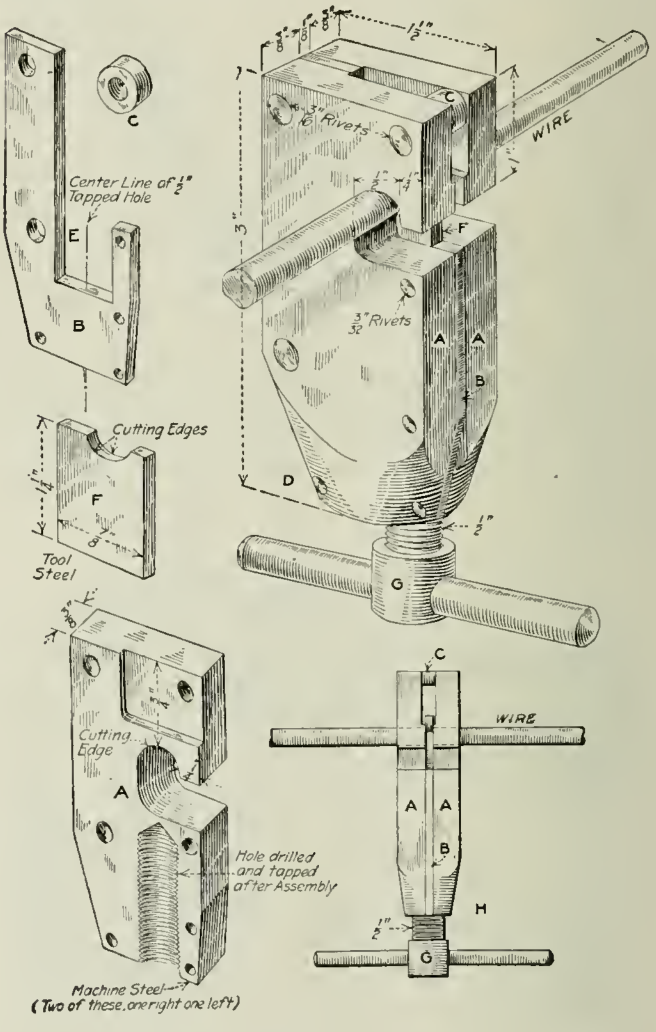
In this room there were two driers, one having 5600 ft. and the other 2800 ft. of 1¼-in. pipe operating under boiler pressure (70 lb.). These were trapped and the discharge led into the hot-water tank, thus saving both heat and water. Water was supplied to the tank by means of a balanced float valve. After this system was placed in operation, it was a common thing to see a tub of water boiled in two minutes, and the saving in coal amounted to about a ton a day, which is pretty good interest on a $600 investment. H. K. WILSON.

New Bedford, Mass

Screw-Type Wire Cutter

A handy tool for cutting heavy copper wire up to 0.5 in. diameter is shown in the figure. The body of the device is made in four parts and assembled. Two pieces, one right and the other left, are made similar to that shown at *A*, and two other pieces *B* and *C*. The parts are assembled and riveted together as indicated at *D*, after which a ½-in. tap hole is drilled and tapped so that it will pass through the center of the recess *E* in part *B*. The holes should extend well down through parts *A*, as indicated in the figure. The recess *E* in part *B* forms a pocket for the cutter *F* when the tool is assembled. In operation the screw *G* is turned back and cutter *F* dropped into the pocket, thus allowing the wire to be placed in the tool, as shown at *D*. The screw is now turned and the cutter shears the wire between the cutting sides of the shoulders *A*, as indicated at *H*. The parts are made of tool steel and hardened on the cutting edges. This little implement can easily be carried around in the tool kit. M. P. BERTRANDE.

Ozone Park, N. Y.



PARTS AND ASSEMBLY OF CUTTING TOOL

Inquiries of General Interest

Relative Loss of Draft in Square and in Round Flues—What is the relative loss in force of draft in square and in circular smoke flues? S. R.

The draft-retarding effect of a square flue is about 12 per cent. greater than of a circular one of the same cross-sectional area.

Charles' Law of Gases—What is Charles' law of the expansion of gases? C. R. D.

The law of Charles, sometimes attributed to Gay Lussac, asserts that all gases have the same coefficient of expansion, and this coefficient is the same whatever the pressure supported by the gas. Hence, for each degree of rise or fall of temperature at constant pressure, its volume will be increased or diminished by a fixed fraction of its original volume. This fraction has been computed to be $\frac{1}{493} = 0.0020284$ on the Fahrenheit scale, the temperature of the original volume being that of melting ice.

Heat Lost in Chimney Gases—What percentage of heat in coal is lost in boiler chimney gases? W. N. R.

The loss depends on the quality, quantity and temperature of the gases. In ordinary boiler practice with natural draft it is customary to supply about 100 per cent. excess of air in order to insure complete combustion. With complete combustion of coal and such excess of air, the losses with different temperatures of chimney gases are about 17.5 per cent. for 400 deg. F.; 21 per cent. for 500 deg. F.; 25 per cent. for 600 deg. F.; 29 per cent. for 700 deg. F.; and 33 per cent. for 800 deg. F.

Chattering of Pressure-Reducing Valve—What can be done to stop chattering and hammering of a pressure regulator used on the steam supply to a steam pump near the steam chest? F. L.

Locate the regulator far enough from the pump so that the volume of steam contained in the pipe between the regulator and the steam chest provides a cushion for the action of the valve without sudden changes of the discharge pressure. This usually will be attained by placing the valve at a sufficient distance from the steam pump to obtain a volume of supply pipe equal to the volume of the steam cylinder of the pump.

Laying Up Heating Boiler—Should a return-tubular boiler that is used for heating be laid up filled or emptied of water? R. L. D.

The boiler should be emptied and after being thoroughly cleaned and dried should be closed up tight. Leaving a boiler stand entirely filled with water during the summer months will prevent rapid rusting at the ordinary water line, but will cause the exterior of the shell and the interior of the fire tubes to rust more rapidly from condensation of moisture out of the atmosphere. Whether the boiler is left filled or dry, the smoke uptake should be disconnected and sealed and furnace, ashpit and all cleaning doors closed tight, to prevent external rusting from circulation of air over the heating surfaces.

Clinker Trouble—Our present coal contains considerable slack and clinkers badly. What is suggested to prevent the trouble? W. B. G.

Keep the fuel bed only about 5 in. thick and fire small charges at frequent intervals. Promptly cover the brighest spots with fresh fuel to prevent holes from burning out that will allow coal to drop through to the ashpit. Avoid excessive stirring of the fire. Any working of the fire bed that may be necessary should be done from the bottom. Keep the bed level by stoking. Leveling the fuel bed with a rake or other firing tool is likely to cause clinker by lifting the ash to the fuel bed. Keep ashpit doors open and regulate the draft with the uptake or stack damper. Promptly quench any ashes or coal falling through the grates. If ashpit is water-tight, keep water standing in it. If that is impractical, blow steam under the grate. The exhaust of a pump or any other supply of waste steam will be beneficial.

Testing Steam Consumption of Engine—How is the steam consumption of an engine determined? W. G. R.

The steam consumption while driving a stated load can be determined by a steam meter that has been calibrated for the conditions, but more generally such tests are made by actually weighing the feed water used for generating the steam supplied or by condensing the exhaust and weighing the condensate. For condensing the exhaust, an ordinary surface condenser may be used, or a series of closed feed-water heaters may be connected together for obtaining sufficint condensing surface. Measurement of the condensate is usually to be preferred to feed-water measurement as less likely to introduce errors from irregularity of working conditions, leakage or use of steam for other purposes than for supplying the engine under test. For establishing uniformity of conditions and reducing the percentage of errors, a feed-water test should have a duration of at least five hours, but with the condenser method an hour's test is sufficient after the normal working conditions have been established.

Quality of Steam Shown by Calorimeter Test—What is the quality of steam determined by a throttling calorimeter test from the following data: Pressure of steam in the pipe from which the sample is taken, 120 lb. gage; temperature in calorimeter, as indicated by the thermometer in the well, 241 deg. F.; pressure in calorimeter as indicated by the manometer, 3½ in. of mercury; barometer 28 in.? R. G. C.

With a barometer reading of 28 in. the pressure of the atmosphere was $28 \times 0.491 = 13.75$ lb. per sq.in. and the absolute pressure of the steam was $120 + 13.75 = 133.75$, or about 134 lb. per sq.in. absolute; and with a pressure in the calorimeter of 3½ in. of mercury, or $3\frac{1}{2} \times 0.491 = 1.72$ lb. per sq.in. above the pressure of the atmosphere, the absolute pressure in the calorimeter was $1.72 + 13.75 = 15.47$, or about 16 lb. absolute. The heat of one pound of steam in the pipe would be equal to the heat of 1 lb. of the steam in the calorimeter.

In one pound of the steam in the pipe at the pressure of 134 lb. absolute, if

h = The heat of the liquid,
q = The quality or fraction of dryness,
L = The latent heat, then the heat of 1 lb. of the original steam would be $h + qL$, and if
H = The total heat in 1 lb. of saturated steam at the pressure which existed in the calorimeter,
T = Temperature of the superheated steam in the calorimeter as indicated by the thermometer.
0.48 = The specific heat of superheated steam at the pressure in the calorimeter,
t = The temperature of saturated steam at the pressure which existed in the calorimeter,

then the heat in the calorimeter $= H + 0.48\ (T - t)$, and

$$h + qL = H + 0.48\ (T - t), \text{ or}$$

$$q = \frac{H + 0.48(T - t) - h}{L}$$

From observations and the steam table, $H = 1152$ B.t.u.; $T = 241$ deg. F.; $t = 216.3$ deg. F.; $h = 321.1$ B.t.u.; and $L = 870.4$ B.t.u. and by substituting,

$$q = \frac{1152 + 0.48(241 - 216.3) - 321.1}{870.4} = 0.968 = 96.8 \textit{ per cent.}$$

[Correspondents sending in inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Annual Meeting Boston Section, A.S.M.E.

The importance of fuel conservation and the remarkable progress in the production of ships in the United States were featured at the annual meeting of the Boston section of the American Society of Mechanical Engineers, held at the Engineers' Club, Boston, Mass., on the evening of May 29. Chairman Albert C. Ashton presided, and the principal speakers were Dr. Ira N. Hollis, past president, and President Charles T. Main, of the national society, and Dr. Charles A. Eaton, of the United States Shipping Board. The meeting marked the climax of one of the best engineering-society seasons ever enjoyed in the New England metropolis. The sessions of the Boston section have been keyed to a high patriotic note; some of the most distinguished officers in the field service of our Allies have addressed it, and the attendance and discussions have reflected a general desire among the members to be of the utmost possible service to the country in this critical period.

Doctor Hollis' Address

Dr. Hollis, who is chairman of the recently appointed Fuel Conservation Committee in Massachusetts, under New England Fuel Administrator James J. Storrow, was the first speaker. He referred briefly to the vital necessity of backing up our military and naval efforts by campaigning at home against every form of waste. America has wasted her natural resources for generations, and the time has come to call a halt. "The subject of conservation," he said, "has come to assume a certain religious aspect, and it is our sacred duty to preserve what the good God has given us, for the welfare of those who come after us no less than for present-day needs. It is the desire of every generation to lift the race a little higher than it found it. Democracy bids fair to fade away if we continue to waste our resources." Dr. Hollis pointed out that coal saving, important as it is, is not the whole end and aim of conservation; the soil, the forests and other resources must be maintained for the general welfare. The speaker said that we must all learn to work together as good neighbors and friends. In closing, he cited an example of teamplay from the battle of Santiago. The firemen on the battleship "Oregon" heard little and saw nothing of the sea fight, and during the long pursuit of the Spanish ships gradually became weary of their arduous tasks at the furnaces. Seeing this, the officer in charge of the fireroom sent a request up the speaking tube that the commander of the vessel authorize the firing of a 13-in. gun to hearten the force below decks. Captain Clark agreed, and presently a 13-in. shell went sailing through the air toward the enemy. Instantly there came a scraping of shovels on the floor and an Irish fireman who had become a bit weary in well doing seized a big shovelful and with a "Take that, you dirty Dago!" hurled home his charge. Such was the effect of a coöperative stimulus upon tired muscles and minds previously out of touch with the stirring events above decks. Every American must take a personal interest in helping the country at this time, the speaker declared, as he took his seat.

President Main on the Fuel Situation

President Main briefly outlined the serious fuel situation which New England is facing with respect to next winter's supply. The New England Fuel Administration estimates that 33,400,000 tons of coal will be needed in the year; the Federal Administration at Washington has reduced this estimate to 30,000,000 tons. There are not enough vessels available to carry the water-borne share of even the smaller amount mentioned. It is estimated that 386,000 tons of shipping would be required to transport the water-borne coal to New England, on the basis of 100 per cent. efficiency in trips and cargo loading and unloading. On Jan. 1, 1918, there were only 200,000 tons available, and a week ago, 276,000 tons. It is anticipated that 60,000 tons more of shipping facilities will be added this year, so that the total estimated tonnage available will be 336,000 tons. The necessity for saving fuel in New England is therefore extreme, and the problem is, How is the manufacturing to be done with the coal which the plants will receive? To answer this question an organized attempt is being made to bring home to the mind of every plant owner in the state the importance of fuel economy, and a booklet has been prepared by the New England Fuel Administration showing how this has been taken up by four representative plants through the organization of shop fuel and efficiency committees, with savings effected during the past winter, and the suggestion that other plants follow suit. Members of the Fuel Administration and engineers in private practice stand ready to assist plant owners in realizing the maximum benefits from their fuel. Extracts from the reports of four plants follow:

Crompton & Knowles Loom Works, Worcester, Mass.

As a result of various steps an economy of not less than 15 per cent. in the use of fuel has been effected. On account of the very unusual winter conditions it is impossible to ascertain the exact amount.

On taking up the matter at the beginning of the winter we appointed from our foremen and executives a so-called Shop Fuel Commission. A little later we appointed a Shop Fuel Administrator, whose business it was to follow up the various methods inaugurated, to see that the best results were accomplished therefrom, and also to see that continued interest was maintained.

The several points covered may be listed under four headings: Improvement in boiler-house practice; improvement in use of power; improvement in use of heat; improvement in use of lights.

Improvement in Boiler-House Practice

1. Raising temperature of feed water by return of condensation. We succeeded in raising the temperature of feed water entering the boilers from 180 deg. F. to 200 deg. F.
2. The burning of all wood scrap and shavings produced in the plant, amounting to five or six tons a day of this material.
3. The establishment of better boiler-room practice by putting observers in the boiler rooms day and night for several days and nights to determine rate and efficiency of firing. The usage of coal by half-hour periods, as fired, was recorded for many days and plotted, from which was evolved a better practice as to uniform and more economical firing.
4. The weighing of all coal supplied to the boiler room and only allowing a certain amount to be used in definite periods. The remainder of the coal was locked up, so that the fireman had to be economical in the use of the portion that was issued to him.
5. Installation of pinhole grates and under-grate blowers to allow use of screenings. While the screenings have not been very high grade, we have been able to conserve appreciably our soft-coal supply. We are analyzing our screenings and discontinuing the use of all that show an unusual percentage of dirt and ash.

Improvement in Use of Power

1. Under the direction of our Shop Fuel Commission, an inspector observed the number of idle machines on which belts had not been thrown off. Vigorous action resulted in the number of machines running idle and wasting power being reduced to an absolute minimum.
2. Where the load was not sufficient to get the maximum efficiency from a motor, conditions were changed to make this possible. All cases of motors working underloaded were eliminated.
3. All overtime that involved the inefficient operation of machinery was stopped.
4. The use of large elevators was restricted to actual needs.
5. Our entire requirements of power had been purchased from the Worcester Electric Light Co. up to last December, obliging us to use live steam for heating. Since the need of fuel conservation became critical we reduced the Worcester Electric Light Co.'s load, at their request, 40 per cent., by operating our own engines and using only exhaust steam for heating. This has been accomplished with practically no increase in the use of fuel.

Improvement in Use of Heat

1. Using only exhaust steam.
2. Under the Shop Fuel Commission a thorough inspec-

tion was made of all doors, windows, transoms, etc., throughout the plant. These were promptly fixed up, and every time the shop shuts down a designated committee goes around immediately after the shutdown and sees that all places are closed. This has saved considerable fuel.

3. On all doors that opened to the outside, automatic door closers were installed.

4. By the appointment of a special inspector we have been able to cut off every day from 20 to 50 per cent. of our heating surface. This has been done by listing the number of feet of heating pipe in the various departments and by having the inspector follow the sun, so to speak, in turning off the steam in the various departments, as the temperature rose in the morning. This saving has been very heavy, as it meant from 200,000 to 500,000 heating foot hours per day. We have upwards of twenty acres of floor space and about twenty miles of pipe for heating.

5. The covering of all exposed steam piping.

Improvement in the Use of Lights

The saving in fuel in connection with the use of lights was large and accomplished in three ways, particularly:

1. The development of interest on the part of the foremen in connection with the problem and actual inspection at various times of the day of lights used, which resulted in the cutting out of a large number of unnecessary lamps.
2. Carbon lamps are replaced with tungsten lights.
3. Reducing the wattage of lamps in places where heavy illumination seemed unnecessary.

Dennison Manufacturing Co., Framingham, Mass.

Study was made in the power house to increase the efficiency of the plant, and a considerable gain was made in the number of pounds of steam evaporated per pound of coal. Study of the power and lighting load was made, and a considerable improvement in conditions was brought about by the following changes made in the manufacturing departments:

Heating of the factory was put into the hands of men appointed in each section, who carried out instructions which were given by the Conservation Committee. A schedule of proper temperatures was posted in each room, and the results of their work was checked up from time to time.

Outside of working hours the watchman received specific instructions as to the proper temperature to be maintained, and steam was turned on in the various departments at specified times in the early morning hours.

Thermometers were installed all through the working departments for the purpose of observation, so that the heat in the department could be kept at the proper point without opening the windows or using more steam than was necessary.

Heating coils in bridges and isolated parts of the plant which were not sprinkled were discontinued, and the valve wheels removed so that they could only be turned on by authorized parties, in case of necessity. This applies to the garage and stable, stair tower, toilets, etc.

Steam was shut off the boarding house while rooms were vacant.

Office work was moved in some cases to warmer locations in rooms where it was not necessary to keep the high temperature, and protections were arranged around the desks so that these locations could be heated to a greater extent than the remaining parts of the room.

Any orders for steam in unusual places or outside of working hours had to have the approval of the man at the head of the department.

A study of the use of hot water was made in all departments, and where it was only used for convenience it was shut off. Self-closing faucets were installed in some cases and the number of outlets decreased was over 30 per cent. The use of hot water was discontinued in the main office as well as in the manufacturing departments.

A reduction in the general illumination around the plant was made; the amount of light used under the existing conditions was cut down to the minimum, and in some places discontinued. Lamps of lower candlepower were substituted in many cases for a larger sized lamp. The time when lights were turned on was curtailed. The sign lighting was discontinued and the street lighting and factory-yard lights were reduced to a minimum consistent with the safety of the plant and the prevention of accidents to employees.

The watchmen were instructed to see that unnecessary lights were not left burning where night work was going on or at any time outside of working hours. All electric and gas-heating applications were turned off from 10 to 15 minutes before closing time. Lamps of less candlepower were used for all indicating lamps, and on instruments in the power house.

In order that the peak load, due to lights, should be eliminated, all passenger service on elevators was discontinued when the lighting load came on, and certain heavy machines, such as the coal carrier in the power house, paper calenders, machinery in the carpenter shop, and certain elevators, were shut down at 4 o'clock or thereabouts, and in this manner the peak load due to lighting was largely eliminated.

The total power and lighting load showed practically a flat curve throughout the day.

Many receiving doors and entrance doors were protected by storm porches and by weather-stripping the cracks around the doors to prevent a large amount of cold air from coming into the building. The space between the box frames and the brickwork in all the buildings was closed up to prevent too much air entering in this manner, and weather strips were put on the window sash in many cases where there was bad exposure. In all departments after the lights were turned on the window shades were pulled down to minimize transference of heat through the glass.

A study was made of the use of steam for process work, and exhaust steam was substituted for live steam wherever possible. Instructions were given operators to keep vent pipes closed. More careful inspection was made of all traps, and in many cases automatic return valves were installed to do away with hand control in such cases. The steam was shut off machines some time before closing instead of waiting for the closing gong. In many of the departments the work was laid out so that for certain periods of the day machine work could be done, and at other times the power was shut down.

The use of compressed air was studied, especially with a view to discontinuing its use wherever possible, and the use of the compressed air for cleaning was discontinued.

In obtaining these results it was necessary to interest everyone in the proposition, and means were taken to keep the different groups of employees informed of the savings which had resulted from the changes in operation.

According to the best estimate we could make, taking into consideration our production figures, outside temperatures and quality of coal, we made a comparative saving of 15 per cent. during the year. At our 1916 rate of consumption this would amount to approximately 1350 tons. During the winter months, when we have our greatest coal consumption, we attained by various economies or greatest savings, in some weeks there being as high a reduction as 32 per cent. in our use of fuel.

In reaching these results we reduced the power demand by about 16 per cent., largely through reduction in the lighting load. The reduction in the power load was largely accomplished by rearrangement of working schedules.

Atlas Tack Co., Fairhaven, Mass.

Our first step was to make all windows and doors as nearly airproof as possible and to instruct our watchmen, especially the man who attends to the heating, to look for all steam and air leaks and to report at once in case any of these should exist, that they might receive immediate attention. The factory's temperature was usually from 55 to 67 deg., according to the character of the work done in each department. We installed in our heating steam pipe a steam-recording gage and allowed only a certain pressure, according to weather conditions. In this way the man attending to the heating shifted the heat from one room to another in order to keep the factory comfortable to work in.

We repaired all steam traps thoroughly, so that all condensation was returned to our boilers, and we also covered all exposed steam pipes with 80 per cent. magnesia.

In our pickling and scaling department we installed a steam-reducing valve lowering the steam pressure from 150 to 60 lb., and also placed in the pickling tubs automatic temperature-control valves, making hand regulation unnecessary.

In the eyelet department automatic control valves and thermostats were applied to all japanning ovens to admit only sufficient steam to keep the necessary oven temperature, all condensation being returned to the boilers by gravity, and eliminating all pumping that would otherwise call for considerable power. We covered the tops of boilers with asbestos cement 2½ in. thick, lowering the outside temperature 10 deg. We have installed on all boilers water columns, high- and low-water alarm, preventing wide fluctuation of water level and assuring much better economy. We have also on each of our boilers a boiler-efficiency meter. This shows the firemen at all times the condition of their fires, and has proved a useful and economical instrument.

We installed a V-notch recording and indicating water meter to measure accurately the water pumped to our boilers and show to the boiler-room force the amount of water evaporated per pound of coal.

On account of the limited tube area in our former feed-water heater, we were unable to get the best results from our exhaust steam. These tubes have been replaced by a more efficient set, resulting in 20 deg. increased temperature. At present our feed-water temperature leaving the heater is 130 deg. and leaving our economizer to boilers, 230 deg. Our boiler feed pumps were repaired and put in first-class condition.

In the engine room all valves are set for the highest economy, and we have installed three switchboard recording watt-hour meters. We are about to install a 5-hp. motor to take the place of our steam engines to run the economizer scrapers.

We are installing hand stoker grate bars, which, according to the builders' rating, will give us about 50 per cent. more boiler rating and about 25 per cent. saving in coal.

We have abandoned our old cooling tower and are installing a spray-pond condensing equipment with motor-driven centrifugal circulating pumps.

All boiler settings and brickwork are examined for necessary repairs and tubes in boilers scraped.

I believe that in 1918 our increased efficiency will net us a saving of at least 20 per cent. in fuel.

The George E. Keith Co., Brockton, Mass.

We have a peculiar plant, in that the buildings are widely separated and there is a great deal of heating radiation in all the buildings. The buildings are of wood frame construction and not as tight as they might be. We appointed one man to patrol these buildings three times a day and to record the temperature in each room. This man was made responsible for turning on and shutting off the steam in each department, and in this way we kept the temperatures down to a minimum, so that there was no extra radiation loss.

We have covered every pipe in the entire plant that was carrying high- or low-pressure steam. We have even made it a practice to cover the return pipes. We have experimented to some extent with asbestos covering on the brickwork of the boiler settings. We have covered one boiler to see how the proposition worked out, and undoubtedly will apply this covering to the other boilers. This covering not only cuts down the loss due to heat radiation, but also stops any air leakage, which in the opinion of the combustion engineer is the most serious loss in the entire plant. Air leakage causes a dilution of gases, and we do not get the percentage of CO_2 which gives us maximum efficiency. Consequently, anything which will cut down air leakage around the settings will save coal more than any other method of boiler efficiency.

We were driven to the burning of screenings because we could not obtain soft coal. In fact, we have been burning screenings in some of our boilers for two or three years with good results. We had to install small forced-draft blowers to get results, but have succeeded in burning as high as 70 per cent. maximum of screenings and soft coal.

We have placed traps on every drip or outlet in the entire plant and on the ends of all heating coils. We have arranged our return system of piping so that there is no loss from any of the piping. All the returns come back to our boiler room and are used for boiler feed. This eliminates the expense of makeup water and of course gives us a boiler feed temperature of about 206 degrees.

We have installed a thermometer system whereby the firemen can tell what the temperature is in any building merely by pressing a button. This thermometer is an electric apparatus operated by means of an electrical contact placed in each building.

We have made it a practice to burn all the scraps and waste from the factories.

We have several items for future development, in that plans are being started for a new central heating plant. We now have three isolated heating plants which cause more or less inefficiency, in that the boilers are old and coal cannot be burned to good advantage. We intend to install automatic stokers, weighing devices for recording the amount of coal used, and coal and ash handling apparatus. We intend to lay out our steam mains and steam piping so that all losses will be cut to a minimum.

We have outlined a system of work through our entire plant; are casing up all the windows, making all of the doors tight, and arranging doors so that they will close automatically, thus doing away with any loss from leaving them open. We have placed vestibules inside the factories where we have any shipping doors.

Skilled Enlisted Men To Be Returned to Necessary Industries

In response to appeals from all over the country, the War Department has decided upon a policy that will permit the return to necessary industries of highly skilled men taken from such industries, under a system of furlough which will be automatic and which will not in the future as in the past leave to the discretion of company and other subordinate commanders the question of whether such furloughs shall be granted. Thousands of applications for such furloughs are now being sent out of Washington by various branches of the War Department, in response to the appeals of manufacturers and other producers of war material whose draftsmen, mechanics and other employees, engaged in the past and now upon Government orders for war work, have been taken from them by operation of the draft.

The application blank is as follows:

APPLICATION FOR RETURN OF ENLISTED MAN
IN HIGHLY SKILLED CLASS OF LABOR TO
NECESSARY INDUSTRY

Dated at....................191

Application is hereby made for the return of following enlisted man:

Name.......................... Residence..................
Exact description of trade....................................
Registered local board............Order No......Serial No....
Last reported to camp....................Unit................
Taken into Army..................191, because...............
....
....
We ask that he be directed to report to......................
....
We have the following direct Government contracts:

Date	Gov. Order No.	Quantity	Description	Dept. of Gov.
......	....	......	....	....
......	....	......	....	....
......	....	......	....	....

We are under contract with the following, who have direct Government contracts from............................Dept.......
....
....
We have established our status as "necessary" industry with District Board No....... of State........located at............
....

By......................(Title)

Sworn to before me at.............
this........day of...............191

....
....
Title of official administering oath.

I have checked the foregoing statements and have found them to be correct.

....
....
Local representative of..................................Dept.

The adoption of the new policy means that enlisted men are to be returned to industry only in cases where the drafted man's employer is willing to swear that the man is badly needed and that no one can take his place. The Government department for which the manufacturer or other employer is working will, upon application, send one of the blank forms to the employer, which he must fill out, swear to before a notary, and have a Government inspector who is conversant with the facts also sign. The signed application then goes to the Adjutant General's office, with request from the interested Government department that the man wanted be granted an indefinite furlough, without pay, with the promise that after the need for the man's service has passed he will be returned to the Army.

While such men are on furlough they are not to be allowed to wear the uniform. The company employing them must furnish the Government each month a report that they are still in employment and the class of work engaged in. In case such men leave their employment, the employers must immediately notify the Government.

Thousands of applications for furloughs for enlisted men in necessary industries have recently reached Washington, and Washington has been unable to grant permission for the necessary furloughs because company commanders and other subordinate officers could not be convinced that certain of their men might be more necessary in civil life than in the ranks. The Adjutant General's office has sent a circular to heads of War Department divisions permitting the new system. The Government is protected, from the army-in-the-ranks point of view, by the fact that wherever a fraud is perpetrated or attempted a sufficient number of persons will be familiar with the circumstances to result in the War Department being notified.

Skagit River Development

The Seattle City Council has definitely decided to proceed with the development of the Skagit River power site, which has been offered to the city free of cost, and all bids for the sale of other sites and the construction of plants for the city have been rejected. As soon as the necessary plans can be completed, bids for the work will be called for by the Board of Public Works, C. B. Bagley, secretary.

Covering in every detail the construction of the proposed hydro-electric power project on Skagit River, Superintendent of Lighting J. D. Ross has submitted to the Board of Public Works a report which shows the initial cost of the first development to be $4,712,080. These figures include the 103-mile transmission line necessary, with an estimated cost of $1,214,000. The summary of the report follows:

The total available power on this river, without storage at the lower or Gorge Creek plant, is 900 cu.sec.ft., capable of developing 25,000 hp. continuous 350-ft. head. The total available on the stream for three plants without storage is 900 cu.sec.ft., capable of developing 65,000 hp. continuously.

After impounding the water by Ruby dam, the equalized flow of the river is estimated to be 4000 cu.sec.ft., capable of developing 289,000 hp. About 350 square miles out of the drainage area of 1100 or 1250 square miles is on the Canadian side.

As far as known none of this can be economically diverted, but no data have as yet been obtained on the Canadian side. For this reason and to be sure of possible low-water years we base our estimates on 200,000 continuous horsepower instead of 289,000. The drainage area is the largest of any Washington power site, being estimated at the lowest to be 1090 square miles and the highest estimate gives 1250 square miles.

The total available fall of the river is 950 ft. and the site lends itself admirably to a successive development in three steps.

The transmission line is 103 miles to the north city limits. The voltage would be 110,000, and the loss in transmission with both lines operating will be 5 per cent. at full load of 50,000 hp. Our estimate includes two lines on steel towers the entire distance. The entire works of the three plants, including foundations, tunnels, the three concrete dams and all reservoir capacity, is set in rock. The tunnels are flow-line tunnels only, being under less than 100 per cent. pressure at any place.

The lowest tentative bid received on this project is $2,381,000 for 50,000 hp. installed, being a price of $47.62 per horsepower. The Cedar original plant, one of the most economical in America, cost $57.74 per horsepower. Estimating $1,240,000 for two transmission lines on steel towers and $275,000 for substations, the cost per horsepower on this bid would be $81.52 per horsepower in Seattle. The Cedar River plant, including substation, cost $95.55 per horsepower.

This estimate includes a diverting dam 25 ft. high and a flume and tunnel 12,000 ft. long.

The dam can be raised to elevation 850 ft., making it about 100 feet high. The rock is exposed on both sides at the best location. The plant then becomes entirely permanent. This permanent plant will cost about $3,499,000 for 50,000 hp. This is $69.98 a hp., installed. With transmission lines and substation all permanent steel and concrete construction, the cost will be $4,998,080, or $105.01 per horsepower ready for distribution at Seattle.

The report of City Engineer A. H. Dimock on the same project states:

The average cost a delivered horsepower of the various projects considered by the city, as follows: Stillaguamish River, $124; Wallace River, $132; Packard Lake, $224, and Skagit River, $105.

Considering the merits of the Skagit River power proposition, however, due allowance must be made for the value of the undeveloped power. On the most conservative basis there is available in this river a total of 289,000 hp., or 230,000 hp., in addition to the 50,000 hp. to be considered in this statement. It is entirely probable that further study of the capacities of this river may show a still larger amount.

The above is based on the lowest flow record obtainable. The value of a horsepower installed of undeveloped power is, of course, difficult to determine. In a discussion on the development and operation of hydroelectric plants in the proceedings of the American Institute of Electrical Engineers for the year 1909, it is stated that the value of land and water rights would average about 10 per cent. of the cost of a horsepower installed, or in this case $10 per horsepower. If this assumption be correct, the value to the City of Seattle of the power possibilities on the Skagit River, which may be obtained without any cost whatever, will be nearly $3,000,000.

All the items entering into these plants will be of the most permanent and durable character. The dams would be of concrete on rock foundations and with rock sidewalls. The water would be conveyed from reservoirs to power house by tunnels through the mountains, also constructed in solid rock. The power houses and equipment would be of the safest possible construction.

It has been shown by the foregoing figures that the present cost of the development of the Skagit River is lower than that of any other, and that it has possibilities for future development and for supplying the power needs of the city for many years to come.

The acquisition of this project and its development as needed will enable the City of Seattle to supply power to its customers at the lowest possible rates. There can be no question that the Skagit River affords the finest opportunity to the City of Seattle, both for present and future needs.

N.E.L.A. Convention at Atlantic City

The National Electric Light Association, as announced in a previous issue, will hold its annual convention at Atlantic City, June 13 and 14, the tentative program of which is as follows:

Thursday Morning, June 13—Presidential address; reports of secretary, treasurer, membership committee; reports Commercial, Technical, Accounting and Electric Vehicle Sections; new business. Thursday afternoon—Report of National Commitee on Gas and Electric Service; report of committee on public utility conditions—war financing of utilities, rate increase activities, etc.; report of public policy committee; discussion of central-station aspects of the labor problem; female employment; meter reading and testing; economized accounting. Thursday evening—Patriotic addresses on the broader national topics of immediate importance to the industry, by distinguished speakers (details in the hands of the president). Friday morning, June 14—Address and general discussion on the coal situation; important war-time topics introduced by the Technical and Hydroelectric Section. Friday afternoon—Important war-time topics introduced by the Commercial, Accounting and Electric Vehicle Sections. Friday evening—Round-table discussions and films of war activities of special interest to member companies, with other appropriate features.

Convention headquarters will be at the Hotel Traymore. Hotel reservations are in the hands of Frank W. Smith of the convention committee, 130 E. 15th St., New York.

Pleasure Yachts May Be Deprived of Fuel

It is probable that the United States Fuel Administration will issue soon an order prohibiting the use of coal and fuel oil by private yachts—meaning any vessel operated not for profit.

Incomplete figures now in hand show an average in commission for the last three years of 282 private yachts driven by steam and more than 1000 driven by gasoline. The total fuel used in these vessels has been deemed worthy of consideration at a time when a shortage of fuel is inevitable. The elimination of these craft would also release a considerable number of men for work in the war industries.

It has been shown that hundreds of vessels formerly operated as private yachts have been turned over to the Government for use in the war.

Navy Needs at Once One Thousand Gas-Engine Men

The Naval Reserve Force must enroll at once 1000 men experienced in the operation and maintenance of gasoline engines. This is an urgent call. The men are required for immediate duty. They will be rated as machinist's mates.

Age limits are 18 to 35 inclusive. Applicants must be American citizens. Draft registrants with letters from their local boards will be accepted.

Apply at Naval Reserve Enrolling Office, 51 Chambers St., New York City, or any navy recruiting station.

Cent-a-Gallon Gasoline Dream Ended

Robert H. Rohde, in the New York *Tribune*, May 5, 1918, gives a very illuminating and lengthy history of Louis Enricht, of Farmingdale, L. I., and his "One-Cent-a-Gallon Gasoline," under the title, "The Amazing Tale of a Cent-a-Gallon Sorcerer." No doubt many of the readers of *Power* will remember how this Louis Enricht sprung into public attention overnight, back in 1916, when he announced to the world that he had discovered how, by mixing a small amount of a green liquid, compounded by himself, into a quantity of water, the latter was immediately converted into a motor fuel equal to gasoline. According to Mr. Rohde's narrative, the early demonstrations of Mr. Enricht's invention were made on a so-called cycle car, and were of a nature as follows:

A bucket of water would be supplied from an old pump, then the witness would be invited to drink of the contents of the bucket, which invariably proved to be plain water. This same water was used to fill the tank of the cycle car. A small bottle containing a green fluid would be shaken over the mouth of the tank. The mixture in the tank would be stirred and the cap affixed. A twist of the crank would start the engine with a curl of vapor that smelt vaguely sweet shooting from the exhaust. Your attention was invited to the odor of the vapor. Then off you went to experience just the same sort of ride you would have had if you had been covering the same road in a cycle car by gasoline.

Perhaps there would be a little of the fuel left in the tank when you returned. Enricht would drain it at once through a pet cock and watch it disappear into the earth. "I must be careful," he would say, "if a few drops of the fluid gets into other hands, my secret is gone. It is easy to analyze, and I do not know how I shall protect it." When you talked it out with him and considered the problem from the inventor's view, this was one of the great arguments for secrecy, a valid reason why there might be delay to giving the boon of "Cent-a-Gallon Gasoline" to the public.

How could the secret be protected? That was the question. The ingredients, Enricht explained, were simple. They could be bought at any drugstore. A child could mix them in the proper proportions. There was nothing to prevent automobile owners from doing that very thing.

Then along came Henry Ford, who "joyrided" many a mile under the impulse of the Enricht fluid. He hunted and hunted for the joker but couldn't find it. He put Enricht in possession of a brand new flivver, straight from the shops; and Enricht poured water into its in'ards and added a little of the green stuff, stirred the mixture, turned the crank and off he and Henry went. But one day found this a closed incident. Henry had seen "Cent-a-Gallon Gasoline" in operation. He had been for a time convinced of its revolutionary merits. He had openly referred to Louis Enricht as a great man. It was said he had made a magnificent offer for the secret, planning perhaps to publish the full history as a benefaction to motor drivers. Maybe the offer wasn't magnificent enough; maybe Ford suffered a change of heart and mind and withdrew it.

He and Enricht parted. They were not friends. Ford sued Enricht for the return of the flivver which had figured in the demonstrations. Officers of the law under due process removed the flivver from Enricht. The old inventor immediately began action against his erstwhile crony. It seems he had substituted for the Ford engine one of his own, so the replevined flivver wasn't really Ford's property at all. And in that litigation Enricht dropped out of sight once more. Some weeks, or some months, passed, then entered B. F. Yoakum.

Enricht and Yoakum had been neighbors. Yoakum was the rich man of Farmingdale. The National Motor Power Co. was organized with Enricht and Yoakum in control. To the company Enricht assigned his secrets in exchange for stock. Now he says that stock was all he got—and all the company had. He insists that the whole capital of the enterprise lies in the value of the secret he had to sell.

As he had fallen out with Ford, so Enricht fell out with Yoakum. In this case a formal offer appears to have been made by the British Government after a protracted period of tests. It was because of a secret sympathy with Germany, the plaintiff alleges, that Enricht would not deal with Great Britain.

The affidavits filed at Mineola were most interesting. They recited how in months of demonstration in the laboratories of the Automobile Club of America Enricht had run engines he had never seen before, engines that could not possibly have been tampered with, on this fuel. Experts had watched every move he made. Moreover, it was asserted that the fluid was no longer the complete mystery of the early days. Yoakum had kept pressing Enricht, demanding as a business associate, his closest confidence. He insisted that the secret should become the property of the National Motor Power Co. And in a measure Enricht had given way. He had made public, at least within the circle in which sat Yoakum and the British experts, a list of ingredients entering into the compound, withholding only one element.

The ingredients were, as he said, common. The experts had bought them and compounded them, leaving it for the inventor to complete the fuel by shaking into each tankful a few drops of liquid from a little vial that never left his possession. Without this liquid the compound gave only slight evidence of motive power.

That little private bottle never left Enricht's possession, but one day it almost did. According to his own story, he had been lured into a deserted road near Farmingdale one day and had found himself confronted with armed men who demanded the bottle, which Enricht at length produced. However, it seems that Enricht had been prepared for some such contingency as he met on that lonely road, for according to his story he had provided himself with a duplicate bottle and it was the dummy he surrendered to the holdup men.

The foregoing is just another one of the questions that keep cropping up at every turn with Enricht and his fuel. However, at every turn he has kept himself covered.

Within the near future the case of Yoakum vs. Enricht must be coming up. Then it will rest with the courts whether Enricht shall be ordered to give to the National Motor Power Co. his full secret.

In the pendency of the suit, Enricht, by his own statement, has been in conference with Secretary Baker and Attorney General Gregory. He asserts the United States Government has made him an offer in excess of that made by the British Government, contingent, of course, on his fluid being all he claims it to be.

"The Government wants my secret only for war use. What I want the Government to do is to protect me after the war. I propose that I should be especially licensed to manufacture the compound, and that it be illegal for anyone else to make it. On that plan I was ready to sell my fuel to the Government for 10c. a gallon and to sell to the general public at 12c. a gallon, of those sales pay a tax of 2c. a gallon and enriching the Treasury at the rate of something like $70,000,000 a year."

So the "Cent-a-Gallon Gasoline" idea has been abandoned. Enricht explained that the cost of chemicals he needs has greatly advanced within the last two years.

"They have had the wrong idea from the first," he says. "Their theory is that I change the chemical composition of water, and they say truly that I must spend more energy in the process than would be produced. As a matter of fact, water is just a carrier. It takes minute quantities of my high explosive through the carbureter into the cylinder. Simple? Eh?"

Thus ends the dream of "One-Cent-a-Gallon Gasoline."

John Coats Takes a Bath

According to the *Electrical Experimenter*, all institutions depending upon the Marion (Ind.) Electric Light and Power Service were without current for a minute recently, and all because John Coats, who takes his regular Saturday evening bath at his home, got hold of a live wire in attempting to shake into life a defunct electric-light globe, and could not let go. Standing in the water with a 110-volt current coursing through his body, all Coats could do was to yell for help. A neighbor quickly discovered his plight, and telephoned the light company, who turned off all current. Coats was injured only in feelings.

Tar Oils for Use in Internal-Combustion Engines*

By A. Vincent Clark

The different classes of both solid and liquid fuels vary greatly in their calorific value. Some crude oils have a calorific value of about 20,000 B.t.u., whereas the heat value of tar oil is only approximately 16,000 B.t.u.

The various groups of liquid fuels show great differences during the process of combustion, and those rich in hydrogen are much more readily combustible than those deficient in this constituent, which is the case with tar oil, with the result that it cannot have a perfect gasification and combustion. Crude tar and the thick tar of gas-works are really intermediate between liquid fuels and coal, and usually the liquid requires some refining before being suitable for use as fuel for internal-combustion engines.

The accompanying table gives a comparison of the composition of various fuels as regards their percentage of carbon and hydrogen.

COMPARISON OF COMPOSITION OF VARIOUS FUELS

	C Per Cent.	O Per Cent.	H Per Cent.	Free H Per Cent.	Molecular Ratio H/C
Benzine	84.5	0.5	15.0	15.0	2.13
Petroleum-oil gas	85.0	2.0	13.0	13.0	1.84
Benzol (C_6H_6)	92.3	—	7.7	7.7	1.00
Tar oil	87.0	5.5	7.5	6.8	0.94
Heavy tar	86.0	9.0	5.0	3.9	0.54
Coal (flaming)	85.0	9.5	5.5	4.3	0.60
Coal (caking)	88.0	7.0	5.0	4.1	0.56
Lignite	64.0	30.0	6.0	2.2	0.41
Anthracite	94.0	3.0	3.0	2.6	0.33
Wood	50.0	44.0	6.0	0.5	0.12
Cellulose	44.4	49.4	6.2	0.0	0.00

Tar oil suitable for use in Diesel engines should have a specific gravity at 60 deg. F. not to exceed 1.1, calorific value not less than 15,700 B.t.u., fluid at 60 deg. F., and a maximum content of water, coke and ash not exceeding 2, 5 and 0.1 per cent., respectively.

Tar oils have been successfully used on some makes of Diesel engines without alteration being necessary to the engine, but more frequently cleaning is usually required when this oil is used and the pulverizers should be cleaned about every 100 hours. The carbon deposit is generally not very difficult to remove and can easily be cleaned off with a blast of air.

It has been found that engines work better on the tar oil when the load is fairly uniform, and less cleaning is required if they are able to keep running continuously at about full load. It is always necessary to start the engines on refined or light crude oil, and if they have to run with a light load, this oil must be continued until the load is increased. No alterations are needed to the setting of the valves whether the engines run on petroleum or tar oil, but in some cases it has been necessary to alter the flame plate of the injection valve to give a sharp edge around the orifice. It is advisable not to turn on tar oil until the jacket-water temperature has reached at least 120 deg. F., and in cold weather it is advisable to pre-heat the tar oil before it enters the fuel pump.

Attempts have been made to run engines with mixtures of refined or crude petroleum and tar oil, but such mixtures have been found liable to produce trouble, probably because of the oils separating out in the tank or distributing pipes, owing to the difference in their specific gravity, so that the actual fuel passing into the cylinders is not of uniform quality. This has been found to be especially the case in cold weather, but the difficulty is quite overcome by using separate pumps and pipes for delivering the two oils separately right up to the injection valve, and this system has been successfully employed on the Mirrlees Diesel engines.

The Mirrlees engine has been adapted to run on tar oil by the employment of what may be termed an ignition oil, which may be refined or light crude, and a small quantity of this latter oil is admitted before the tar oil in order to start combustion. This ignition oil is only about 5 per cent. of the amount supplied. Combustion begins, and the temperature of the gas inside the cylinder is raised by the burning of the ignition oil, so that as the heavier tar oil is immediately afterward injected into the combustion space it is at once ignited, the temperature being high enough to allow proper combustion. The method which is adopted involves the using of two separate pumps, one supplying ignition oil and the other tar oil, the latter being under the control of the other. The two oils enter the fuel valve by different passages, and the ignition oil is admitted as nearly as possible at the bottom of the needle. By this means the lighter fuel is first injected into the cylinder and the arrangement gives quite satisfactory combustion of the tar oil, so that practically an invisible exhaust is obtained. This method of injecting the fuels also reduces the amount of carbon deposit in the combustion space, and the valves and pistons show remarkable freedom from deposits, so that they do not require much more attention than is ordinarily given to these parts.

The engines of the semi-Diesel type may also be run successfully with tar oil as fuel by using an ignition oil, but these engines need an increased amount of the latter, varying according to the design, up to approximately 30 per cent. Upon running them on tar oil it is found that after they have been working for some time at about full load, the amount of ignition oil can be reduced, provided the load remains constant, and in some cases entirely cut out. Probably this feature can be explained by the formation of carbon in the combustion chamber remaining incandescent, and thus serving to ignite the incoming charges of tar oil.

Generally speaking, the hot bulbs need cleaning every day, as a large amount of deposit accumulates in them, which if not removed will make the engine difficult to start and there is a possibility that the bulbs will eventually become completely choked. In addition these engines are much more susceptible to changes in the quality of tar oil than engines employing high compression.

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*Abstract from an article in the April issue of "Gas and Oil Power," London, England

Applications for Water Appropriations

Applications have been filed with the California State Water Commission for the appropriation of water for the generation of power by the following:

The Nevada-California Power Co., of Riverside, Calif., has applied for 12 sec.ft. of Birch Creek in Inyo County for the generation of electric energy to be developed at existing power plants Nos. 2, 3 and 4, by falls 913, 791 and 995 ft., respectively, the horsepower to be developed being 1244, 1079 and 1356, respectively. After use it is proposed to return the water to the Hillside Water Co. The estimated cost of the works is $42,500.

The Southern Sierras Power Co., of Riverside, Calif., has applied for 12 sec.ft. of Birch Creek when said water may be available, for the generation of electric power at existing plants Nos. 5 and 6 of this company. It is proposed to develop 500 and 513 hp. by falls of 366 and 230 ft., respectively, the water to be returned after use to the Hillside Water Co. The estimated cost of the works is $42,500.

Chicago Edison Company's Off-Peak Rates

Some of the figures given on page 747 of *Power* for May 21 do not correctly represent the off-peak rates of the Commonwealth Edison Company of Chicago. George H. Jones, power engineer of that company, states that for off-peak business a limited-hour contract is offered, modified by a rider which provides for an annual guaranty of $24 per kilowatt of demand required. The contract is on the demand basis, the off-peak demand charge being $1.40 per month per kilowatt for the first 25 kilowatts and 90c. per month per kilowatt for excess. The energy charge is 3c. per kilowatt-hour for the first 5000 kw.-hr. of consumption per month; 1.3c. for the next 25,000 kw.-hr.; 1.1c. for the next 70,000 kw.-hr.; and 0.9c. for over 100,000 kw.-hr. A cash discount of 10 per cent. is allowed on the energy charge.

Men Wanted for Submarine Duty

It is desired to call the attention of young men who have had technical training and experience to the fact that their abilities can best be put at the service of the country by selecting a branch of service in which their special qualifications will be of the greatest use.

The Submarine Force of the United States Navy requires the services, as officers on board submarines, of young men who have had technical training in mechanical and electrical engineering and who have had experience in these professions. It is intended to enroll a number of such men as provisional ensigns in the Naval Reserve Force, give them a course of instruction in deck duties at Annapolis and a course in submarine work at New London. Those who successfully pass these courses will then be sent on board submarines for regular duty.

It is requested that any men who desire this duty and who are qualified as below outlined, send their names and addresses to the Commander Submarine Force, U. S. S. "Chicago," care of Postmaster, New York. Qualifications required: Desire to serve in submarines; degree of M. E., E. E. or E. M.; 2½ years' practical experience in profession; not over 35 years old; physically strong and sound. Candidates should, if practicable, receive the indorsement of one of the following organizations: Naval Consulting Board, National Research Council, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Mining Engineers.

Government Calls for Thousands of Technical Men

You may hit the Hun without going to France. In other words, the great army of specialists behind the men behind the guns, working in connection with the production of the material of war, are quite as necessary as the actual fighting forces in the prosecution of the nation's greatest undertaking. The United States Civil Service Commission, whose duty it is to recruit the civilian forces, announces that the War and Navy Departments are badly in need of large numbers of technically trained men. The commission urges, as a patriotic duty, that qualified persons offer their services to the Government at this time of great need. Among the positions now open are the following:

	Usual Entrance Salary
Automotive engineer	$2,400 to $7,200 a year
Automotive designer	1,800 to 3,000 a year
Automotive draftsman	1,400 to 2,000 a year
Automotive tracer	1,000 to 1,400 a year
Expert in motor-vehicle standardization	1,600 to 3,000 a year
Mechanical engineer	3,500 a year
Junior mechanical engineer on high-pressure apparatus	1,600 to 2,400 a year
Mechanic experienced on high-pressure apparatus	3.00 to 5 00 a day
Inspector of mechanical equipment	2,700 a year
Inspector of structural steel	2,400 a year
Inspector of laundry machinery	1,800 a year
Operative in gas manufacture	1,600 to 2,400 a year
Assistant operative in gas manufacture	3 00 to 5.00 a day
Superintendent of high-explosive and acid plant	1,500 to 1,800 a year
Marine-engine and boiler draftsman	3.28 to 7 04 a day
Metal-furniture draftsman	4 00 to 6.00 a day
Engineering draftsman	3 04 to 7 04 a day
Mechanical draftsman	4 00 to 8 00 a day
Apprentice draftsman	480 a year
Refrigerating engineer	3,000 a year

A further long list of technical positions in the War, Navy and other departments are to be filled. For the positions named applicants are not required to report at any place for examination, but are rated upon their education, training and experience, and in some cases on work submitted with the application. Physical ability is also considered in some instances. Ratings are arrived at from information set out in the application blank and from corroborative evidence.

The Civil Service Commission calls particular attention to the fact that all necessary information concerning civil-service positions, and application blanks therefor, may be obtained free of any cost by applying to the commission's representative at the post office in any important city, or by addressing the United States Civil Service Commission, Washington, D. C. Many of the drafting positions are open to women.

Will Tie-In Three Electric Companies

At a recent meeting of the representatives of the Pacific Gas and Electric Co., the Northern California Power Co. and the California-Oregon Power Co. and the members of the California Railroad Commission, at Sacramento, Calif., the details were completed for the "tie-in" of the three companies to effect a full utilization of the hydro-electric facilities of Northern California. As a result, the three companies will immediately start construction on transmission lines to connect up the systems of their respective companies at a total cost of $640,000.

The California-Oregon Power Co. will connect its system up with that of the Northern California Power Co. by reconstructing its transmission line from the plant at Copeo to Castella and by building a 70,000-volt transmission line from Castello to Kennet, a distance of 90 miles. The estimated cost of this work is placed at $330,000. The Northern California Power Co. is to reinforce its lines from Colman to Hamilton, a distance of 80 miles, by the addition of copper conductor of sufficient capacity to handle a load of 8000 kw. throughout the year. The work to be done by the Pacific Gas and Electric Co. includes the construction of a 60,000-volt transmission line from Colusa Corners, near Colusa, to Drum-Cordella, a distance of 40 miles, and the installation at their substation of from 60,000 to 100,000 volts capacity to deliver power into that line.

The entire project is to be completed by Sept. 1, according to the present plans, and it is estimated that as soon as the surplus power from the northern part of the state becomes available the load taken from the steam-generating plants will be such as to effect an economy in the use of fuel oil to the extent of 240,000 bbl. per year.

As soon as the "tie-in" is effected, the Pacific Gas and Electric Co. will be required to reroute power from certain of its existing plants over Wise-Stockton-Mission-San José line to the southern district now served by the company.

Steam and Water Packing and Rubber for Chile

Consul John R. Bradley states in *Commerce Reports* that the American consulate at Punta Arenas, Chile, is desirous of being supplied with catalogs of steam and water packing, sheet rubber and sheet asbestos. There is quite a large demand there for all kinds of packing. This is the home port for some 20 small steamers plying in the coasting trade, besides which there are five meat freezing and packing plants, several sawmills, an electric-light plant, and a canning works; also a coal mine. The purchasing agents in most cases understand English, and catalogs may be furnished in that language. To prevent delay in making these firms acquainted with American products a list of users of steam and water packing and sheet rubber in Punta Arenas, to whom catalogs should be sent direct, may be procured from the Bureau of Foreign and Domestic Commerce or its district and coöperative offices upon referring to file No. 99693.

Use of Bran for Fuel in Argentina

According to the *Commerce Reports* one milling company in Argentina at present has a daily production of about 280 tons of bran, but there is practically no local market for it as stock food, and it cannot be exported because of the lack of shipping. Nearly all of it is used for fuel. The company itself burns about 100 tons per day, and this replaces some 60 tons of coal, which was formerly used. According to Mr. J. Buelinckx, general manager of the company, bran gives about the same result as wood. The remainder of the output of this establishment—about 180 tons a day—is sold to various concerns for fuel. The present price is 28 pesos per metric ton, and this is somewhat cheaper than wood. The company is experimenting in making briquets of bran, but as yet has not commenced their manufacture upon a large scale.

The Future of Water and Steam Power

The following is from lectures prepared by Prof. L. P. Breckenridge as part of his fuel-conservation work for the Fuel Administration.

The development of water power in this country will be gradual. Our coal supplies are vast, and we shall use coal for power production. We shall need 50,000,000 hp. by the year 1930, and of this amount, one-fifth should be water power, or 10,000,000 hp., leaving 40,000,000 hp. to be made by burning coal. This power is probably in excess of our total available potential water power. The writer believes that we might increase our production of power by 12,000,000 hp. without the consumption of any additional coal. To accomplish this, we should expect to assign to water power a development of 4,000,000 hp. This would leave 8,000,000 hp. to be developed by burning coal. It would mean the adoption of more economical equipment on the one hand and more economical methods of procedure and operation on the other.

From a chart, "Power Development in the United States," the following figures were taken:

POWER DEVELOPMENT IN THE UNITED STATES

Year	Millions of Horsepower		
	Water	Steam	Gas
1870	1 10	1 35	...
1880	1 12	2.40	...
1890	1 25	5.00	...
1900	2 20	14.00	0.4
1910	5 25	23 50	
1920*	(9 00)	(33 00)	

* Extended.

While it is not possible to determine with great accuracy figures such as given, it is sufficient to indicate the fact that the total power development in the United States is very great, and that the percentage of the total power now being developed from water fortunately is increasing.

As an indication of present tendencies, it may be well to mention a few of the more important water-power developments that have been completed within recent years, including also the installations at Niagara Falls:

Power Companies at Niagara Falls	Installation, Horsepower
On American side:	
Hydraulic Power Co., of Niagara Falls	144,000
Niagara Falls Power Co	118,300
On Canadian side:	
Ontario Power Co., of Niagara Falls, Ontario	120,000
Canadian Niagara Power Co	62,500
Electrical Development Co., of Ontario (limited)	52,000
International Railway Co	3,000
Total	499,800

The "Salmon River," N. Y., 30,000 hp., under 235-ft. head.

The "Tallulah Falls," Ga., 70,000 hp., under 580-ft. head.

The "Ocoee River," Tenn., one of 27,000 hp., under 110-ft. head, and another 30,000 hp., under 272-ft. head.

The "McCall Ferry," Susquehanna River, ultimate capacity 135,000 hp.

The "Coons River," 13 miles above Minneapolis, 3500 hp. under 17½-ft. head. "Keokuk," Iowa, Mississippi River, present 120,000 hp., ultimate capacity 300,000 hp. under 20-39-ft. head.

The "Pitt River," Mt. Shasta, Redding, Calif., ultimate capacity 200,000 hp., under 939-ft. head.

The "Klamath River," Thrall, Calif., present 10,000 hp., ultimate 53,000 hp. Head not given.

"Big Creek," P. L. and P. Co. to Los Angeles, present 60,000 hp., ultimate 400,000 hp., 1900-ft. head, 15,000 volts, 241 miles transmission.

The price at which power is sold to the consumer depends upon several important factors: (a) The cost of producing the power, (b) the cost of distributing, (c) the amount purchased by the consumer, (d) the amount available at any one time for the consumer, (e) the time at which the power must be used, (f) the extent of coöperation between the producers and users of power, (g) the cost of administration.

At Niagara Falls large quantities of power are sold at \$20 per hp. per year, which is about 0.3c. per kw.-hr. This power is sold near the falls, and the distributing cost is therefore small.

In Toronto, 90 miles from Niagara Falls, the city buys large blocks of power at \$18.50 per hp. and sells 10-hour power at \$28.

In Norway, where the great air-nitrate industries consume large amounts of power, the price is said to range from \$1.90 to \$12 per hp. per year.

In this country steam-generated power is made and sold at prices ranging from \$30 to \$150 hp. per year for 10-hour power. If the plant capacity is 1000 hp. or over, the cost of power need not be more than \$25, with the price of coal at \$4. The cost will, of course, increase for the smaller plants, but may be as low as \$15 for larger plants (3000 hp.) and coal at \$2 a ton.

Test Electric Welding for Ships

A report of the purposes and possible benefits of the ship-welding test now being conducted by the Emergency Fleet Corporation at the Federal Shipbuilding Co. plant at Newark, N. J., under the direction of Arthur J. Mason, has been made to Charles Piez, vice president of the corporation.

The text of Mr. Mason's report follows in part:

Electric welding in its various phases has for years been employed in shipyards and in the arts generally, but for a number of reasons the work has been confined to odd jobs and repairs and the test itself will take the form of building part of a hull at the Federal Shipbuilding Co.'s plant, Newark.

It has been necessary to design a ship to suit the material available, without encroaching on that needed for the regular ship construction at the plant. This has been done. The hull will have the outline, dimensions and strength conforming to the ships the Federal company is building.

Briefly, the program is to assemble a hull rapidly by spot welding, tacking the ship together. After the material is thus assembled and fastened with spot welds, so that it is sufficiently strong to hold its shape, the work is completed by arc welding all seams to insure strength and render the work water-tight. Roughly, the spot welds are expected to be about 10 in. apart.

Electric welding offers a great field for lightening a ship. In this design various views of this opportunity will be tried out. The field here is very great—ultimately 10 per cent. of the steel may be eliminated.

The manufacture of the spot-welding yoke and appliances is placed in the hands of the Universal Electric Welding Co. of Long Island City. The design of the yoke is completed, the patterns are made and steel castings will be forthcoming in a few days. The early stages of the arc welding are to be accomplished by the Wilson Electric Co., which was so successful in the work on the German ships' repairs, but it is the intention to call in all men with ideas and apparatus and to give them a field to test out in actual work. To this end Professor Adams' committee is searching out all available talent.

An adequate system of testing the work when done is under consideration. The primary test will consist of filling the hull with water and shifting the points of support under continual and close scrutiny, as one-quarter of the whole will be riveted in the normal manner. There will be always a gage of comparison with that portion which is welded.

Likewise there will be a chance for comparison of the two forms when subjected to abuse by bumping with rams and in various other ways.

Queer Notion of Factor of Safety

On a recent trip to a remote part of the state, one of the boiler inspectors of the Industrial Accident Commission found an installation which was, to say the least, unique. The boiler was of the vertical tubular type, 30 in. in diameter, and was fitted with a ball-and-lever safety valve. In addition to the ball weight, the lever carried four large-sized horseshoes. Upon inquiry it developed that the operator of the boiler thought he had a factor of safety of 5, since he carried only 40 lb. pressure, and the steam gage was graduated to 200 lb. Any idea that the horseshoes were a symbol of good luck, was soon dispelled by the inspector, who pointed out the grave danger of "loading" the safety valve.—*California Safety News.*

According to Mr. Knudsen, manager of Burmeister & Wain, builders of Diesel motors in Copenhagen, fish oil will make an excellent fuel for Diesel engines used as prime movers. Further, this oil will be practicable for small fishing boats where explosion-type motors are used for motive power. It is interesting to note that experiments have already been made, using fish oil as fuel in fishing-boat engines, and that these experiments have proved successful. —*Commerce Reports.*

Heating Values of Fuels

The following tables are from lectures prepared by Prof. L. P. Breckenridge as part of his fuel conservation work for the Fuel Administration.

TABLE I. RELATIVE HEATING VALUE OF WOOD AND COAL

Kind of Wood	Weight per Cord in lb.	Heating Value B.t.u. per lb.	Equivalent Weight of Coal of 13,500 B.t.u
Ash	3520	5450	1420
Beech	3250	5400	1300
Birch	2880	5580	1190
Cherry	3140	5420	1260
Chestnut	2350	5400	940
Elm	2350	5400	940
Hemlock	1220	6410	580
Hickory	4500	5400	1800
Maple, hard	3310	5460	1340
Oak, live	3850	5460	1560
Oak, white	3850	5400	1540
Oak, red	3310	5460	1340
Pine, white	1920	6830	970
Pine, yellow	2130	6660	1050
Poplar	2130	6660	1050
Spruce	1920	6830	970
Walnut	3310	5460	1340
Willow	1920	6830	970

TABLE II. APPROXIMATE HEATING VALUES OF DIFFERENT COALS

Fuel	Heating Values B.t.u. per Pound
	(varies)
Wood (dry)	5.500–7,500
Peat (air-dried)	about 7.500
Lignite	5,200–7,500
Bituminous coal	9,500–14,500
Anthracite	11,500–14.000
Straw	about 5,100
Corn	7,200–8,200
Tanbark (dry)	about 6,100
Hydrogen	62,000
Crude oil	17,500–21,000
Kerosene	0.863 sp.g.–18,700
Gasoline	0.710 sp.g.–18,500
Natural gas	About 850 per cu.ft.
Producer gas	About 125 per cu ft.
Blast-furnace gas	About 95 per cu.ft.

Constants for Heat Transmission

B.t.u. transmitted per square foot per hour per degree difference in temperature between inside and outside air are as follows:

CONSTANTS FOR BRICK WORK

4 in. thick = 0.68
8 in. thick = 0.46
12 in. thick = 0.33
16 in. thick = 0.27
20 in. thick = 0.23
24 in. thick = 0.20
28 in. thick = 0.18
32 in. thick = 0.16
36 in. thick = 0.15

MISCELLANEOUS CONSTANTS

Reinforced concrete, 20 per cent. more than brick. Add one-third more for stone. Add one-half more for cement or concrete walls.

1 sq.ft. of wood as flooring	0.083	1 single skylight	1.118
1 sq.ft. of wood as ceiling	0.104	1 double window	0.560
1 sq.ft. of wood as wall	0.220	1 double skylight	0.621
1 sq.ft. fireproof flooring	0.124	1 door	0.420
1 sq.ft. fireproof ceiling	0.145	Cor. iron wall	0.840
1 sq.ft. cement as flooring	0.310	Wood wall	0.280
1 sq.ft. dirt as flooring	0.230	Copper, silver-plated and polished	0.02657
1 sq.ft. wood, under slate, or composition roof	0.300	Copper, polished	0.03270
1 sq.ft. wood, under iron	0.170	Zinc and brass, polished	0.04906
1 sq.ft. tile (no bds.underneath)	1.250	Sheet iron	0.08585
1 sq.ft. cement roof	0.600	Cast iron, new	0.6480
1 single window	1.090	Cast iron, rusted	0.6868
1 single monitor	0.950	Oil or varnish	1.4800

The amount in square feet of each kind of surface is to be multiplied by its respective constant shown, and by the difference in temperature between inside and outside air. The sum gives the loss of heat in B.t.u. by exposure then add to the foregoing as follows:

Ten per cent. for northern exposure and where the winds are to be counted on as an important factor.

Ten per cent. if heated day time only, and the location of the building is not exposed.

Twenty per cent. when the building is heated day time only, and the location of the building is exposed.

Thirty per cent. when the building is heated during winter months intermittently with long intervals of non-heating. —*From the "Ideal Fitter," compiled from well-known authorities.*

When the engineer's requisitions are not honored in full, it is time to get a new chief or a new man in the supply department. Trust a man or fire him.—*Marine Engineering.*

A Good Suggestion for All

Do you ride all the bumps or bumpers of the war news from day to day? Many good patriots do. Each morning brings its passing changes in the war situation; now gloom in the form of a setback on the western front, or further disintegration in Russia, or rumors of delay in our own war preparations. Next morning, like as not, there will be something of a hopeful nature, such as the checking of the Huns' drive in Italy, or a raid by the British or French, or good news here at home. To follow and feel all these glees and glooms from day to day is human and exciting. But it involves much useless wear and tear of the spirit. There is another viewpoint—that of disregarding the daily shifts and changes in the war situation, keeping one's attention concentrated on the long haul of war and the final result.

That haul is still a long one. For Germany is not beaten yet, but the results are sure, because we have right on our side, and also the largest battalions. If you grow warm and then cold, and alternate between enthusiasm and depression with the daily news changes, you not only waste your energy, but are likely to fluctuate in your policy as a business man and your determination as a patriot. The good resolution to save food, support Uncle Sam financially and cheerfully, adjust your business and habits to the war program will be stiffened on the morning that you read about some Hun atrocity against our own soldiers in France. But in a week there may be news of a different character, which leads you to let down a little, on the assumption that Germany has begun to crack and that the war is about over. It is good business, good patriotism and good conservation to forget most of the headlines in the morning paper and concentrate strictly upon the long, hard grind between today and the final result. That will save your spirit, buck up your resolution and enable you to do your utmost in winning the war.

Moreover, it will enable you to get out of the war, as a business man and a patriot, the utmost benefit from war adjustments. Those adjustments make for wiser and more economical personal habits, as well as a business grounded in sound economy. Even should peace come tomorrow, you can never go back to the old heedless wasteful ways either in business or livelihood. Don't ride the bumps of the war news!

Settle down in harness for the long grim haul that counts. —*James H. Collins, Editor "Weekly Bulletin."*

Modern Towers of Babel

One of the distinct hazards in employment in this country rests on the coworking of men of different nationalities who do not understand the language of one another, and the question has been frequently raised in the courts as to when an employer becomes liable for injury to one of his workmen caused by negligence of another who has not become "acclimated" to our language.

Very recently this question was presented to the New York Court of Appeals in the case of Barber vs. Smeallie, 117 Northeastern Reporter, 611, where a non-English speaking employee started a pump while a coemployee was known to him to be in a perilous position, resulting in injury to the latter. The injured man, in suing his employer, sought to fix liability under the rule of law that an employer is responsible for injuries inflicted by a fellow employee who was previously known to be so incompetent for the work assigned to him as to make the employer guilty of negligence in retaining him to the peril of other workmen. But the court, reversing judgment which had been awarded in the injured man's favor, decided that a worker cannot be said to be incompetent merely because he does not understand English, and that the employer cannot be held in such instances unless there was a direct and natural connection between his unfamiliarity with English and the accident. This unfamiliarity could not be said to be the cause of the accident in this case; the direct cause was mental deficiency of the negligent man, apart from his linguistic ignorance, and it was not claimed that the employer previously knew of that deficiency.

Personals

J. C. Halvey has resigned his position as master mechanic with the A. H. Crist Co., Cooperstown, N. Y., to accept a position with the Air Nitrates Corporation, and after spending some time studying the processes at Niagara Falls, he will proceed to Muscle Shoals, Ala.

Frederick D. Herbert, who has for years been identified with the marine industry and for the last ten years New York manager of the Terry Steam Turbine Co., has been elected president and general manager of the Kearfott Engineering Co., Inc. He will continue to handle the marine work of the Terry Steam Turbine Co., at 95 Liberty St., New York, which is the office of the Kearfott Engineering Co., Inc.

J. A. Kinkead, who has been the New York representative of the Parkesburgh (Penn.) Iron Co. for the past ten years, leaves shortly to locate in San Francisco to look after the interests of the same company and also the Chicago Railway Equipment Co. there. On finishing his course in the University of Illinois, Mr. Kinkead was employed as chief inspector of material for the Northwestern Railroad and later had general charge of the inspection of material for the American Locomotive Co. He is a well-known member of many technical and engineering societies and clubs.

Engineering Affairs

The Pennsylvania State Association of the N. A. S. E. will hold its annual convention at Chester, Penn., June 20, 21. Indications point to a successful meeting.

The Canadian Association of Stationary Engineers will hold its twenty-ninth annual convention at London, Ont., June 25-27. The meetings of the delegates and the display of the exhibitors will be held at Hymen's Hall, Queens Ave. and Clarence St. A hustling local committee assisted by G. C. Keith, Secretary of the Exhibitors' Association, are completing final arrangements.

The National District Heating Association will not hold its regular convention this year, but the executive committee, together with the chairmen of the standing committees, and as many members as possible, have decided to meet at the Breakers Hotel, Cedar Point, Ohio, July 8-9, to discuss various matters now affecting the heating companies and to receive reports of the standing committees for the year.

Miscellaneous News

Production of Coal was somewhat curtailed in the Charleston, (W. Va.) section last week operators of the mines claiming that a part of the loss of production was due to the failure of the Logan Power Co. to furnish sufficient current to them.

United States Fuel Administrator Garfield announced recently the appointment of John P. White, Labor Advisor to the Administration, as the representative of the Administration on the Labor Policy, of which Felix Frankfurter is chairman. It is the task of the Labor Policy Board to find out what the needs of labor are so that a labor budget can be made. The Government departments having industrial-service bureaus independent of each other have given rise to some confusion and waste, variations in wages leading workmen to leave one job for another. In one sense the Labor Policy Board will constitute a centralized employment agency for the United States.

Business Items

The H. W. Johns-Manville Co's. Houston (Tex.) office will be located at 424-426 Washington Ave. on and after July 1.

The Colonial Supply Co., Pittsburgh, Penn., because of its increasing business has purchased and moved into the building at 217 Water Street.

The A. Gulowsen A/S of Christiania, Norway, manufacturers of the "Grei" heavy oil engine, has incorporated the Gulowsen Grei Engine Co. at Seattle, Wash., and is erecting a large factory where these engines will be manufactured for supplying the American trade.

The Crane Packing Co.'s New Yory City office has moved to larger quarters in the Park Row Building, with Julian N. Walton as manager. A. W. Payne, for some time manager of this district, has been made sales manager of the United States and Canada, with headquarters at the home office in Chicago. The Pittsburgh offices are located in the May Building, the Philadelphia office in the Colonial Trust Building.

The Reeves Engineering Co., Trenton, N. J., has been incorporated to act in the capacity of constructing and efficiency engineers and to specialize in the design and construction of power and industrial plants. The business and assets of the Reeves-Cubberly Engine Co., Trenton, N. J., have been absorbed by the Reeves Engineering Co., which will continue the manufacture of the Reeves steam and gas engines.

Parr Terminals Co., Wilfred N. Ball. Engineer, 225 First National Bank, Oakland, Calif., wants catalogs and other data from manufacturers of materials or equipment used in the construction of piers, warehouses, industrial buildings, belt line railway and street work and cargo handling equipment; coal bunkering and handling equipment; floating drydock and marine railway equipment; general shipyard machinery and equipment.

Peerless No. 4810 Air Hose was used in a remarkable record at driving rivets made under handicap at the Morse Dry Dock and Repair Co.'s plant in South Brooklyn recently. Bertram Bieher, riveter, and his holder-on, Eddie Hesse, with four heater boys, drove 1480 regulation-size ⅞-in. button-head rivets in 4 hours and 10 minutes. For a record of this kind it is obvious that air hose plays an important part in rivet driving. It would not do to have to stop to make repairs.

Trade Catalogs

Monthly Stock List of Cutters.—The Cleveland Milling Machine Co., Cleveland, Ohio. Pp. 36; 3½ x 6 in.; illustrated.

The Stoker for the Higher Volatile Coals. Laclede-Christy Clay Products Co., St. Louis, Mo. Pp. 12; 8½ x 11 in.; illustrated.

Buffalo Forges. Buffalo Forge Co., Buffalo, N. Y. Pp. 111; 5 x 7½ in. Illustrating and describing complete line of portable and stationary forges.

Coxe Stoker. Combustion Engineering Corp., New York City. Bulletin Cl. Pp. 29; 6 x 9 in. Showing the application of the traveling grate idea. Copy free on request.

Zelnicker's Bulletins. Nos. 241 and 243. Walter A. Zelnicker Supply Co., St. Louis, Mo. Listing bargains in rails, cars, locomotives, general power-plant equipment and machinery.

Link-Belt Silent Chain. Link-Belt Co., Chicago, Ill. Book No. 312, Pp. 40; 6 x 9 in. Giving illustrations and reasons why the silent chain drive is the most efficient transmission for operating machine tools.

Pulverized Coal Equipment. Lehigh Car, Wheel and Axle Works, Catasauqua, Penn. Catalog No. 71. Pp. 28; 8 x 10½ in. Descriptions and illustrations of various units used for the production of pulverized coal attractively presented.

Skinner Automatic Engines. Skinner Engine Co., Erie, Penn. Pp. 47; 8½ x 11½ in. An attractive illustrated catalog devoted entirely to the exposition of single-valve center- and side-crank Skinner engines, in single-cylinder type from 50 to 600 hp.

Light for the Clothing Industry. Edison Lamp Works of the General Electric Co., Harrison, N. J. Bulletin No. 43,410 contains the latest information on the correct methods of lighting industrial plants. It is well illustrated, showing various lighting schemes most suitable for industrial purposes.

Wheeler-Balcke Cooling Towers. Wheeler Condenser and Engineering Co., Carteret, N. J. Bulletin 109-B. Pp. 28. Shows Wheeler-Balcke cooling towers of numerous designs in capacities varying from a few thousand gallons per hour to nearly a million gallons per hour. It is shown better, in some cases, to combine natural and forced draft. Two pages are devoted to Wheeler-Barnard forced draft cooling towers, which are at times found preferable to the Wheeler-Balcke. Wherever sufficient ground area is available, however, the Wheeler-Balcke is usually considered by consulting engineers as the standard natural-draft tower.

NEW CONSTRUCTION

Proposed Work

9.

Me., Waterville—The Lockwood Co. is having plans prepared by I. W. Jones, Arch., Milton, N. H., for the erection of a new hydroelectric power plant here.

Mass., Boston—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has received low bids for improvements to its power plant at the Navy Yard, here, from Rideout, Chandler & Joyce, 178 High St., $31,000 (180 days); W. G. Cornell Co., 923 12th St., Wash., D. C., $35,884 (100 days); Lynch & Woodward, 287 Atlantic Ave., $37,764 (100 days).

Mass., Wellesley—Wellesley College is having plans prepared by French & Hubbard, Engrs., 88 Pearl St., Boston, for the erection of a 35 x 45 ft. addition to the boiler house here.

Conn., Danielson—The Goodyear Cotton Mills, Inc., plans to build a brick power house and install steam turbine engines. Estimated cost, $100,000.

N. Y., Auburn—The Empire Gas and Electric Co. plans to issue $1,717,000 bonds; the proceeds will be used to improve and extend its system. H. S. Coleman, Geneva, Gen. Mgr.

N. Y., Buffalo—The Buffalo General Electric Co., 206 Electric Bldg., has had plans prepared for the erection of a 1-story, 95 x 106 ft. sub station addition to its plant. Estimated cost, $17,000.

N. Y., Ossining—The Commission of New Prisons, Hall of Records, New York City, will receive bids for the erection of 5 buildings at Sing Sing; heat and power systems will be installed underground in tunnel. Machinery includes two 400 hp. boilers, piping, 25 hp. motors, etc.

N. Y., Otisco—The Otisco Light and Power Co. has petitioned the Public Service Commission for authority to build and operate an electric lighting plant.

N. Y., Warsaw—The Warsaw Elevator Co. has had plans prepared for repairs to its 1-story power house. C. E. Ketchum, Pres.

N. J., Newark—The Board of Education will soon award the contract for the installation of heating and power in the proposed Hawkins St. School.

N. J. Ogdensburg—The Wharton Steel Co. plans to rebuild its boiler plant at the limestone quarry which was recently destroyed by fire.

Penn., Enola—The Pennsylvania R. R. plans to improve and alter its power plant and engine house here. A. C. Shand, Broad St. Station, Philadelphia, Ch. Engr.

Penn., Meadville—The Northwestern Electric Service Co. plans to build an electric transmission line from here to Kearsage. A. E. Rickards, Commerce Bldg., Erie, Mgr.

Penn., Philadelphia—The Mifflin Chemical Corporation, Delaware and Tasker St., has had plans prepared for the erection of an addition to its boiler plant.

Wash., D. C.—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has received low bids for the construction of an electric duct system between the Navy Yard, here and the Capitol Power plant at Garfield Park (a) work complete (b) work complete according to bidder's plans and specifications, from N. W. Ryan, New York City, (a) $14,904 (60 days); G. M. Gest, 1330 Woolworth Bldg., New York City (a) $16,500 (75 days); F. S. Smith, 612 14th St., (a) $28,643 (60 days).

Wash., D. C.—The Bureau of Yards and Docks, Navy Dept., plans to build a power house at St. Juliens Creek, Va.; Specification No. 3072. Estimated cost, $7500.

Va., Norfolk—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will soon award the contract for the installation of an electric lighting and power system in shipbuilding slip No. 1. Estimated cost, $15,000. Noted May 28.

W. Va., Mannington—The Rachel Coal Co. plans to rebuild its power house, ventilation system, etc., at its mine.

N. C., Henderson—The Henderson Box and Lumber Co. plans to install a 150 hp. boiler, engines and a 150 kw. direct connected generator.

Tenn., Ripley—The Ripley Oil Mills is in the market for a second-hand 20 x 42 in. left-hand, rope-drive Corliss engine and also a 75 hp. crude-oil engine.

Tenn., Rockwood—The Public Light and Power Co., Chattanooga, plans to rebuild transmission line from here to Lenoir City. W. R. Stern, Winchester, Mgr.

Tenn., Spring City—Dayton Light and Power Co. plans to build transmission line from here to Dayton.

Ky., Fulton—A. S. Baldwin, Chief Engr. of Illinois Central R. R., 135 East 11th St., Chicago, will soon award the contract for the erection of various units here, including a 40 x 150 ft. boiler house; two 150 hp. boilers, one 85 ft. electric turntable, etc., will be installed. Total cost, $225,000.

Ky., Whitesburg—The Elkhorn Superior Block Coal Co has increased its capital stock from $35,000 to $100,000; the proceeds will be used to install new electrical machinery.

Ohio, Canton—The Canton Gas and Electric Co. has petitioned the State Public Utilities Commission for authority to build a high tension transmission line along the right of way of the Chicago, Burlington and Quincy R. R.

Ohio, Cleveland—The National Woolen Co. is having plans prepared by A. Gairing, Arch., for the erection of a 2-story power plant. H. W. Stecher, 3131 West 53rd St., Pres.

Ohio, Creeksville—The Central Power Co. plans to build a transmission line from here to Bearfield Twp E. T. Wagenhals, Newark, Supt.

Ohio, Fremont—The City Council is considering the installation of a gas and electric lighting plant to be erected here.

Ohio, Norwood—City will sell bonds for improvements and extensions to its electric lighting and water works systems. W. R. Suhr, Auditor.

Mich., Homer—The Homer Electric Light and Power Co. plans to build additions to its plant. G. H. Rising, Engr.

Ill., Amboy—A. S. Baldwin, Chief Engr., of the Illinois Central R. R., 135 East 11th St., Chicago, will soon award the contract for the erection of various units here, including a 40 x 150 ft. boiler house, etc.; two 150 hp. boilers, one 85 ft. electric turntable, etc., will he installed. Total cost, $250,000.

Ill., Carbondale—A. S. Baldwin, Chief Engr. of Illinois Central R. R., 135 East 11th St., Chicago, will soon award the contract for the erection of various units here, including a 40 x 150 ft. boiler house, two 150 hp. boilers, one 85 ft. electric turntable, etc., will be installed. Total cost, $250,000.

Ill., Jacksonville—City plans to vote on bond issue to build a dam, control station, etc. About $75,000. S. Greeley, 64 West Randolph St., Chicago, Engr.

Ill., Mounds—A. S. Baldwin, Chief Engr. of the Illinois Central R. R., 135 East 11th St., Chicago, will soon award the contract for the erection of various units including an addition to the boiler house; two 150 hp. boilers, one 85 ft. electric turntable, etc., will be installed Total cost, $250,000.

Wis., Wausau—City plans to establish a central lighting and heating plant here.

Iowa, Neola—City plans to improve its electric lighting and power plant. Estimated cost, $16,000.

Iowa, Sioux City—The Midland Packing Co. plans to build a boiler and power plant in connection with its proposed packing plant. Gardner & Lindberg, 140 South Dearborn St., Chicago, Engr.

Minn., St. Paul—The Northern Pacific Mutual Beneficial Association is having plans prepared for the erection of a hospital and power plant. Total cost, $300,000. H. S. Smith, 203 Railroad Bldg., Pres. L. Bassindale, Capital Bank Bldg., Arch.

S. D., Bradley—Dakota Northern Power Co. plans to build a power station. E. H. Lewis, Secy.

Mo., Maysville—City has plans under consideration for improvements to its electric lighting plant.

Okla., Miami—The Luck Jenny Mining Co. will build a concentration plant at its mine in Hockerville. Equipment including engines, boilers, etc., will be installed. Estimated cost, $60,000. W. F. Cooper., Supt.

Utah, Salt Lake City—Salt Lake Co. will soon award the contract for the installation of a heating system in the courthouse. S. G. Clark, Clerk.

Nev., Palisade—The Union Mines Co. plans to install a large quantity of electric machinery in its proposed concentrating plant.

Ariz., Kingman—The Schuylkill Mining Co. plans to install a power plant in connection with its milling plant now under construction.

Ariz., Phoenix—The State Hospital for the Insane has had plans prepared for the erection of a power house. Noted Apr. 16

Wash., Bellingham—The Boundary Red Mountain Mine plans to rebuild its power plant which was recently destroyed by fire.

Calif., Lompoc—The Lompoc Light and Power Co. plans to improve its plant and distribution system. Estimated cost, between $5000 and $10,000. A. H. Wishon, Fresno, Mgr.

Calif., Los Angeles—The California Edison Co. has been granted a franchise by the Board of Supervisors, for the erection and maintenance of an electric distributing system in Los Angeles County.

Sask., Lloydminster—W. and E. Johnson plan to build an electric lighting plant. Estimated cost, $60,000.

CONTRACTS AWARDED

R. I., Lonsdale—The Lonsdale Co. has awarded the contract for the erection of a transformer station, to The J. W. Bishop Co., 109 Foster St., Worcester, Mass.

N. Y., Albany—H. A. Biggs, Commissioner of Health, has awarded the contract for the installation of a heating system to the Merrill Co., 19 Pearl St., Boston, Mass., $45,082; the electric lighting system, to Gagen & Butler, Inc., 1402 Bway., New York City, $10,484. Noted Apr. 9.

N. J., Jersey City—The Elks Club Association has awarded the contract for the installation of lighting and power for its building on Hudson Blvd., to L. Fort, 428 Hoboken Ave. Estimated cost, $9000.

Ohio, Columbus—The Smith Agricultural Chemical Co., Champion and Leonard Sts., has awarded the contract for the erection of an addition to its power house, to the Frankenburg Constr. Co., 705 Columbus Business Savings and Trust Bldg.

Ohio, North Canton—The Hoover Station Sweeper Co., c o H. W. Hoover, has awarded the contract for the erection of a 1-story, 40 x 50 ft. addition to its boiler house, to Custer Bros., 141 Smith Ave., N. W. Canton. Estimated cost, $8000.

Mich., Cheboygan—The Cheboygan Electric Light and Power Co. has awarded the contract for the erection of a new power house at the Black River dam, to W. Moody, Cheboygan.

Mich., Detroit—The D. Stott Flour Mills Co., Warren and Grand River Ave., has awarded the contract for the erection of a 1-story, 35 x 50 ft. boiler house, to the Wisconsin Bridge and Iron Co., 1362 Penobscot Bldg. Estimated cost, $10,000.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5 65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.00	$4.35	$3.90
Barley	2.15	1.50	2.40	1.75
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70	$3.25—3.40
Mine-run	2.35—2.50	3.00—3.15
Screenings	2.05—2.20	2.75—2.90

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.55-2.90	$2.55-2.70	$2.55-2.70
2-in. lump	2.55-2.90	2.55-2.70	2.55-2.70
Steam egg	....	....	2.20-2.40
Mine-run	....	2.35-2.50	2.00-2.20
No. 1 nut	2.55-2.90	2.55-2.70	....
2-in. screen	2.05-2.20	2.05-2.20	....
No. 5 washed	2.05-2.20	2.05-2.20	....

Birmingham—Current prices per net ton f.o.b. mines are as follows:

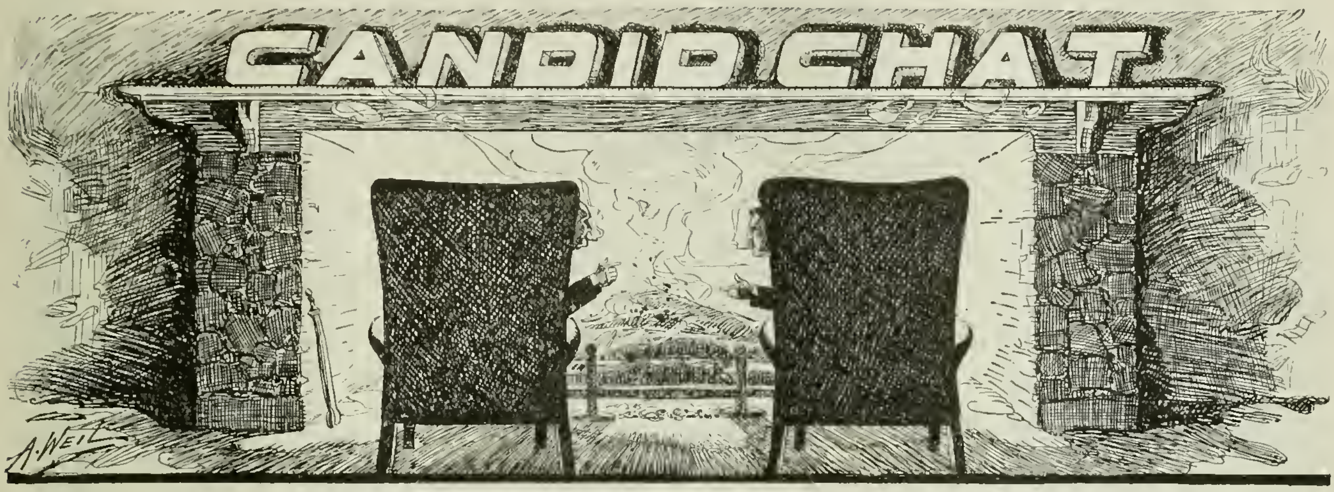
	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cababa.	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

POWER

Vol. 47 NEW YORK, JUNE 18, 1918 No. 25



Confidence in Employers

IT is the confidence which even the humblest worker has in his employers and the product he helps to make that goes toward general success. Too often we see and hear of engineers and others in power-plant work who lack confidence in their employers.

For instance, an engineer wants some new appliance, a new piece of apparatus or some supplies. He wants them immediately whether they are of great necessity or not. Well, perhaps owing to expenditures in other lines or departments, the firm is not in a position to buy these things just at the time the engineer wants them.

As a result, the engineer loses confidence in his employers—not that the loss of confidence is deserved, for generally the engineer views only one side and that is his. He finally decides that the firm is too cheap to lay out a few dollars, so what is the use of trying to do things. He neglects what old apparatus he has—to his own undoing.

An engineer had a cold-water pump in his plant, drawing water from a deep well and pumping to a high pressure. The pump was not placed in a very suitable position—it was exposed to all sorts of dirt and grit. Of course it was running under hard service, and with a little extra care could have been made to hold out awhile longer. Instead, the engineer wanted a new pump and a larger one. He could not get one, so he made up his mind that the firm was too cheap a firm for him to work for, and he quit. The new engineer came and gave a lot of time and patience to the old pump, and it was not very long before he had a nice increase in salary, besides getting just the pump he wanted.

Engineers, realize that there are other expenses in an isolated plant besides the power house, and your employer has to meet them all. Let your employers see that you have full confidence in what they are doing, and they will surely place confidence in you.

Contributed by J. C. Halvey, Cooperstown, N. Y.

FIG. 1. INTERIOR VIEW OF THE PRESENT BADEN STATION BOILER ROOM

Remodeling the St. Louis Baden Station

By K. TOENSFELDT

The remodeled station will contain four boilers from an old station and four new boilers of the same type and size, making a total of 3300 boiler horsepower. Chain-grate stokers will be used. The total investment will be $177,500, and it is estimated that the yearly saving in operating expenses will be about $11,797.

THE Baden Station or High-Service Station No. 3 is situated in the northernmost part of the City of St. Louis and was built in 1896. The growth of the city westward, leading farther from the original pumping station and into the higher parts of the surrounding country, necessitated additional pumping capacity and a higher main pressure. The Baden Station, the water mains from which in general circumscribe the older central or downtown parts of the city and supply the outlying western, southern and the higher districts, pumps a pressure of 125 lb. into a closed system. The high-service stations Nos. 1 and 2, supply the central and lower districts and pump against a pressure of 85 pounds.

The high-service stations Nos. 1 and 2, and the low-service station No. 2 have been reconstructed with modern equipment and were completed during the summer of 1916, and in the fall of last year an ordinance was passed appropriating funds for the reconstruction of the Baden Station. Although the present time is most inopportune for such an undertaking, the physical condition of the plant is such that the change is a necessary one. Fortunately, the Water Division is able to make use of much of the equipment from another station where the equipment of two engine houses was connected to the boilers of one remodeled boiler room, leaving the machinery of the abandoned boiler room available.

In the engine room there is little to be done. The six original vertical, triple-expansion pumps are in good condition, some revealing better duties on recent tests than were obtained on the acceptance tests. The remodeling of the engine room will merely involve the installation of a single new 10-in. steam header and loop to replace the present three 10-in. mains. The renewal of these is necessitated by the anticipation of using higher steam temperatures, which mean the use of heavier cast-steel valves and fittings in place of the present light cast-iron ones.

There will be a resultant saving in the engine room due to the use of superheated steam in the pumps and a saving in radiation loss due to the single header replacing the three present headers. A series of tests were made on pump No. 13 at the high-service station No. 2 to determine the saving effected by superheating. Fig. 3 shows the results graphically.

It is of interest to mention that superheated steam has caused cracks of destructive extent in the old unannealed high-pressure cylinder heads of the pumping engines at the high-service station No. 1. These were renewed with new annealed heads with properly proportioned reinforcing ribs.

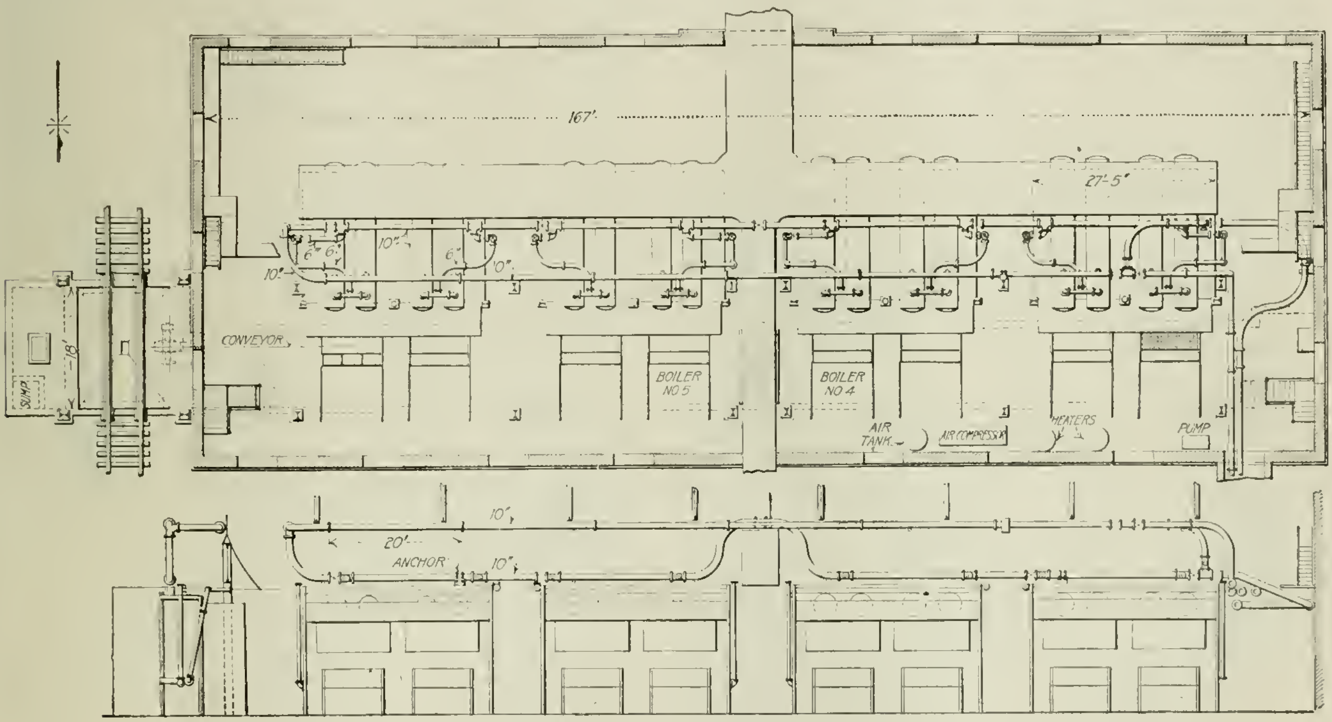


FIG. 2. PLAN AND ELEVATION OF THE NEW BADEN STATION BOILER ROOM

The boiler room of this station was completed in 1898. The equipment consist of four batteries of two each, or eight 277-hp. water-tube boilers each of which is equipped with down-draft type of furnaces. The boiler plant at present is well taxed to its capacity during periods of maximum pumping, and is in immediate need of enlargement. The boilers are in their twentieth year of service, having done duty practically continuously day and night, and they have already been running longer than what is considered the usual life of boilers of this type. In Fig. 1 is shown an interior of the present boiler room and indicates the attendant requirements in man-power with these old-type hand-fired boilers for handling coal and ashes. The tube spacing of the down-draft furnaces is such that the large-sized coals must be bought for fuel.

The following is taken from the annual report of 1917 and shows the saving that can be effected by remodeling the boiler plant, based on the actual operating and coal costs for the year 1916-17:

Total coal burned, tons	22,750
Cost of egg coal unloaded at $1.65 per ton	$37,537
16 firemen at $90 per month	17,280
16 coal passers at $65 per month	12,480
1 boiler-room foreman at $75 per month	900
1 boiler washer at $90 per month	1,080
Total	$69,277
Cost per 10,000 lb. of steam	$0 24
Total water evaporated, lb	288,000,000
Cost of proposed new tunnel	$10,000
Cost of proposed new bunker, coal and ash-handling equipment	60,000
Cost of four new 400-hp. boilers	35,200
Cost of four new superheaters	7,500
Cost of moving four 400-hp. boilers from Bissell's Point to Baden	3,200
Cost of brick settings for eight boilers	9,600
Cost of stokers for eight boilers	16,000
Changes in steam headers and feed lines	3,000
Cost of new breeching	5,000
Cost of proposed new stack	28,000
Total investment	$177,500

To evaporate 288,000,000 lb. of water with screenings containing 10,000 B.t.u. per lb. would require

$$\frac{288{,}000{,}000 \times 970 \times 1.07}{10{,}000 \times 0.65} = 46{,}000{,}000\ lb.$$

where 1.07 = factor of evaporation and 0.65 = efficiency. Hence with the new equipment we would have

Total coal burned, tons	23,000
Price per ton	$1 35
Cost of screenings	$31,050
6 firemen at $90 per month	6,480
8 coal passers at $65 per month	6,240
1 boiler-room fireman at $75 per month	900
2 boiler washers at $90 per month	2,160
Interest on investment at 6 per cent	10,650
Total cost to generate steam	$57,480
Cost per 1,000 lb. steam	$0 199
Yearly saving possible	$11,797

This represents a saving on the investment ($177,500) of 6.6 per cent. even during these times of high prices.

It may be of interest to relate some of the symptoms of age in the boilers. Each unit has two 36-in. drums which were originally of material $\frac{5}{16}$ in. thick with longitudinal, triple-riveted lap joints. The old tubes are requiring continual renewal, as hydrostatic tests to 150 lb. after turbining, invariably reveal leaks, with the consequent removal of from two to eight tubes. These tubes, when cut to pieces, have commonly shown weak spots. During the last year a tube rupture which occurred in the sixth bank caused a temporary shutdown of the entire station. If it were not for the immediate reconstruction of the plant the boilers would all have to be retubed.

The plant will furnish steam at 150 lb. pressure and 150 deg. superheat. The type and size of new boilers determined upon for the remodeled Baden station was governed by the water-tube boilers that were removed from the high-service station No. 1, due to connecting the engines of this station to the boilers of the high-service station No. 2, as already mentioned. These boilers, four in number, are in good condition, each of 410 hp. capacity, and will be dismantled and reinstalled together with their superheaters at the Baden station. In order to maintain uniformity of parts throughout the boiler room, four new boilers of the same type and size will be added. The total plant capacity will be 3300 boiler horsepower which, it is estimated, will serve the pumping demands for the life of the boilers.

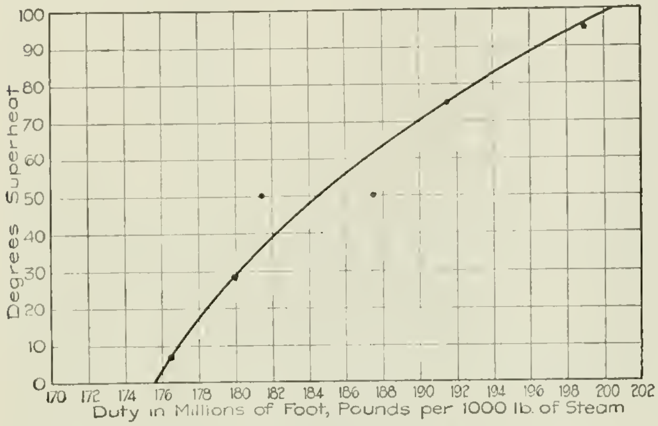


FIG. 3. CURVE SHOWING THE RESULT OF TESTS

The boilers will be fired by chain-grate stokers with a ratio of boiler-heating surface to grate area of 48. This ratio, with a properly designed furnace, will drive the boiler efficiently at below rating and at 30 per cent. and more over capacity. The chain-grate stoker was selected as being best adapted for the purpose, considering the extent and nature of the load, the grade of coal to be burned and the amount of money invested. The daily peak of the maximum pumping periods at this plant, which pumps into a closed system, varies about from 1.1 to 1.3 of the average and from 1.2 to 2.0 of the minimum. The chain-grate stoker meets these load demands nicely, and it was considered unwise to go into a more costly and elaborate type of stoker with all attendant auxiliaries, especially in a water-works boiler plant where the reserve capacity in the equipment is larger than in most commercial plants.

The question of installing an economizer was also considered, and although a fair return on the investment might be realized, over the life of the economizer, yet with the present load and cost of economizers, and for a few years to come, it was questionable whether any gain would be realized. Provision has been made, however, in the planning of the boiler plant and in the breeching, should occasion arise in the future for the installation of economizers.

Fig. 2 shows a plan of the boiler room. Coal is dumped from the railway track into the track hopper, passes through a crusher and reciprocating feeder into a continuous pivoted bucket conveyor, which elevates it and dumps it, with the aid of a traveling tripper, into the desired bunker. The same conveyor receives the ashes from the boilers and delivers them to the ash hopper over the track hopper. Ashes may be deflected through a chute to a car on the side track or may be stored in the hopper. A conveyor of the same type, handling both coal and ashes, has been in service at the low-service station No. 2 for three years, and no appreciable wear due to handling ashes in the same conveyor has been noticed. The storage capacity of the bunkers was made as large as possible, this feature having manifested itself as very desirable during the past winter.

Fig. 4 shows a transverse section through a boiler setting. Coal may feed from the bunker through automatic weighing scales into the stoker hopper, or it may be shunted by means of a long spout (with the scales pushed aside) from the bunker past the stoker hopper into the siftings hopper and down onto the conveyor, whence it may be elevated and dumped into another hopper.

All coal is weighed as used, and the boiler-feed water is measured by a venturi meter with integrating and indicating recorders. A weekly efficiency record showing the relative station performances is bulletined at all stations. Each boiler is equipped with indicating steam-flow meter and CO_2 apparatus. Stack-breeching temperatures are recorded on a continuous chart.

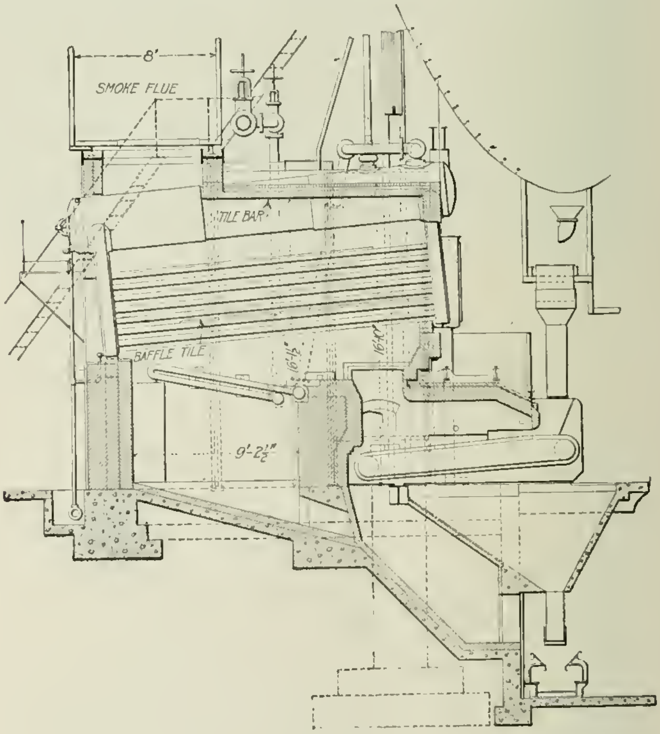


FIG. 4. SECTION THROUGH ONE OF THE BOILERS AND SETTING

The steam piping was designed on the loop plan so that both in the engine and boiler rooms there will be two ways of getting steam to the engines or from the boilers. Fig. 2 shows the piping in the new boiler room in both plan and elevation. The maximum velocity in the 10-in. header alone will approximate 7600 ft. per minute. All valves and fittings will be of extra-heavy cast steel with all joints male and female faced.

A new reinforced brick-veneer smoke-stack, 235 ft. high and 9 ft. 6 in. mean diameter, will maintain a 1 in. draft at the breeching of the farthest boiler. The design was treated to conform with the style of the architecture of the station buildings.

During the reconstruction of the station the service must be uninterrupted, and for this reason the new boilers face opposite to the present ones. This permits the new breeching and stack to be erected while the old boilers are in service and throws the major part of reconstruction work out of the way of the firing aisle of the old boilers.

It is expected to have the Baden station well toward completion by the summer of 1919.

Some Characteristics of Babbitt Alloys

The melting point of both genuine babbitt and strictly lead-base babbitt is around 500 deg. F., and this is about as high a melting point as can be obtained in a babbitt alloy. The melting point of a babbitt is always lower than the arithmetical mean of the melting points of the metals forming the compositions, and variations from certain rules in mixing reduces the melting point of the mixture below that of the most fusible metal in the alloy.

As an illustration, take a mixture of 87 per cent. lead and 13 per cent. antimony. Since the melting point of lead is 619 deg. and of antimony 834 deg. F., it would be natural to suppose that adding antimony to lead would bring the mixture to a higher melting point than that of lead, say to the mean melting point of the two, about 645 deg. F. At any rate, it would not be unreasonable to expect to obtain a higher melting point than that of lead (619), but as a matter of fact the melting point of this alloy is 477 deg. F. This is the lowest melting point of the series of lead and antimony mixtures.

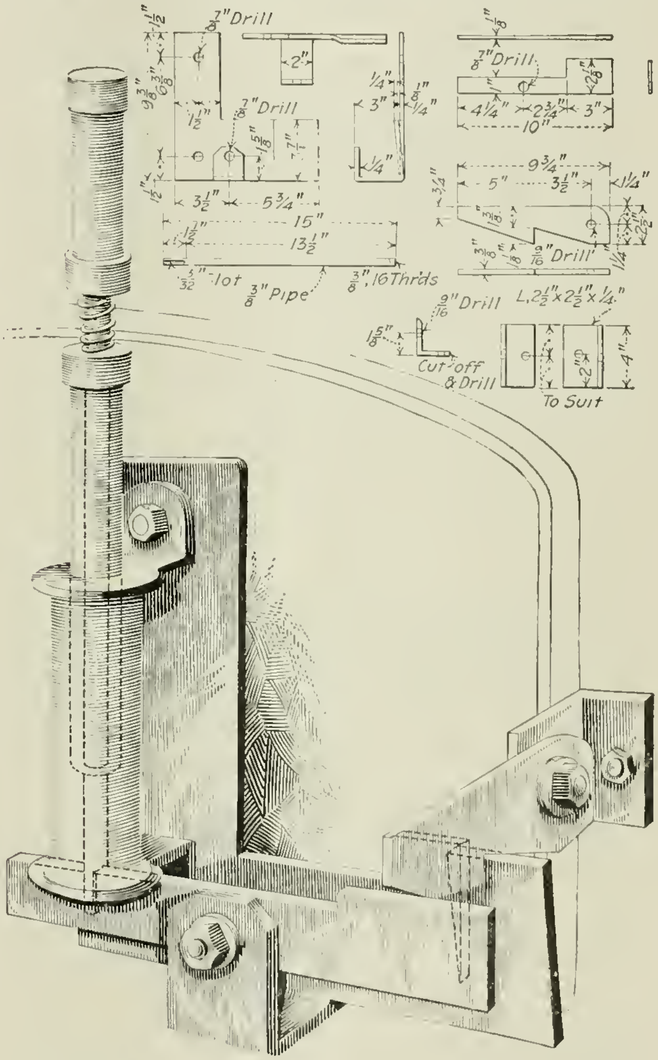
A tin and lead mixture consisting of about 60 per cent. tin and 40 per cent. lead melts at about 336 deg. F., representing the low limit, while another of about 60 per cent. lead and 40 per cent. tin melts at about 412 deg. F., representing the high limit. This latter mixture is known commercially as "wiping solder" and is used for that purpose by plumbers because it remains in a pasty stage while cooling through a range of 70 deg. F.

There is, however, a widespread belief that the cost of a tin-base babbitt can be cheapened without injury to its quality by the addition of lead, and also that the quality of a lead-base metal can be improved by increasing the tin content—this latter idea being based no doubt on the assumption that if a little tin is good more is better. But without knowledge of the effect produced in alloying certain kinds and proportions of metals, it is an easy matter to fall into grave error in compounding babbitts. Intermediate grades of babbitts have their use, but they can only be used successfully under most favorable conditions, and they generally fail under heavy pressure, high speed and scant lubrication, chiefly because of their low fusibility, which makes them highly susceptible to the influence of frictional or initial heat. As far as outer appearances go these intermediate grades seem to be most desirable, and they will also stand the usual physical tests of hammering, cutting and bending; but when put in service, they are apt to give trouble. This is generally attributed to some mechanical defect or to the lubrication, as users are in the dark as to other possible causes, the chief one being the low melting point, influenced, as shown, by the mixtures.

Safety Latch for Furnace Door

By C. W. Howard

The illustration shows a safety latch for boiler-furnace doors, which I designed and put on the Heine boilers of the Celina (Ohio) Municipal Electric-Light and Water-Works plant. These latches have been in continued use for two years, and in that time have given no trouble and have required no repairs. The parts are shown in sufficient detail, with dimensions, to permit anyone to order or construct others from them.



GENERAL VIEW AND DETAILS OF SAFETY LATCH

The object, of course, is to provide a latch that will hold the door closed and prevent the fire from being blown out into the fireroom in case of a tube failure, and at the same time one that is not cumbersome to manipulate. This device, I believe, meets these requirements and is at the same time inexpensive to make. A slight pressure on the handle above the spring raises the latch so that the door can swing open.

Interpreting Steam-Turbine Test Curves

By H. E. BRELSFORD

A brief description of standard turbine data curves, and how they are derived and used in interpreting turbine characteristics is given.

THE following curves are all based on a constant number of jets or nozzles in operation. Fig. 1, a power-pressure curve, is plotted to show the increase of power with increase of pressure at a constant speed (approximately so, varying only with governor regulation). Used simply as an indication of the turbine's power capacity, this curve shows the maximum power of the turbine. As the initial steam pressure is generally a fixed quantity, the maximum ring pressure is determined, hence the horsepower at this pressure is determined. This horsepower may be increased or diminished by using larger or smaller nozzle areas, and of course using more or less steam proportionally. Ring pressure may be defined as the pressure existing on the first set of nozzles and it is controlled by the governor. With a given speed it takes a certain amount of pressure to run the turbine at no load. This readily shows that with atmospheric exhaust the power-pressure line will not pass through the 0 gage-pressure point. As a general case this may be stated in this way: When the power-pressure line is plotted, the point at which it intersects the pressure line will be at a pressure greater than the exhaust pressure, the magnitude of the difference representing the sum of the no-load or rotation and radiation losses in the turbine. This form of curve is valuable as it may be used as a chart to show the horsepower being developed by the turbine at any given ring pressure while in operation. This curve is, of course, determined experimentally by an actual test and is a straight line.

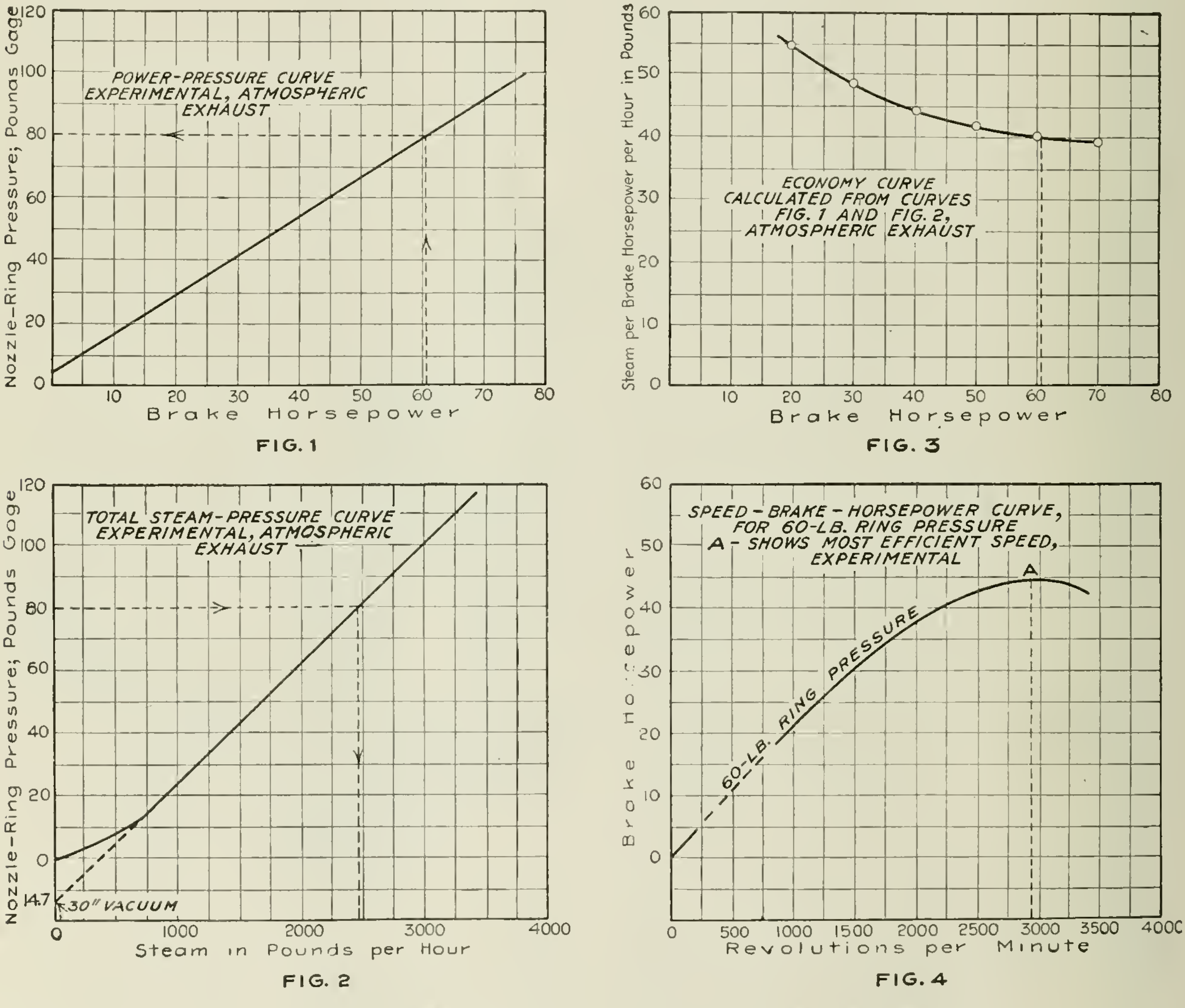


FIG. 1

FIG. 3

FIG. 2

FIG. 4

FIGS. 1 TO 4. CURVES SHOWING DIFFERENT CHARACTERISTICS OF STEAM TURBINES

Fig. 2, a steam-flow-pressure curve, is plotted to show the rate of flow of steam with any pressure. This curve is also a straight line except in the region where the absolute exhaust pressure (back pressure on the jets) is less than 58 per cent. of the absolute nozzle-ring pressure (initial pressure on the jets). In a single-stage turbine or a single-element Curtis turbine with atmospheric exhaust, with jets discharging into atmosphere, the initial pressure must be more than 10.63 lb. gage or the points on this power-pressure curve will not be in a straight line. A multi-stage turbine has the same characteristic straight-line pressure curve, but here the break is determined by the relation of the ring pressure to the pressure in the first stage. There is hardly a perceptible difference, however, from the straight single-stage turbine. On a multi-stage turbine the exhaust pressure can be carried through a very considerable range before altering the steam-flow rate.

With any nondiverging nozzles the steam flow per hour is calculated from the formula

$$W = \frac{SA}{0.04V}$$

where

W = Pounds steam per hour;
S = Velocity in feet per second of steam issuing from the nozzle;
A = Area of nozzle throat (also mouth) in square inches;
V = Specific volume of steam at the pressure into which the jet discharges;
0.04 = A constant which takes into account the time and space factors of the different quantities.

It will thus be seen that on a multi-stage turbine if the exhaust pressure is increased it raises the back pressure against each set of jets or nozzles. Each stage then can be considered as an individual single-stage turbine, and its characteristic pressure-flow line would be identical with the first case discussed. It should be noted, though, that the ratio of back pressure to initial pressure on the last stage, and hence the ratio of specific volume to velocity, is slightly different from the ratio of first-stage pressure to ring pressure. The lower end of a flow curve is, however, not of any consequence, as the real operating conditions are always at least above quarter load.

The curve, Fig. 2, at the lower end shows where the line curves to the left and passes through 0 gage pressure. If this curve was plotted to absolute pressures, it would pass through absolute-zero pressure the same as if the straight portion is produced in Fig. 2. If plotted to gage pressure the straight part produced will pass through absolute zero the same as when plotted to absolute pressure, 14.7 below zero gage. If the throat area of an expanding nozzle is known, this curve can be computed according to Napier's formula, but ordinarily it is determined by test and this serves as a check on nozzle or jet dimensions. One point determines this line, as it can be drawn through absolute zero and the given point. It is also an interesting fact that the steam flow is independent of the speed as far as can be determined in commercial testing. This fact makes it possible to make a steam-flow test with the turbine's rotor locked so that it cannot rotate. There is, however, a small difference existing, theoretically, due to the reheating effect of the greater relative velocity between the steam and the blading.

An economy, or brake-horsepower-water-rate curve, is given in Fig. 3 and is plotted to show the variation of the economy or steam rate with the output at constant speed. It is, of course, a well-known fact that the economy at partial loads is not as good as at full load, or at the load for which the turbine was designed to operate with best economy. An economy curve will therefore show an improvement with increase of load, the speed remaining constant, until a point is reached where the quantity of steam is the maximum for which the turbine was designed, and then the rate per horsepower will usually increase. This curve is derived directly from curves 1 and 2. For instance, if it is desired to determine how much steam is required per horsepower-hour when the output is 60.75 hp.: Then on curve 1 at 60.75-hp. pass vertically to the power line and from the intersection pass horizontally to the pressure line and read the pressure required to produce 60.75 hp. On curve 2 at this same pressure, 80 lb., pass horizontally to the flow line and at the intersection drop straight down and read the quantity of steam flowing at this pressure, namely, 2460 lb. per hour. This value divided by the brake horsepower gives the pounds per brake-horsepower-hour; that is, 2460 ÷ 60.75 = 40.5 pounds.

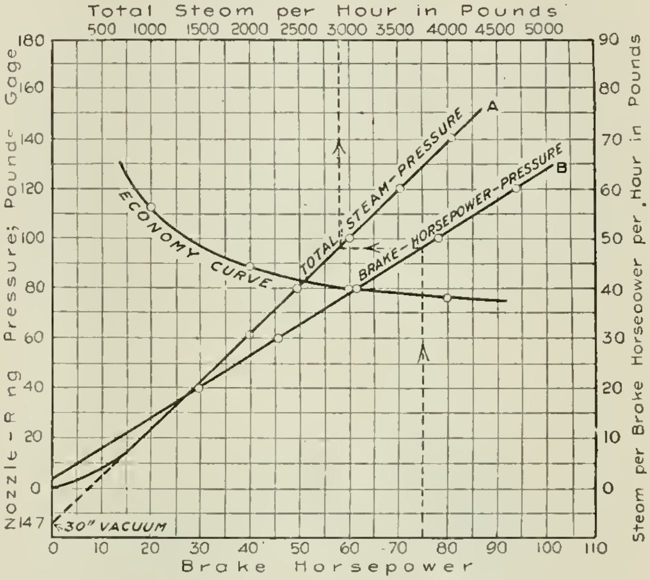


FIG. 5. COMBINATION OF CURVES FIGS 1, 2 AND 3

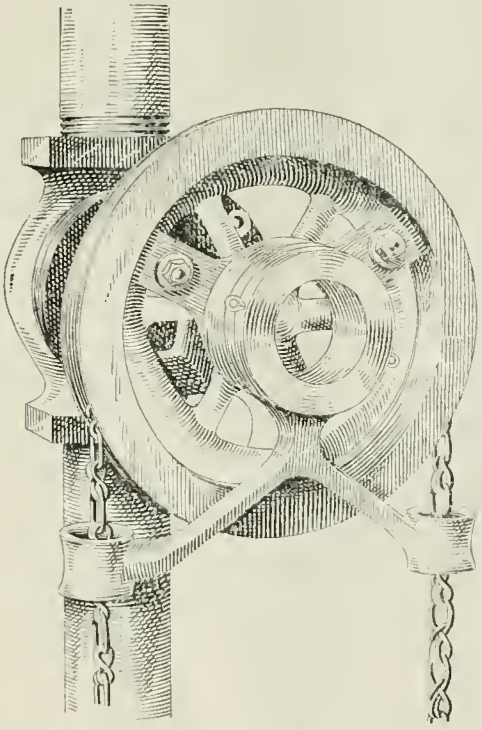
These curves are shown combined in standard form in Fig. 5 together with an indication of the way one point was determined on the economy curve. The steam per brake-horsepower-hour at 75-hp. load is determined by finding 75 on the brake-horsepower line at the bottom of the figure and following vertically to the brake-horsepower-pressure line, then horizontally to the total-steam-pressure line and up vertically to the total-steam-per-hour line at the top of the figure, and read 2900 lb. total steam per hour. The steam per brake-horsepower-hour equals 2900 ÷ 75 = 38.7 lb. Find 38.7 on the pounds of steam per brake-horsepower-hour line on the right of the figure, and run horizontally to the left until the vertical line running from 75 brake-horsepower is intersected, which will give this point on the economy curve.

A power-speed curve, Fig. 4, is plotted to show the variation of power with speed at a constant pressure. This curve is made from tests and is used principally to show the point of maximum efficiency. Sometimes many such curves are drawn at varying pressures and thus indicate the range of the given turbine. As the pressure increases, the velocity of the steam issuing from the jets or nozzles increases, so also the point of maximum efficiency would be at a higher speed, exhaust conditions remaining constant. Windage and friction losses, including also steam friction on the buckets, increase with increased steam and wheel velocity, hence with a given design a limiting pressure will be reached where further increase does not make the point of maximum efficiency lie at a higher speed. It is, of course, desirable to make the pressure and velocity conditions such that this maximum efficiency comes at the point of operation. The operating point is not always the full-load point for this reason:

In many cases the turbine will operate at less day, hence it is desired to have this the best economy condition. Full load would be for such a small percentage of the time that some allowance could be made in the matter of economy.

Improved Rim for Chain-Operated Valve

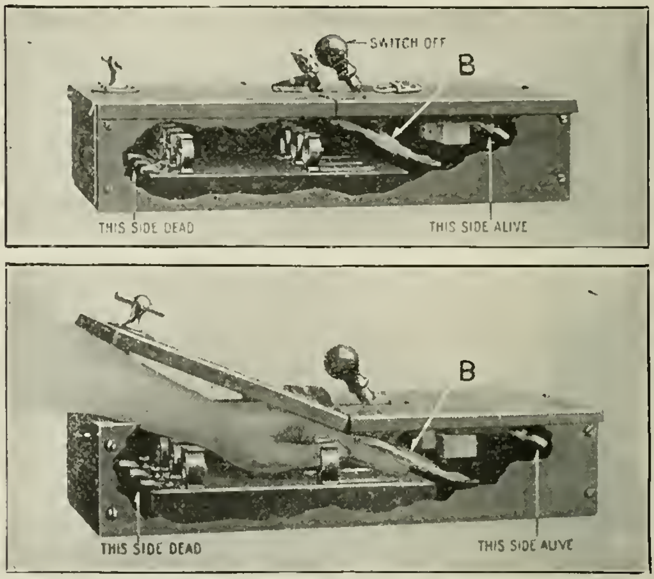
A recent improvement on the Babbitt rim for chain-operated valves, a description of which was published on page 560 of the Jan. 11, 1916, issue of *Power*, is illustrated herewith. By means of this rim, valves may be adapted for operation by chain, the sprocket rim being adjustable to fit different sizes of valve wheels. The improvement consists of a guard having two arms through which the chain passes. In any ordinary installation a guard, to prevent the chain from jumping off the wheel, is unnecessary, but on shipboard or where the valve stem is not horizontal or where other unusual conditions exist, such a device is sometimes advisable. These rims are made by the Babbitt Steam Specialty Co., New Bedford, Mass.



CHAIN GUIDE FOR VALVE WHEEL

Krantz Auto-Lock Switch

Wherever the workmen have little knowledge of electricity, it is desirable to use switches having no live parts exposed or accessible in the ordinary operation of the switches or when replacing fuses. To accomplish this the Krantz auto-lock switch, illustrated, marketed by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., has been developed and is intended for use on main circuits or wherever an ordinary knife switch is applied. The switching parts and fuses are inclosed in a steel box the cover of which is in two parts, one being screwed on to form a permanent covering for that end of the box containing the switch, and the other part being hinged so as to swing back and permit the renewal of fuses, as shown in the figures. A latching mechanism makes it impossible to open the cover without first throwing the switch to the "off" position and rendering all fuses and other accessible parts dead. As long as the door of the case is open, the switch contacts cannot be closed.



SECTION THROUGH AUTO-LOCK SWITCH. TOP—SWITCH OPEN; COVER CLOSED. BOTTOM—SHOWS THAT LIVE PARTS CANNOT BE REACHED WHEN COVER IS OPEN

Two padlocks can be used independently of each other, so that the switch cover can be locked shut with the switch either "on" or "off," or the switch can be locked in the "off" position with the cover either locked or open. Contact is made by means of a laminated spring-copper brush *B*, double-ended, with auxiliary arcing contacts at each end.

The double-ended brushes provide a double break, dividing the arc between the two ends, each of which is provided with a separate arcing tip. In the closed position the switch is held in positive contact by throwing a toggle over center. A spring provides a quick-break for opening, the mechanism being independent of the operating handle. These switches are supplied for 250, 500 and 600 volts, for either alternating- or direct-current service, and in capacities up to 2000 amperes.

The apparent consumption of crude oil in April was 4.3 per cent. greater than in March, 1918, and 19.9 per cent. greater than in April, 1917.

The Engine as a Reducing Valve

We often see the statement that an engine taking steam at high pressure and exhausting into a low-pressure heating system simply acts as a reducing valve. While this is true in one sense, it is well to keep in mind the difference between the two in the effect on the quality or quantity of the steam. In order to do any work the engine must abstract some heat from the steam. This may demonstrate itself in the form of water in the exhaust steam, being steam that has given up all its latent heat. Under other conditions the exhaust may still be dry saturated steam, but the steam supplied to the engine in this case must have been superheated to a greater or less degree or the steam carried late in the stroke, but there is a loss of heat just the same.

With the reducing valve, however, the case is different; the steam does no work except upon itself. The work done in overcoming the friction or resistance to the passage of the steam through the contracted orifice may be thought of as producing frictional heat that is in turn absorbed by the steam in passing, producing superheated steam at the lower pressure, just as air or water carries away the heat from a brake shoe. There is, of course, no gain in heat in the reducing valve, for it is apparent that it has no means of generating heat; nor is there any loss of heat (except the slight radiation), so there is nowhere else for all of the heat present in the higher-pressure steam to go except to be carried onward by the lower-pressure but slightly superheated steam.

This difference should be kept in mind concerning the use of exhaust steam for heating as against steam from a high-pressure boiler passed through a reducing valve or a contracted orifice such as a partly opened valve. For each horsepower-hour of work done by the engine there has disappeared from the steam not less than 2545 B.t.u. of heat. If an engine takes only 15 lb. of steam to develop one horsepower for an hour, it will be seen that about 170 B.t.u. taken from each pound of steam passing through is enough to account for all the power developed. If the engine takes 30 lb. of steam, half as many (85) B.t.u. will be taken from each pound of steam. To determine the percentage of the total heat taken from the steam in the form of useful work, it is necessary to divide 2545 (the B.t.u. equivalent of one horsepower-hour) by the pounds of steam passing through the engine per hour (the engine's water rate). This gives the B.t.u. taken from each pound of steam; this (with two decimal places added) divided by the total heat in the steam for the given pressure and degree of superheat, if any, as shown by the steam tables, gives the percentage of heat taken from the steam for each horsepower of measured work.

Friction and radiation loss is not taken into account. For example, a water rate of 30 lb. per hp.-hr. gives 2545 ÷ 30 = 85 B.t.u. per lb. taken from the steam, and if saturated steam at 150 lb. gage is used, the total heat of which is 1195, then 85.00 ÷ 1195 = 7.1 per cent. If a separator attached to the exhaust pipe took out all the water, there would be discharged from it about 1¼ lb. of water per horsepower-hour (plus that from radiation), since 30 lb. of steam has given up heat to the extent of the difference between 1195 B.t.u. in steam at 150 lb. gage (substitute any other pressure) and 1150 B.t.u. in steam at atmospheric pressure, or 45 B.t.u. per pound times 30 lb. (or substitute the water rate of the engine) = 1350, a little more than half the total B.t.u. (2545) called for; the remaining 1195 B.t.u. must come from some of the steam giving up its latent heat and returning to a liquid state, to water. In doing so each pound will, of course, give up 970.4 B.t.u., so that 1195 ÷ 970.4 = 1¼ lb. (approximately) of water would result. The radiation loss is no greater than would result from an equal surface and temperature difference, and leakage may or may not be considerable. The 28-odd pounds of dry saturated exhaust steam from this engine is therefore of the same value for heating or like purpose as saturated steam generated at the same pressure in a low-pressure boiler.

U. S. S. "GEM," SCOUT PATROL NO. 41, ASSIGNED TO THE SUBMARINE DEFENSE ASSOCIATION. ONE OF ITS PRESENT USES IS THE TESTING OF VARIOUS SORTS OF FUELS

[It was our privilege recently to take part in a cruise during which the fuel used was powdered coal burned in an apparatus installed by the Fuller Engineering Co. So far as we know this is the first boat to be run with this kind of fuel. The test of "colloidal fuel," which is powdered coal suspended in the colloidal condition in fuel oil, described in our issue of May 28, 1918, wa also made upon the "Gem."—Editor.]

Compulsory Co-operation of Central Station and Isolated Plant

BY S. R. SAGUE

Correspondence with city officials of Cleveland, Ohio, the Fuel Administration and others, concerning the advisability of enforced coöperation of public-service and privately owned plants, so as to avoid duplication of distributing systems and prevent waste of coal.

RECENT experience indicates that, if a statement is repeated often enough, people will come to believe it This seems to be the crux of the central-station controversy with the isolated plant. The central station has declared again and again that it is cheaper to buy power than to make it in individual plants, and it is astonishing to note the inroads that such propaganda has made into good engineering.

In urging the adoption of purchased power the motives of the central station are ulterior. The question as to whether it is better, from a financial viewpoint, for the client to operate his own plant, is never considered Therefore, the writer for several years has endeavored to bring about an arrangement whereby such a matter could be handled as an engineering problem and solved to the best advantage of all. But such coöperation does not exist in the policy of the central station.

Happily, I believe that the day is here when such coöperation must be effected. The large commercial coal requirements of the United States are north of the Mason and Dixon line, and all factories, with but few exceptions, north of this line require heating in the winter. In line with the idea of coöperation, I wrote the mayor of Cleveland, Ohio, on July 10, 1917, the subjoined letter. Cleveland operates a municipal central station erected to compete with the privately owned plant of the Cleveland Electric Illuminating Co., and the rate for service was fixed at one cent minimum and three cents maximum.

I wish to call your attention, at this time, when conservation seems to be the watchword, to a matter whereby considerable saving could be effected in this community in the conservation of coal. A manufacturing city such as ours, situated in a climate subject to the rigors of winter, must have three commodities, inseparably associated; namely, heat, light and power, and all three are derived from coal. To obtain light and power we must produce heat, and to burn coal to produce heat only we lose energy which could be converted to light and power and still leave as much heat for heating as before. To make light and power and dissipate the exhaust steam to the atmosphere or condensers is to lose the heat value of the exhaust steam.

The campaign of the Illuminating company and the municipal light plant to obtain power users is a campaign of inefficiency, at least for the winter months, and one prompted entirely by selfish motives. Both the Illuminating company and the municipal light plant are a necessity, but they do not take a sufficiently wide view of all the requirements of the city for light, heat and power. They emphasize the power and light features to the neglect of the heating, and consequently there is partial duplication of the coal requirements of the city as a whole. The large central stations can make current for power and light cheaper than the small isolated plant; but in the wintertime it is not possible in a majority of cases for them to furnish light and power and have the manufacturer furnish heat, and have the combined cost of light, heat and power as low as though the manufacturer fired his own boilers and obtained light and power to the extent of his requirements, and had his heat besides.

In some cases the coal requirement for heating certain factories is in excess of the requirements of those factories for power, in which case the excess current generated would be disposed of advantageously; for if all boiler plants for heating purposes would, in the winter at least, pass their steam through engines to the extent of the heating requirement, the generators these engines would drive could be paralleled with the distributing system so as to pump back on the line any excess power over the particular factory's requirements, which would then be available somewhere else, where less heat but more power would be required.

The central stations would act to smooth out the system, just as the reservoirs on our water systems take the come and go of daily varying requirements. In the summer all coal would be burned most advantageously at the central stations. This, as regards factory requirements, would taper off in the spring and fall to a minimum in the winter. In the summer, most chimneys, except where process steam is required, would be smokeless, aiding the housekeeper and keeping our city clean when we want cleanliness most. We would not mind our usual soot in the wintertime. By this, 25 per cent. less coal would be burned and real efficiency obtained.

Furthermore, the two power companies are duplicating transmission and going into the same territory. One line or distributing system could be made to do if the municipal light plant and the Illuminating company were hooked in parallel and both delivered power to the same distributing system, just as railroads operate over each other's tracks on an agreed compensation per car mileage, or as oil wells pump into a common pipe line. The oil the pipe line delivers to the owner at the terminal is not the actual oil he pumped, but is oil of the same gravity and test, just as the electricity would be of the same cycle and voltage. There is no more need for two electric distributing systems than there would be for two water systems or two gas systems.

For the city to buy a coal mine and bring in power and light over high-tension transmission lines would not relieve the coal shortage except as regards the use of coal by the light plant, because the same amount of coal for heating must be spent as heretofore, and there lies the great bulk of the manufacturer's real coal problem. This, however, would also help the Illuminating company in case of shortage, if both systems were tied together.

This communication was acknowledged by the mayor, who referred it to the commissioner of light and heat. I next received a letter from the commissioner of light and heat, which, for various reasons, I prefer to withhold in this communication, but its context may be surmised from my reply of July 27, 1917, as follows:

I am afraid you overlooked the main point in my letter, namely, heat as well as light and power; also, it was my intention to treat of power users or factory loads entirely, and not domestic.

It is manifestly impossible to heat either a factory or a home with electric current, no matter how cheaply you get your coal. One unit of electricity costing one cent is equivalent to 3413 B.t.u. One pound of coal contains, say, 13,000 B.t.u., and one ton would then contain 26,000,000 B.t.u., and using arbitrarily an efficiency of 50 per cent., which is low, you would get 13,000,000 B.t.u. from a ton of coal, which would be equivalent to 3809 units of electricity costing $38.09 on a basis of one cent per unit. With coal at even $10 a ton the domestic user could not afford to heat electrically, much less a factory using even cheaper steam coal.

Any proposition covering the generating of current either here or at a mine must be on the basis of power and light only—not heating. You will see that the point of my letter dwelt largely on the question of heat in combination with light and power. They cannot be separated, as all originate from coal, and any factory requiring heat makes a potential light and power equivalent whether it knows it or not. In other words, if each pound of coal could be made to deliver its total equivalent in heat as well as in light and power, we would make enormous savings.

You lose sight entirely of my suggestion of one distributing system for both plants. This would immensely improve the load factor, which you say is desirable. The stand-by losses and reserve apparatus necessary for sudden increases in load would be reduced by one common distributing system, as these items are now in duplicate, whereas only one set need be held for emergencies. In fact, by an equitable arrangement with the Illuminating company, the municipal light plant could be run at a maximum at all times, whether generating here or at a mine, pumping its current into a common distributing system.

You state that the immense heating load comes on in winter, requiring enormous capacity. This is not so if you arrange one distributing system and have each factory make current, using exhaust steam therefrom to an amount necessary to heat, and pumping any excess current generated back on the line for use elsewhere. I still feel you have missed the point of my letter and the thought contained therein, and your solution still must consider heat, light and power inseparably in the commercial field at least, which in turn will aid the domestic field on light and power only. Electric heating is a mirage.

To this I received no reply—central stations do not like to discuss heating—but it illustrates how any effort is smothered. Along this line, I sent a circular letter to a list of power users. One of these letters was forwarded to some central station, with the result that I received a letter from the Society for Electrical Development, Inc., as follows:

Our attention has been called to a circular letter sent out over your name, advocating the installation of isolated industrial plants, and claiming that it is more economical to burn coal in such isolated plants than it is to take central-station service, the claim being made that this is one way of conserving coal. The letter speaks of statistics proving this. We are very much interested in the subject and would appreciate it if you would kindly send us the figures upon which this statement is based.

To this I replied under date of Mar. 13, 1918, as follows:

The writer was interested to receive your communication. We are rather under the impression that your society is, as the letterhead states, a corporation for coöperation, but only so far as it benefits the central station. We may be misinformed in connection with this and, if so, would appreciate your setting us straight.

We, in our work, have endeavored to view the positions of the central station and the isolated plant from an engineering standpoint, and make no effort to encourage the installation of an isolated plant where we believe central-station service is the best. However, we believe that the central stations do not take this attitude, but claim that the installation of central-station service is always best, speaking from the user's standpoint. With this position we cannot agree.

We cannot conceive that central-station service is more economical where the heating load is the principal item to be considered. The central station has made an effort to shut down many power plants where the coal consumption for heating has been equal to or greater than the actual amount of coal required for power purposes. During the winter months, this requires the plant so served to burn the same amount of coal as previous to its connection to the central station, and also compels the central station to burn additional coal for supplying the power formerly supplied in the isolated plant, which still retained exhaust steam for heating.

You are entering into a discussion which has a great many ramifications, and the answer to the argument is the particular installation under discussion at the time. A general blanket answer cannot be formed.

The average manufacturer is less posted on his power plant than on any other department of his establishment and is subject to the influence of a salesman who can often put before him figures which are not borne out by facts. We are sorry to say that many installations in this territory have been made for central-station connections on this basis, rather than on the basis of engineering. It is also a question as to where the central station becomes large enough to have economies such as will enable it to sell advantageously to a user whose isolated plant is of such size that reasonable economies could be secured in it.

We believe that the Society for Electrical Development, Inc., should establish a policy and recommend to its associates the inadvisability of having solicitations made for the purpose of getting central-station connection regardless of the actual figures entering into the engineering requirements. You must admit that power generated from the coal required for heating during the winter months is a byproduct of considerable value, particularly in the face of the present price of coal, and this value is a national asset which should be conserved, even if it does not tend to the direct interests of the central stations to conserve it.

We have had the pleasure of recommending central-station service in a great many instances, and probably have as much apparatus connected on the central-station service as any company in the United States, from our motor sales department; but we must consistently recommend either central-station connection or the installation of an isolated plant on the basis of the best interests of the person served.

In response I received a very courteous letter of acknowledgment, to which I replied as follows:

Most certainly we believe in central stations. They are as necessary to our economic development as water-works or street cars; but we do take issue with central stations when they endeavor to secure connections which, upon careful investigation, show not to be to the advantage of the subscribers. When we speak of central stations, we mean such large installations operating condensing, as can show economies superior to the average isolated plant, when the cost of generating current alone is considered; but we do not believe that the average central stations, so called, in some of the smaller towns, are in position to compete with isolated plants of sometimes approximately equal capacity, particularly when the reclaimed value of the exhaust steam is available for heating. With the small central station, running noncondensing, such heat is thrown into the atmosphere or, if running condensing, into the condensers. This heat is a manifest loss and should be, as far as possible, conserved with the idea of cutting down the coal requirements of the country to the lowest possible point.

However, this was referred to the Fuel Administrator, and I was in due time written by him, whereupon I replied as follows:

To answer your question, let me ask you another: If a firm requires 100 boiler horsepower to heat a factory (say 3300 lb. of steam per hour at 5 lb. pressure) and is buying from the central station 1000 kw.-hr. per 10-hour day to operate machinery, what is the national coal loss in that individual case per day?

Answer: The amount of coal used by the central station to generate the 1000 kw.-hr.

You will agree that the following statements are pertinent to the discussion for the northern section of this country, which is the large coal-using as well as manufacturing section of the nation:

1. In this latitude for five months we positively must heat our factories.
2. Fuel transportation during the heating season is more difficult than during the nonheating period.
3. Complete recovery of all values (heat, light and power) from every pound of coal is necessary, particularly during the heating season.
4. The isolated plant during the nonheating months may lose some of the gain made during the heating months.
5. Eliminate, as much as possible, during heating months the enormous heat values dumped into condensers by central stations to make low generating costs.
6. Burn coal economically in isolated plants to heat by exhaust steam and use current generated as well for power.
7. Admit the economic necessity of central stations and isolated plants.
8. Connect to the central station where economies can be shown to be in its favor.
9. Operate isolated plants where coal savings warrant.
10. Review the entire matter from an engineering standpoint.
11. Prevent solicitation of commercial enterprises as power users by central stations for selfish gain, regardless of the national coal pile.
12. Prohibit central stations from taking on power users at a lower rate than cost to produce current for the purpose of keeping up volume in central station.
13. Compel isolated plants to arrange to burn coal eco-

nomically. Allot isolated plants only such coal as they would require if operated economically, thereby compelling savings by the installation of economical apparatus.

No acknowledgment was received, so I wrote again:

> We had the privilege of writing you with reference to isolated plants versus central stations as power-producing units, and their advantages from the coal-saving standpoint. Up to the present, the writer has not had the pleasure of hearing from you further, and wonders if he can be of any assistance to you in this matter.
>
> We recognize that it is not advantageous for the central station to name a rate for short-time connection, such as the summer months; but if the central station were paid an amount for the nonheating season for power on the basis of the cost of producing the power in each individual isolated plant, it would be decidedly to the advantage of the central station to accept such a connection, and it would not be to the disadvantage of the proprietor of the isolated plant to pay to the central station the amount which he otherwise would have paid anyhow.
>
> In this way we would throw the load on the central station, with a minimum of coal consumed in the summertime, and throw the load on the isolated plants and conserve the heating value of the exhaust steam in the wintertime, and make a tremendous saving all around.

So far, no acknowledgment has been received.

Now, the whole system is one of inherited policy—a selfish policy, a policy of "get while the getting's good"; but a foolish policy, a policy founded upon apparatus in isolated plants of a design and pressure of thirty years ago, a policy which the central station thinks is advantageous to them when, in fact, it is not, if they would view it from the standpoint of good engineering.

The central station should get some load from all. If such a policy had been in effect prior to the war, how flexible would have been our response! We could quickly arise to the requirements, instead of having thousands of important industries hanging upon the hope that nothing will happen to the central station. A flash on some turbine would shut down thousands, while trouble with an isolated plant is more quickly repaired and affects only those workmen in the one plant.

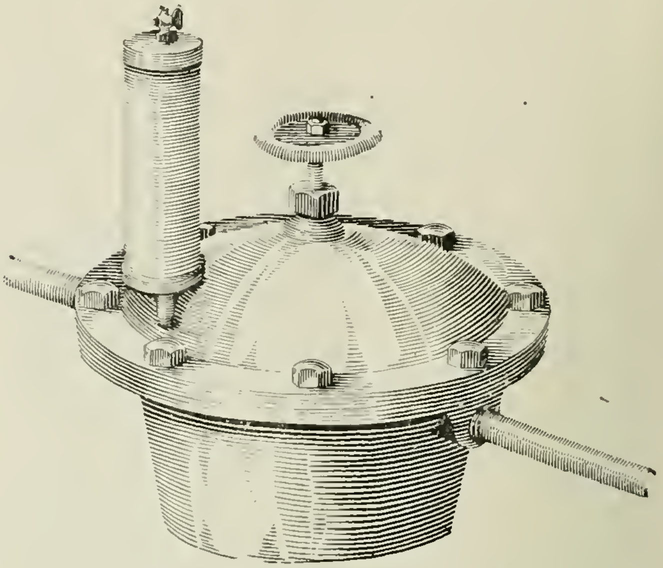
Saving coal is possible only to the extent that we can recover all values of heat, light and power, and charters for public utilities should require a filed report of all conditions of each prospective central-station user, from an engineering standpoint. This report would be referred to a properly constituted committee of disinterested engineers who would issue a permit for a given number of units from the central station per year, which would be the total amount required less the number of units that could be generated by the coal used to heat by apparatus of maximum economy.

[Through the influence and the financial assistance of the National Council of Defense, an agreement has been entered into between the Cleveland municipal light plant and the Cleveland Electric Illuminating Co., providing for an exchange of power between the two. The electrical connection of the two stations will practically guarantee war plants against shutdowns due to failure of power.—Editor.]

Air-Bound Steam Traps

By M. A. Saller

In a woodworking plant a number of live-steam coils were used for drying lumber, and these coils were drained by high-pressure steam traps. Because of the air which found its way into the coils, the traps became airbound and sluggish in operation. Instructions were given to open the pet-cocks and blow out the air from the traps at frequent intervals, but as is often the case, the instructions were soon overlooked. The engineer equipped each of the traps, as shown in the illustration, with an extra chamber made of pipe fittings, giving added space for the air so that the traps would operate a longer period without attention. Such an auxiliary chamber might be used to advantage in other cases where similar trouble occurs.



AIR CHAMBER ATTACHED TO STEAM TRAP

Method of Squaring Mixed Numbers and Extracting Square Roots

By John S. Carpenter

No claim of originality is made for the following method of squaring or extracting the square root of mixed numbers, as it is an application of the binomial theorem, but in fifteen years of practice I have never seen it introduced by anyone else. It is used with accuracy on the slide rule when there are decimals to be obtained. To the average operating engineer the conventional method has its terrors. This way involves very simple operations which are easily checked, at a glance in many cases. Most tables do not have squares of fractions.

Let it be required to square such an awkward number as $14\frac{1}{4}$. From a table or the slide rule we have as the square of 14 the answer 196. Now to this add twice fourteen times $\frac{1}{4}$, which is 7; also add the square of $\frac{1}{4}$, which is $\frac{1}{16}$; the total is then $203\frac{1}{16}$. Try another, say $30\frac{1}{8}$. The square of 30 is 900; twice 30 times $\frac{1}{8}$ is 7.5; $\frac{1}{8}$ squared is $\frac{1}{64}$, or 0.015625; adding, we have 907.515625 exactly.

Let it be required to extract the square root of 1121.56. Looking down the column of squares in a table, we see that the square of 33 is 1089; deducting this from 1121.56 leaves 32.56; dividing this by twice 33 gives 0.493; the answer then is 33.493. If we quibble over the last figure, square 0.493 and deduct it from 32.56, which is then 32.32; divide anew by twice 33, and we have 33.490, a little closer. For most purposes it will not be necessary to deduct the second square.

In a drafting room where the grade of help was not of the best, men who fell down repeatedly on the conventional method mastered this one with ease.

About Preventable Boiler-Room Losses

The shadow of the central station looms over the head of an engineer of an isolated plant. He is told of a few things that could be done to better the condition of his boilers and is promised a surprise in the difference in fuel consumption if the suggestions are carried out.

ONE evening as Willis was making his way home from his plant he went by a roundabout way and stopped in to visit with Joe Beards, the engineer at the Bartlett Tool Works. The plant consisted chiefly of four return-tubular boilers, and a Corliss engine drove a generator that supplied power and light for the plant.

"How goes things?" asked Willis, as he helped himself to a chair and lit his favorite pipe. "You got through the coal shortage without getting down and out, I hope."

"Just about and no more," answered Joe, seating himself in another chair. "Some days I was on the ragged edge of nothing, as you might say, and the boss was about to throw up his hands, shut down the plant and run with central-station service. He says they have given him figures that about convince him it would be cheaper in the long run. If he does that, it will let me out, that's sure, but I don't see that I can do anything about it, do you?"

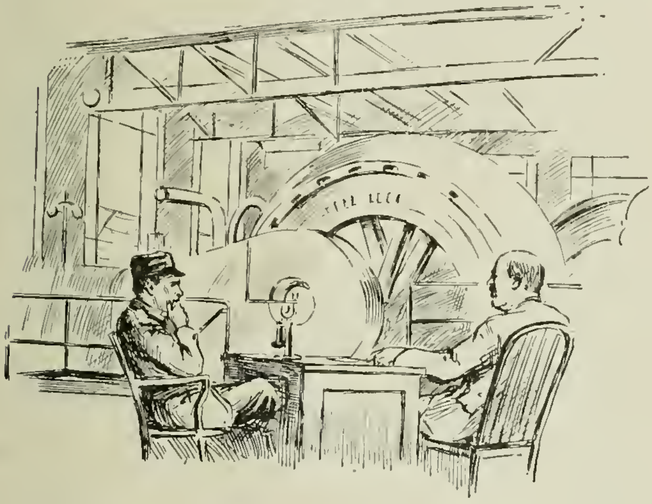


FIG. 1. "I NEVER RAN A BOILER TEST AND NEVER EXPECT TO," SAID JOE

"Joe, if it were my plant, I believe that I would have considerable to do about it. If it were my plant, I would take figures to the 'old man' and show him that he could run his own plant cheaper than he could buy outside current."

"You might do it with your plant, but I can't with mine because I don't know what the operating costs are."

"Well," replied Willis, "if I were you I would get busy and get some inkling as to what it was costing to run this place. You certainly can stop all preventable waste whether you know what it is costing each year to operate or not. Take, for instance, your boiler room. How great are the preventable losses? You say you don't know, but I take it that your plant is no better than the average, and if that is so about 8 per cent. of your furnace losses in fuel consumption could be cut out. Because you burn a lot of coal is no reason to assume that you are making a lot of steam. Some furnaces can make a boiler evaporate an average of, say, 9 lb. of water per pound of coal, and the best that is obtained from others is about 6 lb. of water per pound of coal. Now with which do you think your outfit averages up?"

"I don't know," answered Joe. "I never ran a boiler test and never expect to; in fact, I don't know how. What good would it do, anyway?"

"Well, seeing that you have mentioned it, a boiler test wouldn't amount to much unless your boilers and furnaces were in fit condition in the first place. There wouldn't be much use in starting anything of that sort, because a satisfactory test cannot be had unless the furnace is in shape, and furthermore, when it comes to evaporation tests, the kind of boiler that is put over a furnace cuts a big figure, and more than that, the condition of the boiler cuts still another figure."

"Hold on a minute before you get all out of breath," interrupted Joe. "You just said that some tests will show an evaporation of 9 and some 6 lb. of water with each pound of coal burned. What's the reason?"

"Generally, it is because one furnace is better than another, although the quality of the coal will have a lot to do with it, as well as the condition of the boilers. A furnace, to be efficient, must be one that will burn the most combustible with the least surplus of air."

"How are you going to find out what is the proper amount of air?" was Joe's next question. "You can't see how much air is going into the furnace."

"By gum, that's right, I hadn't thought about that; but for all that you can tell all right if you only know how, and that is by a flue-gas analysis. When you burn a fuel in a boiler furnace, you will get two principal gases, carbon dioxide (CO_2) and carbon monoxide (CO), and the amount of each in the flue gases is determined by the amount of air that gets into the boiler furnace. The greater the volume of excess air the lower the percentage of CO_2 and the greater will be the loss in fuel. Reasonably good practice will call for about 40 per cent. excess air, which would give about 14.5 per cent. CO_2. If the excess air is raised to, say, 100 per cent., the percentage of CO_2 will decrease to about 10, and the fuel loss will be about 17 per cent., and the more excess air that gets into the furnace the lower the CO_2 and the greater the fuel loss."

"A fellow was telling me something about CO_2 awhile ago," remarked Joe. "He said that a smoking chimney meant low CO_2. If that is the case, I guess Joe Simmons over at Skinner's factory must be having a steady run of low CO_2, because his chimney smokes about all the time."

"I calculate you ain't making any mistake in your assumption, but don't you kid yourself into believing that it's the smoking chimney only that indicates poor furnace conditions. A clean chimney may show, and at the same time four or five times the proper amount of air may be passing through the furnace and over the boiler-heating furnace with the corresponding low CO_2."

"As far as I can see," said Joe, "you have to have an instrument to find out what the CO_2 is in the flue gases, and it costs money. In this plant I don't see that I will get very far as an expert operator of a CO_2 machine."

"Perhaps not just at present; but if you'll do your part, I don't think you'll have any difficulty in getting any apparatus to assist you in running the plant cheaper. One thing you can do for a starter is to either buy a draft gage or make one. They don't cost much, but if the company can't raise the price, you can make one by bending a piece of glass tube into the form of U-tube" (Fig. 2) "and connect one end of the tube to the furnace. The draft in the furnace is of more importance than most engineers seem to think, and it has a good deal to do with the amount of coal you burn. Then you should also have a thermometer for taking the temperature of the gases going to the chimney. The furnace temperature of a boiler will be around 2400 deg. The more heat that is absorbed by the boiler heating surface the lower the temperature of the gases going to the chimney. Now, what do you get?"

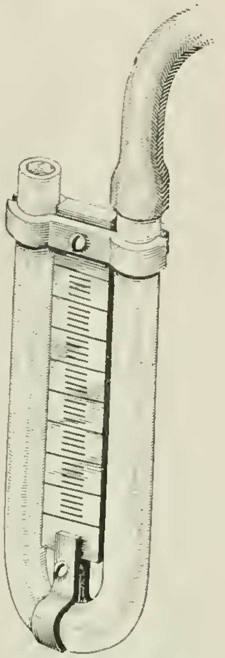


FIG. 2. HOME-MADE DRAFT GAGE

"Search me, I never had a thermometer in the place. About what should I be getting?"

"I take it that you are getting close to 600 deg.; probably higher. You likely have scale on the shell and tubes of your boilers, soot on the inside of the tubes and cracks in the brick setting. Outside of that and a leaky safety valve and a blowoff valve, I guess your boilers are about on the average."

"How do you know that there is scale in my boilers, soot in the tubes, leaky valves and cracks in the boiler setting?" asked Joe in surprise.

"Deduction, Joe, nothing else. I know the rest of us engineers in town have scale and enough of it to fight, and it keeps us on the jump, so to speak; but in the last six months you haven't cleaned your boilers—you told me so—therefore they must have scale. As to soot, you haven't anything but a piece of pipe to blow tubes with and it is covered with cobwebs. I saw them when I came through the boiler room, as I also saw the cracks in the boiler setting. The cobwebs show that the blower had not been used for some time, and the cracks show no signs of any attempt having been made at stopping them up. The escape pipes of the safety valves were dripping water and leaking steam, and the blowoff pipes were hot when I passed them; both sure indications that they leak, and that is about enough for one time.

"The thing for you to do before you begin to bother with CO_2 is to stop up the cracks in the boiler settings, clean out the scale in the boilers, blow the tubes every day and scrape them at least once a week. Don't forget to grind in the safety valves as well as the blowoff valves. I know your safety valves are of the old ball-and-lever type and should not be allowed to be used, but they'll have to go for awhile, I take it. I'll bet you a bag of peanuts that you'll see a difference in the coal bill if you will fix things up as they should be. If your chimney-gas temperatures are high now, and I guess they are, you will find that with clean boilers they will be lower; yes, considerably lower.

"Then you will find that your fireman won't have to force the fires so hard. You see, it is only necessary to keep the temperature of the combustible gases high enough to allow of their combustion. An extremely high temperature, while it has advantages, also has disadvantages due to the danger done to the furnace lining. High temperature in the rear of the combustion chamber is not an evidence of efficiency, as it may be caused by the gases being burned in the rear connection, and striking the cooler heating surfaces of the boiler, these gases will pass to the chimney but partly consumed. The hotter the gases entering and leaving the tubes the more heat is wasted in the chimney.

"Then for a change you might go into the boiler room a little more frequently and jack up the firemen once in a while just to let them know who is boss. I noticed as I came past the ash pile that there were some mighty big clinkers."

"Yes, I have noticed that myself. It must be the coal we have been getting."

"Perhaps it is," answered Willis, "but I'll make a guess that it's because the firemen carries thick fires and keeps stirring them up. That will do it, and running with the ashpit doors closed, which preheats the air in the ashpit before it goes up through the grate, will help make them."

"I don't see what a thick fire has to do with making clinkers," said Joe, as he glanced at the clock to see how near shutting-down time it was. "We have to carry enough fire to take care of the load, that's certain."

"I'll tell you what it does. A thick fire cuts down the air supply and so lets the ashes become heated. If plenty of air passes through the fuel beds the air absorbs the heat in the grate and ashes and keeps them comparatively cool. When the fireman runs a bar under his fire to break it up, he brings ashes up into the fuel bed where it fuses and forms clinkers. This lifting of the ashes and clinkers from the grate allows the live coal to fall upon them and this will overheat the grate. The thicker the ash bed and clinker the greater is the air supply cut down. It is better to carry a thin fire because a better air supply is possible if you do."

"All right, Willis, you have had quite a whack at lecturing on do and don'tless things. You told me to get a draft gage. Now, tell me, what shall I do with it after I get it? What work will it do in the first place or any other place?"

"Well, you lunkhead, a draft gage will tell you how much draft measured in inches of water you are getting. For two cents you can't tell whether the draft is poor or good, as the case might be. A draft gage will tell you what draft you are carrying, and it is of considerable importance. If there wasn't draft, there wouldn't be much of a fire in the furnace. If there is too much draft, there is the danger of getting too much air, which would reduce the CO_2 we have been talking about.

"To burn coal to the best advantage, the draft must be regulated. You cannot regulate your draft unless you know what it is, and if you will try it out you will be surprised at the difference such a small item as a twentieth of an inch in a draft will make in the amount of coal burned.

"With the boiler run at its rating, the approximate draft will be about 0.25 in. of water, but you would have to experiment to find out what would be the best draft to carry with your load and boilers. The least draft that you can carry and still make steam for the load to be carried, the better, although this can be carried to extremes in cases where the grate area is excessive. The only proper way to know the correct draft is to analyze the flue gases, which you can't do as yet. The damper is the proper method of regulating the draft, although many firemen will do so largely by closing the ashpit door, and in doing this the air pressure is increased on every other part of the boiler settings where cold air reaches them, and the more cracks in the boiler settings the more air is drawn into the furnace through them.

"You take my advice and get after a few of the things around the plant that are helping to prevent Uncle Sam from licking Kaiser Bill and at the same time are working you out of a job, and see if things don't look a little brighter as far as keeping your plant going is concerned if no more. Now don't throw up your hands and say it can't be done. Think it over, and while you are doing that I'll toddle along home and shake my fist at the table."

Purchasing Power-Plant Equipment

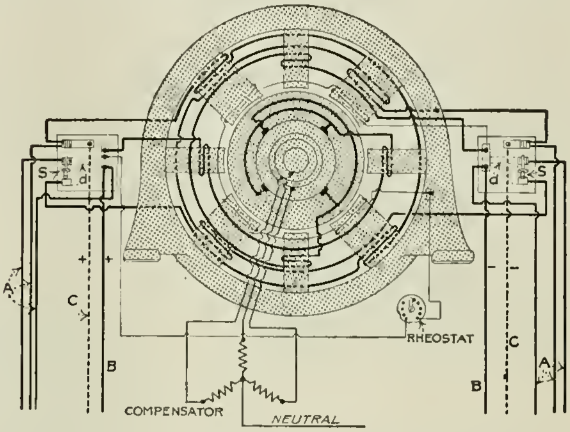
Cases are all too common where the purchaser is seemingly unaware of the operating characteristics of the machinery being bought, when considered in relation to its operation with machinery previously installed, and where the builder's representative gives the desirable features only of the new equipment and says nothing about the changes in the existing plant that he knows will be absolutely necessary to the operation of the plant as a whole after the proposed machinery is installed. One instance in mind will emphasize the need of a more candid exchange of engineering knowledge between the manufacturer's representative and the purchaser, especially when it is evident that the latter is not technically up on the problem under consideration.

Previous to my connection with my present employer, the management bought a motor-generator set, which was installed in one of the plants being gradually changed over from direct to alternating current. The plant at that time contained three direct-connected 220-volt direct-current units, all of which were compound wound. These units were operated on a 110- to 220-volt three-wire system, with the neutral taken from a motor-generator balancer set.

The new motor generator consisted of a 2300-volt three-phase 60-cycle synchronous motor driving a 220-volt interpole compound-wound three-wire direct-current generator, with collector rings outside of the commutators to which the star-connected compensator for the neutral was connected.

The purchaser undoubtedly did not know and the builder did not mention the probable trouble ahead until the machine was installed and attempts were made to parallel it with the 220-volt compound units and balancer set. The result was so disastrous that the erector cut out the split series-field winding, making the machine a shunt interpole three-wire generator, with the result that it could not be made to carry its rated load even when all the shunt-field resistance was cut out and the brushes shifted to a point where destructive sparking occurred.

An expert, sent out by the manufacturing company to investigate the trouble, spent several days testing the machine and reported that it worked perfectly as a compound generator, and for the first time called the purchaser's attention to the fact that the other compound-wound machines to operate in parallel with the new one should have their series-field winding split and additional cables, switches and circuit-breakers would be necessary and additional busses would have to be installed. This meant considerable expense at a time when an effort was being made to change over to alternating current, and the matter was dropped with hard feelings all around, the machine being operated as a shunt machine under partial load until such time as enough of the direct-current load was connected to the alternating-current system for the motor-generator set to take care of the direct-current service. Then the series-field winding was connected back into circuit with a switch mounted in each terminal block, as shown at *S* in the figure, so that the series-field winding could be short-circuited whenever it was necessary to operate this machine with other direct-current units.



CONNECTIONS OF THREE-WIRE GENERATOR

With the switches closed the machine operates as a direct-current shunt generator, and with the switches open the armature current passes through the compound winding, giving good voltage regulation and making the machine available for a full load.

The six heavy lines *A* and *A* in the figure show the main leads as it was intended to connect up the machine. *B* and *B* are positive and negative leads as run by the manufacturer's engineers, thus leaving the series-field winding cut out of circuit. The dotted lines *C* and *C* show positive and negative leads as now run to the switchboard, and the dotted section *d* and *d* shows the connection between the series-field and the interpole windings.

The Electrical Study Course—Losses in Direct-Current Machinery

The losses in direct-current machines are friction, excitation, armature-copper losses and core losses. These losses are discussed, and the method of determining the efficiency of a generator is given.

WHENEVER energy is changed from one form to another, there is always a loss in the transformation. For example, the amount of energy transmitted by the steam to the cylinder of an engine in the form of heat is not all available at the flywheel to do useful work. A large percentage of the energy actually supplied to the engine is lost in the exhaust, in radiation from the surface of the cylinder and in overcoming the friction of the moving parts, etc.

What has taken place in the engine is, the energy in the steam has been converted into a mechanical form of energy which may be used to do the mechanical work of driving any kind of machinery. If the engine is used to drive an electric generator, then we will have another transformation of energy; that is, the mechanical energy transmitted to the engine's shaft or flywheel will be converted into electrical energy and transmitted through the circuits to the devices supplied by the generator. In this transformation from a mechanical to electrical energy there is also a loss just as in the steam engine; that is, if the energy delivered to the engine's flywheel is capable of developing 100 hp., then less than 100 hp. will be delivered to the circuits. Part of the power developed at the engine shaft will be expended in overcoming the friction of the moving parts of the generator, exciting the field coils, the losses due to the resistance of the armature circuits and eddy-current and hysteresis losses.

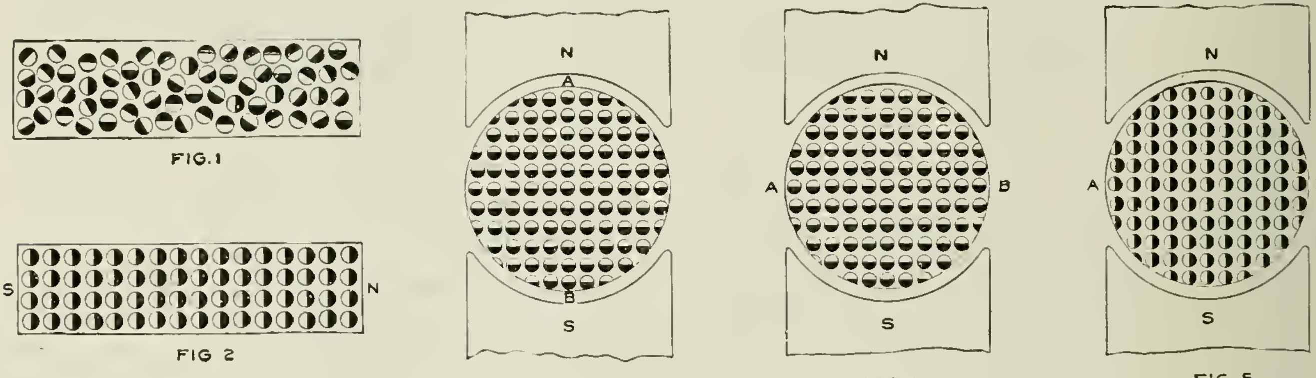


FIG. 1

FIG 2

FIG. 3

FIG. 4

FIG. 5

FIGS. 1 TO 5. ILLUSTRATE HOW IRON MOLECULES ARE SUPPOSED TO ARRANGE THEMSELVES WHEN UNDER THE INFLUENCE OF A MAGNETIC FIELD

The friction losses in a direct-current machine consist of the friction of the bearings, brushes on the commutator and the friction of the air upon the revolving element. The last item is usually known as the windage losses. The total friction losses amount to about 6 per cent. of the capacity of the machine for a 1-kw. unit to about 3 per cent. for a 1000-kw. unit. These may be considered as the mechanical losses of the machine; that is, they represent mechanical power that has been supplied to the generator and that has not been converted into electrical power, but has been expended in doing the mechanical work of overcoming the friction of the generator.

The current that is used to excite the field coils represents electrical power that has been generated in the armature, but is used up within the machine to energize the field coils, therefore is not available for doing work outside of the machine. The amount of power required to energize the field coils of direct-current machines is about 6 per cent. of the total output for machines of 1-kw. capacity to about 1.4 per cent. in 1000-kw. sizes.

Since the energy expended in the field rheostat is also charged up against field losses, the power loss in the shunt-field winding is practically constant, being only changed slightly by the hand adjustment of the rheostat. The losses in the shunt-field winding are therefore equal to the volts at the armature terminal times the current supplied to the field coils.

The energy expended in the field coils is sometimes referred to as the excitation losses or I^2R losses in the shunt-field winding; that is, the loss in the field coils is equal to the square of the current times the resistance of the field coils and that of the section of rheostat in series with the coils. For example, the total resistance of a shunt-field circuit is $R = 27.5$ ohms, and the voltage at the armature terminal is $E = 110$; then the current flowing in the field coils is $I = \frac{E}{R} = \frac{100}{27.5} = 4$ amperes, and the watts $W = EI = 110 \times 4 = 440$. The watts are also $W = I^2R = 4^2 \times 27.5 = 4 \times 4 \times 27.5 = 440$, which gives the same result as the former method.

In the previous lesson we found out that a part of the voltage generated in the armature was used up in overcoming the resistance of the armature windings to the flow of the current. This also represents a loss of power supplied by the prime mover to the generator. This loss is usually called the armature copper loss, or I^2R loss, and is one of the chief factors in increasing the temperature of the machine. The power loss in the armature copper is equal to the voltage drop through the armature winding times the current supplied by the armature; it is also equal to the square of the current times the resistance of the armature winding.

For example, the resistance on a given armature is $R = 0.1$ ohm, and the total current supplied to the load and shunt-field winding is $I = 150$ amperes; then the volts drop in the armature is $E_d = IR = 150 \times 0.1 = 15$ volts, and the watts loss in the armature is $W = E_d I = 15 \times 150 = 2250$ watts. The watts loss is also $W = I^2R = 150 \times 150 \times 0.1 = 2250$.

The losses in the armature copper vary from about 4 per cent. of the capacity of the machine in 1-kw. units to 1.8 per cent. for units of 1000-kw. capacity. These losses vary as the square of the current supplied by the armature and are practically zero at no load, being only those due to the shunt-field winding current, and at a maximum value at maximum load. The resistance of the armature circuit is usually considered as that of the armature windings, brushes, series-field windings if the machine is compound-wound, and the machine leads and terminals.

In the lesson on direct-current armature constructions in the Jan. 13, 1918, issue, it was shown that when the armature core is revolved between the polepieces, it cuts the lines of force and therefore generates a voltage the same as the windings do. It was also shown that the current caused to circulate around in the core by this voltage, or eddy current as it is called, created a pull that opposed the turning effort of the prime mover driving the generator, consequently represented a direct loss of power. The eddy-current losses are usually combined with the hysteresis losses and are called the iron or core losses.

The hysteresis losses are those which are due to the friction of the molecules, of the iron in the armature core, on each other as they align themselves with the lines of force when the armature is revolved. This is illustrated in Figs. 3 to 5. In the lesson "Elements of Magnetism—II," in the Jan. 30, 1917, issue, it was explained that a piece of iron acted as if each molecule was a magnet having a north and a south pole, and that under normal conditions the molecules arrange themselves so that the N and S poles of one molecule were neutralized by the N and S poles of other molecules and thus form a neutral condition, as in Fig. 1. When the piece of iron is brought under the pole of a magnet, this pole will attract the opposite pole of the molecules of the iron and cause them to be arranged in a systematic group, as in Fig. 2, thus producing a N pole at one end of the bar and a S pole at the other. In the same way, when the field poles of an electrical machine are magnetized, they cause the molecules in the armature core to arrange themselves systematically as in Fig. 3. Now if the armature core is turned 90 deg. from the position in Fig. 3, as in Fig. 4, it will be seen that although the core as a whole has revolved 90 deg. to the left as indicated by *AB*, the field magnets have held the molecules of the iron core in the same position in each case. For this to be possible the molecules have done what is equivalent to turning to the right 90 deg. If they had remained in a fixed position in the core, the condition that would exist is that in Fig. 5, from which it is seen that if each molecule turns 90 deg. to the right from the position in the figure, a condition exists in the core corresponding to that in Fig. 4. This is just what appears to be going on in the armature core all the time that it is revolving and the field poles are magnetized. As the armature revolves as a whole in one direction the molecules are revolving about their axis in the opposite direction. The molecules revolve at the same rate as the armature core in a two-pole machine, or one revolution for one pair of poles. The latter statement conforms to the condition existing in all multipolar machines; that is, the molecules make a complete revolution about their axis for each pair of poles in the machine. In a four-pole machine they would be revolving twice as fast as the armature, in a six-pole machine three times as fast, etc.

To cause the molecules to revolve about their axis requires a certain amount of power. The power that is expended in changing the position of the molecules is the hysteresis losses in the core. This, combined with the eddy-current losses, is called the core losses, and amounts to about 4 per cent. in machines of 1-kw. capacity to about 1.2 per cent. in 1000-kw. machines. If an attempt is made to turn the armature of an electrical machine by hand, with the field poles dead, it should turn very easily, but when the field poles are magnetized, it will be found that a greater effort must be developed to turn the armature. This increased effort required under the latter condition is due almost entirely to hysteresis, or in other words, to rotating the molecules of the core.

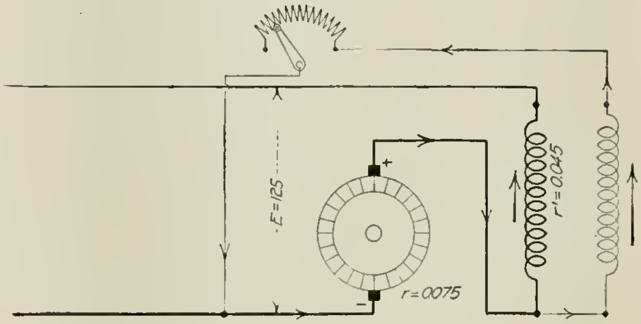


FIG. 6

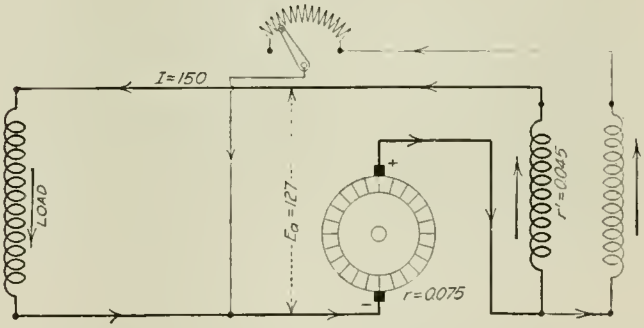


FIG. 7

FIGS. 6 AND 7. DIAGRAMS OF COMPOUND GENERATORS

The total losses at full load in a 1-kw. machine amount to about 20 per cent. of the output, while in the 1000-kw. machine they are about 4.5 to 5 per cent. In other words, when a 1-kw. machine is delivering its full-rated load (1-kw.) it will require about 1.2 kw. to drive it, and when a 1000-kw. machine is delivering its full rated load (1000 kw.) it will require about 1050 kw. to drive it.

The ratio of the output of a given machine to the input is called the efficiency and is usually expressed in a percentage, thus: Per cent. efficiency $= \frac{\text{output} \times 100}{\text{input}}$, from which, output $= \frac{\text{input} \times \text{per cent. efficiency}}{100}$, and input $= \frac{\text{output} \times 100}{\text{per cent. efficiency}}$.

For example, a given generator requires 50 hp. to drive it when supplying 32 kw. to a lighting system. Find the percentage of efficiency that the machine is operating at.

The input in this case is horsepower, kilowatt $= \frac{\text{hp.} \times 746}{1000} = \frac{50 \times 746}{1000} = 37.3$; then per cent. efficiency $= \frac{\text{output} \times 100}{\text{input}} = \frac{32 \times 100}{37.3} = 86$ per cent. approximately. That is, only 86 per cent. of the power supplied to the machine is available for doing useful work in the lighting system.

The problem given in the last lesson is shown in Figs. 6 and 7. The resistance of the armature and series-field winding is $R = r + r' = 0.075 + 0.045 = 0.12$ ohm. At no load the machine develops 125 volts. When the armature is supplying a current $I = 150$ amperes to an external circuit, as in Fig. 7, the volts drop through the armature and series-field winding is $E_d = RI = 0.12 \times 150 = 18$ volts. The load current flowing through the series-field winding was assumed to have caused the armature to generate 20 volts more than at no load, or a total $E = 125 + 20 = 145$ volts. The load current caused 18 volts drop, then the volts across the line terminals is $Ea = 145 - 18 = 127$, or an increase of $127 - 125 = 2$ volts.

A given shunt generator when supplying a constant load requires 175 hp. to drive it, and the voltage at the armature terminal under this condition is 115. The core losses of this machine amount to 4.5 hp., the field winding resistance is 11.5 ohms, the armature copper losses are 3500 watts, and to overcome the friction on the machine requires 1.5 hp. Find the percentage of efficiency at which the machine is operating.

Commutator Was Strained

By E. C. Parham

The general practice in tightening commutators is to heat them first so as to soften the insulation and thereby make it more yielding to the pressure; the resistance then offered to the tightening of the nuts gives an indication of how tight the construction is. One method of heating large commutators, after the machine has been installed, is to apply a number of gasoline torches around the periphery while the armature is kept rotating fast enough to prevent overheating in spots. Another method is to operate the machine with load and with the brushes shifted to a position that causes considerable sparking.

A large generator gave trouble by sparking at the brushes, which was attributed to loose commutator bars. According to the operator's statement, the commutator when the machine was installed was a little out of round, as indicated by the brushes riding up and down once per revolution. Slight eccentricity of the commutators of an engine-driven generator is not at all unusual, nor is it, as a rule, objectionable on this type of machines, and there are hundreds of machines operating satisfactorily in this condition. The commutator is finished in the shop after being installed on the armature, but even at that, when the armature is installed on the engine shaft the commutator frequently runs with a slight eccentricity which can best be removed by truing it up while the armature turns in its own bearing.

The operator in this case had tightened the commutator without heating it, and, to make sure that it was tight, applied all the pressure that three men could exert with a six-foot length of pipe on a wrench. The result of this treatment was that the commutator was so tight that the heat due to normal operations caused the commutator bars to bend out in the middle—this caused poor brush contact, and the sparking became worse than ever. By loosening the commutator, heating it and retightening, using the pressure of two men with a two-foot length of pipe on the wrench, and then grinding the surface with a stone, commutation became perfect, although the commutator was still eccentric.

Blowoff Pipe Scaled

The engineer who has no trouble with scale in his boilers is a fortunate individual. The scale-forming salts in boiler-feed water, as is well known, coat the boiler shell and tube, frequently to such an extent that in the case of return-tubular boilers the tube ends become burned and are prevented from leaking seriously only by the heavy deposits of scale around the tube and on the boiler heads. In water-tube boilers the scale problem is so serious in many localities that some of the tubes become practically stopped up with a hardened lime deposit.


FIG. 1. SCALE IN HORIZONTAL PIPE

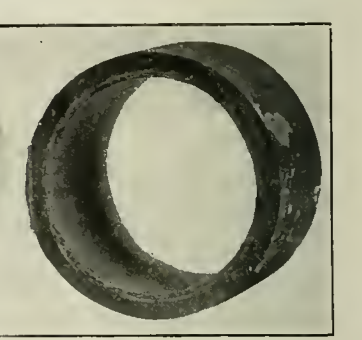


FIG. 2. SCALE IN THE VERTICAL PIPE

The boiler blowoff pipe is not exempt from scale deposit, and sometimes the formation presents an interesting study. For instance, Fig. 1 shows a piece that was cut from the horizontal section of a blowoff pipe on a 72-in. boiler. This pipe had been in use for four years, and the boiler was, so far as known, blown down at least once each day. It is interesting to note the built-up layers of scale, as shown by the variation in colors. Although the inside diameter of the pipe is approximately $2\frac{1}{2}$ in., the opening through the scale is but $1\frac{3}{16}$ in. at its greatest diameter.

In Fig. 2 is shown a piece of the pipe that was cut out of the vertical section, and, as may be seen, the scale formation is but about $\frac{1}{16}$ in. thick, and evenly distributed at that. An interesting question is, Why did the horizontal pipe scale so much more than the vertical section?

Editorials

What Are You Doing With Your Coal?

THE United States must furnis 634,594,000 net tons of bituminous coal to feed e ever-increasing demand of the war machine for fu and to keep the country warm during the present c year. Estimates compiled by the Fuel Administra n indicate an increased demand for 79,866,000 ne ons of bituminous coal, which must be met either an increased production or by conservation and nitation in the use of coal. To meet this demand full by production would mean an increased output 14.4 per cent. over the production for the year 19 which amounted to 554,728,000 tons.

The estimates are based up figures submitted by the various departments of th Government indicating their increased demands for el during the current year. In some cases the uel dministration has found it necessary to go direcly industrial consumers to ascertain the amount of hei equirements. To secure an output of 634,594,00 to during the coal year it would be necessary to rain n an average weekly production of more than twelv illion tons. This amount has not been producedin y single week during the history of the bitumino al mining industry. The nearest approach to thi r irement was reached during the week of May 25, wh the week's production was estimated at 11,811,00 tons.

The demands for s g ships from American ports on foreign service sh he largest percentage of increase. The Shippi oard has estimated that to supply bunkers to s in the foreign trade will require thirty per ce ore coal than in 1917. The industrial requirem of the country, augmented by the tremendous ex n of war manufactures, will demand eighteen pe t. more fuel during 1918 than during 1917. The ic utilities of the country will need a fifteen per increase, domestic consumers a thirteen per cent rease and the railroads a seven per cent. increase he requirements of last year.

In addition to t increases, new requirements for coal will demand ditional nine million tons. Two million tons of t e allotted as a substitute in the West for oil, wh ay not be available because of ocean transporta ifficulties, and seven million tons will go to give ditional ten days' storage supply to the industri erns and public utilities outside of the New En States. The regular allotment to New England rovide for thirty days additional storage in thos es.

There will b crease in the amounts allowed for exports, for nufacture of beehive coke or for bunkering do ships, including those on the Great Lakes.

The indus onsumption of coal will be about eighteen per greater for this current year than it was last But this presupposes still greater economy in the use of coal than has even now been widely achieved. With the Fuel Administration classifying power plants and giving priority of coal to those that do all they can to economize, engineers must not cease but must increase their vigilance in and about the plant.

No engineer could do better than spend an hour with his chief, going over with him this classification plan of the Fuel Administration. The argument that the matter of power costs is insignificant compared with the cost of the product made at the mill or works no longer holds. Coal is essential, be its cost great or small. To get it in reasonable time a plant must show that it is using it economically. The plant management must *show*—not assert or promise or protest, but show—that it is using it efficiently. Our readers may be sure that the Fuel Administration means business. The coal-mine operators, particularly those of Pennsylvania, have been shown recently, and in a surprisingly forcible manner, that the Fuel Administration means business.

If you keep no account of the performance of your plant, particularly the boiler room, begin to do so immediately. Use as high-class scales and meters as you wish, but use something right away. A record of wheelbarrow or dump-cart or carloads of coal is better than no record at all; but such crude means should be temporary only. The time is here when the management must see the necessity of providing the right selection of meters, instruments and equipment for the plant. Having got them on the recommendation of the engineer, he expects that the engineer knows how best to use them and that he will so use them.

Fires in Turbo-Generators

THERE are numerous ways in which a turbo-generator may fail in service, and for periods of from a few seconds, where the steam end opens inadvertently owing to the overspeed device operating or a mistake on the part of the operator, to several weeks when the generator burns up and must be rewound. The steam end of a turbo-generator causes lesser delays, but more frequent ones than the electrical end. Worn bearings, stripped or eroded blades may be renewed in a few hours. With the electrical end it is usually a different matter, for the trouble, instead of being localized and readily get-at-able, is such as necessitates disturbing parts other than those affected, and much work in reaching them.

The larger the capacity of a machine the greater the dependence placed upon it; the greater the importance, therefore, of maintaining it in service and the more serious its failure. Precautions may be justified with large units that would not deserve consideration with smaller ones, nor would they be financially feasible.

Undoubtedly, the most serious accident that can be-fall a turbo-generator, which is not only the most expensive to repair but also of the most protracted delay, is that of a burn-out. Rarely is but one coil alone damaged, but generally several. Often the core is damaged too, necessitating replacement. In any case taking out and replacing the damaged coils require that other coils also be removed in reaching those injured. As a matter of fact, many coils are usually damaged, if not by the actual short-circuit and accompanying arc, by bending and movement in the slots under the enormous magnetic stresses set up by the short-circuit current. When a generator short-circuits internally, a fire may follow, though not necessarily, and a sustained internal fire may cause a short-circuit, although the cause cannot always be easily determined after the event, since the consequence removes the cause in many cases.

A few years ago, when one of the leading central-station companies installed a large turbo-generator, an occurrence of world-wide interest at that time, the matter of internal fires and possible modes of protection were considered, it being felt by some that the chance of conflagration occurring was a very real one, accompanied by very extensive damage. However, at that time the ruling opinion was that the large modern turbo-generator contained nothing that would burn, and that such machines were amply protected. Since that time several serious fires have occurred in turbo-generators—one in the station already referred to—that resulted in extensive damage to the units involved, heavy expense for repairs and perhaps an even greater cost due to loss of capacity and operating smaller and less efficient machines.

The incidents cited in the discussion letter, "Fires in Turbo-Generators," on page 705 of May 14 issue, clearly indicate that the modern turbo-alternator is far from being fireproof, and if fires do occur they are rarely quenched before the windings are destroyed. Although experiments have been carried on recently, as pointed out on page 883 in this issue, to find out the best method of extinguishing fires in large generators and motors, this subject has not received the attention that it merits, as evidenced by the large number of machines that have been destroyed by fire, with no special means of extinguishing the fire at hand. This seems to be one feature in the design and operation of large electrical machines that, if given the proper attention, holds forth possibilities of greatly increasing the reliability of this class of equipment.

Duty of the Employer in Reconstruction of the Crippled Soldier

ALMSGIVING tends to make the recipient more dependent. On the other hand, if the same individual is provided the wherewithal to earn his own living and made to feel that he is earning it, he will be put in a fair way to achieve success and become an asset to the community. It is with this fact in mind that the American Red Cross has undertaken the reconstruction work for our crippled soldiers, thousands of whom will return from the battlefronts before the termination of the war. The employer's side of this work is clearly outlined in an article, "Duty of the Employer in the Reconstruction of the Crippled Soldier," by W. C. McMurtrie, on page 890 of this issue.

It is well known that our pension system, in so far as constructive ends are concerned, has been a failure. The pension did not provide sufficient means to support the disabled soldier in decency, and instead of arousing in the cripple a desire to help himself, it was an incentive to idleness and, not infrequently, worse. From the experience gained in foreign countries it has been demonstrated that the only sound method of dealing with the disabled soldier is to train him for a trade in which his physical disabilities do not incapacitate him. The work carried on in Europe has shown that it is practically possible to train every cripple in some class of work so as to make him an independent and useful citizen.

The problem of making not only the military cripple but also the industrial cripple useful should be considered, for we cannot afford to allow a healthy man to be a dependent on the nation when a little intelligent effort on the part of an employer might make him a productive worker and an independent citizen.

According to the plan under way in this country, the Government will provide the necessary medical treatment, supply artificial limbs, conduct the training for an occupation and find the job. It will, however, rest with the people whether they will encourage the soldier to accept the advantages of training which will refit him for a life of usefulness and self-respect. There is a general feeling that the nation should maintain the crippled soldier in idleness for the rest of his natural life. Nobody will deny that the disabled soldier is entitled to every consideration, but maintaining him in idleness or in a charity job is generally the last thing that tends toward maintaining him as a self-respecting citizen. As Mr. McMurtrie has pointed out,

> Too many employers are ready to give the crippled alms, but not willing to expend the thought necessary to place him in a suitable job. This attitude has helped to make many cripples dependent. With our new responsibilities to the men disabled in fighting for us, the point of view must certainly be changed. What some cripples have done other cripples can do if only given an even chance. If the employer will do the returned soldier the honor of offering him real employment rather than proffering him the ignominy of a charity job, it will be a great factor in making the complete elimination of the dependent cripple a real and inspiring possibility.

Garabed Giragossian, who was going to pluck energy out of the vast unknown, has failed at this writing to exhibit an operating machine. He told the writer that he has had a machine in operation and has run it from eight o'clock in the evening until two in the morning continuously and many other times for shorter periods; that he can stop and start it any time at will and can demonstrate the practicability of his plan inside of a week after the appointment of the investigating committee. Come on, Garabed, step on the gas!

". . . We have added to the American flag since our war against Germany began, nearly 4,500,000 tons of shipping. We have today under contract and construction 819 shipbuilding ways including wood, steel and concrete, which is twice as many shipbuilding ways as there are in all the rest of the shipyards of the world combined."—*Chairman Hurley of the Shipping Board.*

Indeed the Yanks are coming!

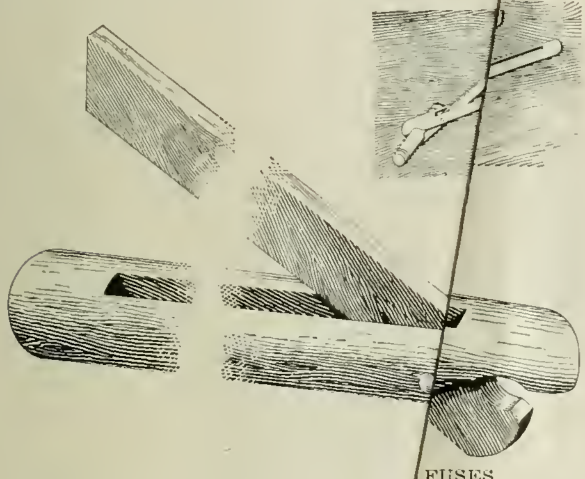
Corrspondence

Wooden Pliers for Replacing ses

The illustration shows a pair of wooden pl handy for replacing blown-out high-voltage poten trans- former fuses with safety to the operator. It made of an ordinary broom handle and a f 1 x ¼-in. hard maple. The broom handle is slott eceive the maple piece. Anyone can make this too will find it handy around the switchboard, especia green help.

George Dewar.

Hoosick Falls, N. Y.



HANDY PLIERS FOR REPL FUSES

Burning Wood to serve Coal

It has been suggested freq of late that we of the Southern States burn wo rder to conserve the supply of coal. I have bee sted particularly in the descriptions of differe ods of burning this fuel. I believe, to be cons that seven-tenths of the steam plants in the St lorida are generating steam with wood as fuel. from the larger plants the same proportion wi rue for the State of Georgia. Alabama, of co nearer to the coal fields and therefore burns m There seems to be a general impression tha uel is plentiful in these three states, but man are burning slabs and strips because cord w her impossible to get or so expensive as to prohibitive, which would seem to indicate that not so plentiful after all.

In my opinion it criminal to waste a thousand B.t.u. in wood l, and the present methods are most wasteful. y economical way of burning wood or slabs, it, or grind it to ¾- or 1-in. size, store in an storage bin and feed directly to boilers e ith dutch ovens. In this way all the fuel recei be hogged, stored and burned as needed. The onomy resulting from an installation of thi uld be a closer regulation and a more unifor combustion, as the fire-doors would not hav ened so often, admitting large volumes of cold air, and less damage would be done to the boiler setting. A motor-driven chain conveyor could be used to deliver the hogged fuel to the firing floor or directly to the furnace.

I would like to see more discussion on wood as fuel. Aside from the reasons why I should burn it, I am interested in any suggestions as to how I can use it to better advantage.

W. Walton Cranford.

Fort Myers, Fla.

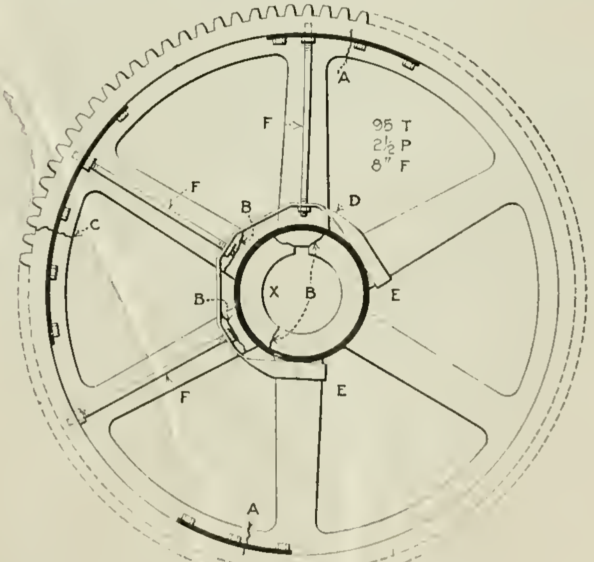
Repairs to Broken Gear Wheel

The machine to which a large gear, broken as shown in the illustration, belongs should be in use every day, so when it broke it was up to the master mechanic to make quick repairs, for under present conditions the delivery of a new one or having the broken one welded would mean the loss of valuable time.

We found the web cracked through and the rim partly through at *A*. The hub and arms were broken through at *B* and the rim at *C*, and the gear was forced around on the shaft until the key was about at *X*. We drew the key and removed the wheel from the shaft, then drew the gear together with rods and bolts as closely as possible. Next, three rings were shrunk on the hub, two on one side and one on the other, and plates made to fit the inside of the rim, as shown by the heavy lines. These were drilled and put on with capscrews after the hub was drawn up by the bands. The arms were stiffened by means of rods from the strap *D* hooked over two good arms and on the other side, where the hub was long enough to receive it, by a large band. The gear was then replaced, keyed up tight and the machine started, and it ran as well as ever.

John Drummond.

Granby, Que., Canada.



BROKEN GEAR WHEEL REPAIRED AND RETURNED TO SERVICE

Instruments Improve Plant Economy

In the plant in which the writer is chief engineer, two 372-hp. water-tube boilers equipped with chain-grate stokers were installed. One of first questions to arise was that of damper regulation. It was decided to control the dampers from the fronts of the boilers, using straight pieces of shafting and rocker-arms to complete the connection with a ratchet lever mounted at the side of the setting. This arrangement worked satisfactorily until a draft gage, a recording steam-pressure gage and a hand CO_2 outfit were purchased. The recording-pressure gage began to tell tales. Fig. 1 will give an indication of what was happening. The firemen would allow the steam pressure to drop 10 or 15 lb., then open up the feed on the stokers so that a large quantity of green coal was fed onto the grates. They would also open up the damper and allow a rush of cold air into the furnace, lowering the temperature of the combustion chamber as well as carrying 50 per cent. of the volatile gases up the chimney unburned.

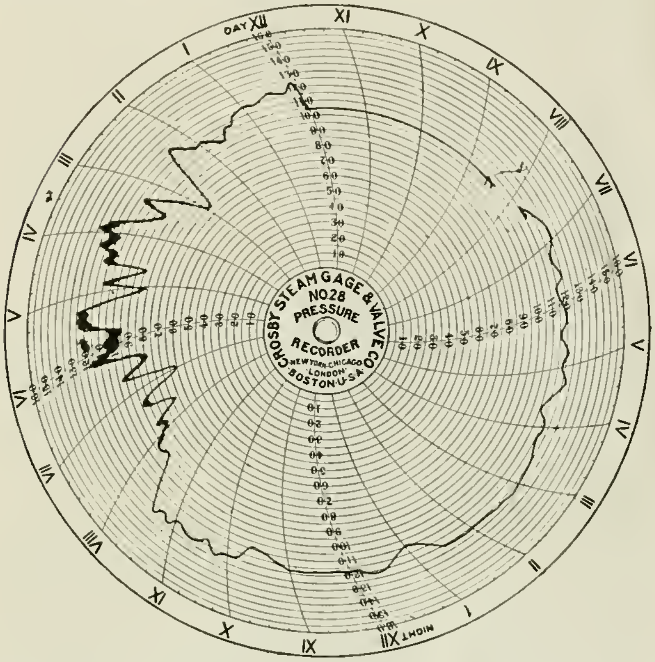


FIG. 1. PRESSURE CHART BEFORE PURCHASE OF INSTRUMENTS

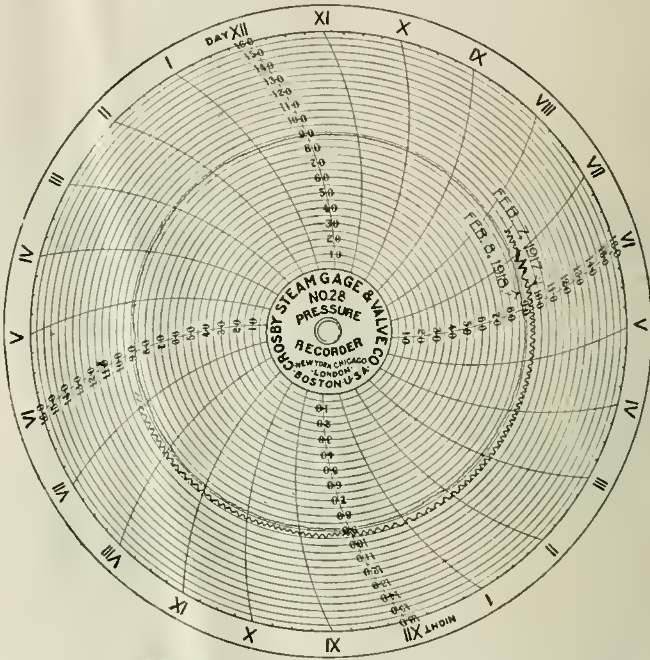


FIG. 2. COMPARATIVE PRESSURE RECORDS TAKEN FEB. 7, 1917, AND FEB. 8, 1918

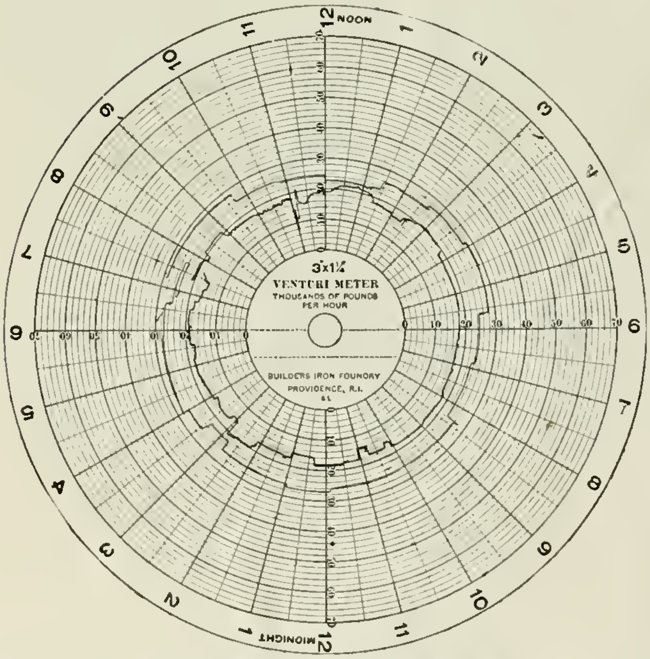


FIG. 3. VENTURI-METER READINGS SAME DAY IN CONSECUTIVE YEARS

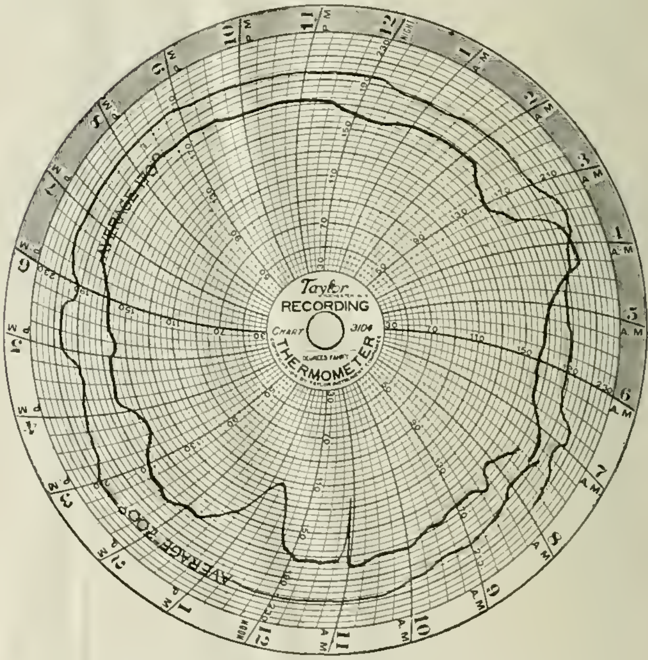


FIG. 4. RECORDING-THERMOMETER CHART, SHOWING INCREASE IN FEED-WATER TEMPERATURE

Instructing the firemen to continue to operate the boilers as they had in the past, I connected up the CO_2 analyzer and took a reading when the combustion was good and the steam pressure normal. The result was 12 per cent. CO_2. When the steam pressure began to drop, the fireman as usual, proceeded to admit a large quantity of green coal and open up the damper. A sample of gas showed only 5 per cent. CO_2. Evidently a change in firing methods was in order to stop the fluctuation in pressure, and it was apparent that the draft was not regulated as it should be.

A damper regulator was purchased and this instrument worked to perfection. Still there was not proper control of the stoker engine. This difficulty was overcome by taking off the governor, putting a ½-in. bypass around the main throttle and opening the valve just enough to keep the engine turning over. An arm from the damper-regulator shaft was then connected to the throttle valve, and the regulator was set to operate at a small variation in pressure. The outer circle in Fig. 2 shows the result of the first attempt, and the inner circle indicates what is now being done in the plant. The variation in steam pressure is very small and the CO_2 seldom goes below 11 per cent.

It is worthy of mention that the recording charts are being conserved by using them from year to year on corresponding days by changing the color of the ink. The records shown in Fig. 2 were taken on Feb. 7, 1917, and Feb. 8, 1918. The plan is not so much to conserve the paper charts as to create comparative records of corresponding days in two or more years, depending upon the number of times the charts are used. This is a great help in operating the plant at high efficiency. Take for example the venturi-meter chart in Fig. 3. It shows how much the load has increased in a year's time, and Fig. 4, a chart from the recording thermometer, indicates the relative feed-water temperatures. The last-named instrument is a great improvement over putting your hand on the discharge pipe of the boiler-feed pump to learn the temperature of the water. Besides, it helps to locate any trouble that may develop in the pump. When the latter begins to give trouble, it is not always easy to tell whether the water is too hot or whether the pump is airbound. With a thermometer there is no difficulty in making the proper decision.

In the plant under discussion the use of a recording thermometer resulted in a considerable saving in coal. It was impossible to get the feed-water temperature above 170 deg. If it could be raised to 200 deg., calculation showed that a saving of $1.83 per day in coal could be effected. The trouble was in the location of the feed-water heater. It had been placed on a dead end from the exhaust heating line, so that there was no circulation through it, and the only way to remove the air was to open the roof valve, which of course was a waste of heat. Remodeling the piping connections so that all the exhaust steam passed through the heater on its way to the heating system made a feed-water temperature of 200 deg. possible, and as shown in Fig. 4, this temperature has been exceeded. J. J. SPANGLER.

Mooseheart, Ill.

Operated Turbine with Stripped Blading

I have read with interest some of the articles in *Power* regarding steam-turbine accidents and I wish to relate an experience due to losing six rows of the low-stage blading on a 500-kw. unit in the plant in which I am employed. The accident occurred with about 40 per cent. load on the turbine just after the generator had been synchronized with another unit and at the time the attendant was building up the vacuum on the condenser.

I was not at the plant when the accident occurred, but arrived about fifteen minutes afterward, and from evidence and from information gathered from the operating engineer I am of the opinion that the stripping of the blading was caused by water being forced up into the low-pressure end of the turbine by the priming pump after the circulating pump had stopped owing to a blown fuse on the motor drive, a jet type of condenser being used.

After removing the stripped and distorted blading from the cylinder and spindle, we put the turbine back in service and operated it for several months before renewing the low-stage blading, being able to pull the full rated capacity of the generator, although at a considerable increase in steam consumption. HOMER I. REEDER.

Emporia, Kan.

Fires in Turbo-Generators

The article "Fires in Turbo-Generators," by M. A. Walker, appearing in the Jan. 22 issue of *Power*, and the letter by Everett Palmer in the May 14 issue commenting upon this article, show conclusively that the problem of extinguishing fires in turbo-generators is one that should cause every power-plant operator serious concern. The number of turbo-generators in this country that have been completely destroyed by fire and that might have been saved with only the loss of one or two coils had the proper facilities been provided to take care of such emergencies, should make both operators and manufacturers consider such protection seriously. These fires have cost thousands of dollars for repairs, and even larger sums due to the long period required to make the repairs, which in many cases require practically rebuilding the whole core and winding of the generator. At first it was thought that the high-voltage turbo-alternator did not contain much that could burn, but today we know by many experiences that short-circuits in these machines will not only cause the insulation to be destroyed, but will also destroy the winding and core themselves.

Recently, a series of experiments was conducted by the General Electric Co., as reported in the January, 1918, issue of the *General Electric Review*, as to the best means of extinguishing fires in high-speed totally inclosed motors and turbo-generators. As a result of these experiments the conclusion was reached that steam, if supplied in sufficient quantities, will put out any fire that may occur by burning insulation; further, that the insulation, if properly dried out after a steam bath, will not be materially damaged. This method has the further advantage of relieving the boilers of some of their steam when practically the whole load of the unit is suddenly thrown off.

Carbon tetrachloride, while not as effective as steam, will put out such fires if used in sufficient quantities. It has the disadvantage, however, that it will attack and destroy the insulation; furthermore, its fumes are very injurious when breathed.

Carbon dioxide seems to be equally effective in putting out these fires, but it is hard to apply. It has to be kept in containers under high pressure, and there are instances where, when these gases were released, the outlet nozzles were quickly frozen up, owing to the refrigerating action.

As pointed out by Mr. Walker and Mr. Palmer, it is necessary that the machine be made dead and disconnected from the line immediately when the trouble occurs, which can probably be best accomplished automatically, after which the steam should be turned on as soon as possible.

Another feature is the ventilating air. This must be cut off and the dampers at both intake and discharge must be closed, for the admission of large quantities of air will have a very marked effect in causing the fire to spread. In my opinion steam is far superior to water for putting out these fires, not only by reason of the advantages already pointed out, but also because the use of water is attended with some uncertainty as regards both its application and its effect on the rotating parts. Steam readily penetrates to all parts of the windings and will readily reach a fire in any remote part of the windings, where it might be impossible to reach it with water unless a considerable quantity is used. B. A. Briggs.

New York City.

Analyses of No. 2 Buckwheat Coal

In the May 21 issue of *Power*, page 728, under the title, "Coals of the United States," are given the proximate analyses of a number of coals from representative districts, the authority being Bureau of Mines Bulletin No. 22.

In the coals listed only one analysis of an anthracite is given. This is reported as being from an anthracite culm, but the results of this one analysis are so good compared with the anthracite received at the plant where I am employed that I ask you to give the inclosed analyses room in your publication so that others may see that all anthracite steam fuel is not as good as the article referred to would indicate. These analyses have not been chosen, but are the consecutive results of occasional samples taken and analyzed by a capable chemist.

PROXIMATE ANALYSES OF ANTHRACITE NO. 2 BUCKWHEAT (RICE) COAL

Date Car Unloaded	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.	Coal Received From
	——Per Cent. of Dry Coal——					
Dec. 29, 1917	4.10	72.85	23.05	....	......	Mine A
Dec. 29, 1917	4.85	75.90	19.25	....	......	Mine B
Jan. 1, 1918*	4.05	62.60	33.35	....	......	Boiler room H
Jan 1, 1918*	4.30	66.35	29.35	....	......	Boiler room S
Jan. 3, 1918*	4.05	76.50	19.45	....	......	Boiler room H
Jan. 3, 1918*	4.95	69.95	25.10	....	......	Boiler room S
Mar. 1, 1918	5.70	71.00	23.30	....	......	Mine B
Mar. 1, 1918	5.70	66.70	27.60	....	......	Mine B
Mar. 11, 1918*	7.00	73.10	19.90	....	......	Boiler room S
Apr. 11, 1918	6.40	73.20	20.40	...	......	Mine C
Apr. 11, 1918	6.60	75.00	18.40	...	......	Mine B
Apr. 16, 1918	6.50	70.50	23.00		......	Mine A
Apr. 16, 1918	6.70	72.70	20.60			Mine A
Apr. 20, 1918	8.00	74.30	17.70	0.65	11,399	Mine C
Apr. 20, 1918	5.90	75.50	18.60	0.85	11,379	Mine A
Apr. 25, 1918	7.40	68.40	24.20	0.62	10,208	Mine D
Apr. 25, 1918	5.65	69.55	24.80	0.68	10,352	Mine B
May 3, 1918	5.35	74.85	19.80	0.92	11,358	Mine A
May 3, 1918	5.40	77.30	17.30	0.78	11,557	Mine A
May 8, 1918	6.80	71.80	21.40	0.82	11,169	Mine B
May 8, 1918	6.10	66.50	27.40	0.90	10,173	Mine B
May 16, 1918	6.85	72.55	20.60	0.76	11,370	Mine B
May 16, 1918	6.80	74.90	18.30	0.68	11,612	Mine B

* Samples were taken from the supply in the boiler rooms.

Anthracite culm is generally understood to be inferior to No. 2 buckwheat (rice). We are now using about 8000 tons of this No. 2 buckwheat per month, and if we could have the analysis equal that given in the Government bulletin quoted by you, we could do with about seven or eight less cars per month based on the reduction of ash only, not considering the increased efficiency of boiler operation with the better fuel.

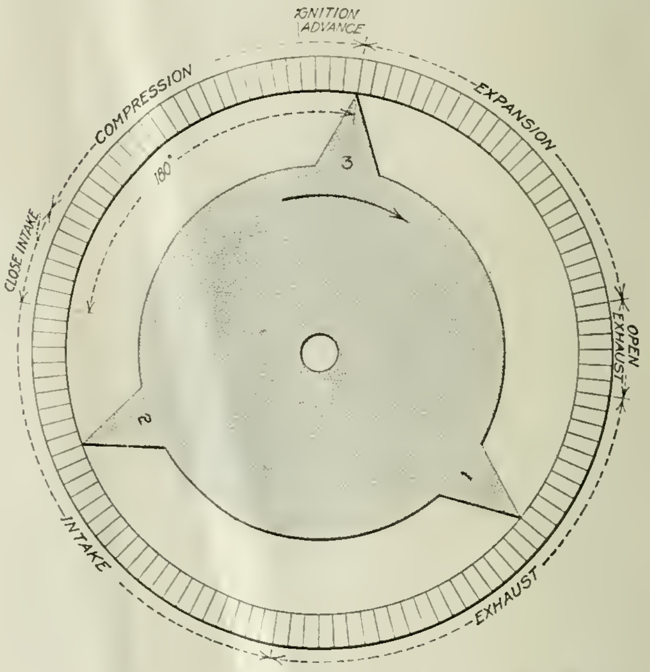
Pottsville, Penn. W. W. Pettibone

Gas-Engine Cycle Indicator

The figure shows a diagram of a cycle indicator for a three-cylinder four-stroke-cycle internal-combustion engine which I designed. To engineers familiar with the cycle the indicator is self-explanatory. The circular scale represents the four strokes of the cycle, or two revolutions of the crankshaft and one revolution of the camshaft. The pointers 1, 2 and 3 on the rotating member represent the cylinders and their working parts.

The pointers are numbered in the firing order of the cylinders, and the center piece must always contain as many pointers as there are cylinders in the engine. The center portion may also be made round and of the diameter of the inner circle of the scale, and in place of the pointers lines may be drawn and numbered accordingly. No matter how many cylinders there may be in the engine, the pointers will always show the relative positions of the vital working parts.

The indicator may be used for practical and educational purposes. If geared to the engine so that the center portion revolves at camshaft speed, the engineer can tell at a glance how the engine stands and what adjustments must be made, and by turning the engine two revolutions every valve and igniter can be set.



FOUR-STROKE-CYCLE, INTERNAL-COMBUSTION ENGINE CYCLE INDICATOR

In looking at the diagram, No. 3 piston stands at top dead-center for ignition. No. 1 and 2 show the position during exhaust and intake respectively. Turning the engine a little farther, No. 2 intake closes with about 36 deg. delay at the lower end of the stroke. A little farther turning closes No. 1 exhaust at the upper end of the stroke. For demonstration purposes the indicator may be used as a hand instrument.

Pittsburgh, Penn. John Fetzer.

Surplus electric power produced by the Stimson Mill Co. at Ballard, Wash., by the burning of waste material will be sold to the City of Seattle at 0.004c. per kw.-hr. The mill company agrees to deliver to the city 1300 kw. for 12 hours and 300 kw. for the other 12 hours of the day.

Inquiries of General Interest

Advantages of Throttling Wet Steam—How is the operation of an engine improved by partly closing the throttle when the supply of steam is from a boiler that is priming? D. W. J.

By partly closing the throttle the process of wiredrawing the steam reduces its pressure, and the heat contained in the initial wet steam is sufficient to convert the mixture into dry steam at the reduced pressure, with the advantages of removing danger of a smash of the cylinder from presence of a large amount of water and of obtaining work of expansion from a larger proportion of the boiler output.

Radial Valve Gear—What is meant by the term radial valve gear? R. G.

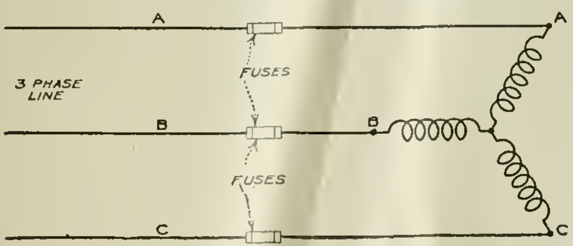
The name radial valve gear has been applied to a number of reversing gears that are quite different in design but agree in deriving the mid-gear motion of the valve from a source that is equivalent to an eccentric with 90 deg. advance combined with another motion that is equivalent to that of an eccentric with no angular advance. The general principle of operation of radial gears is that of obtaining from some reciprocating or revolving piece of the engine, an arrangement of radius bar and link work, a point in which shall describe an oval curve, and by altering the direction of the axes of this curve to produce a valve motion adapted to variable cutoff, reversal or stoppage of the engine.

Diameters of Mating Cone Pulleys—With stepped or cone pulleys used for belt transmission at variable speeds, should the sum of diameters of corresponding drivers and followers be constant for a constant length of belt? F. W.

When the belt is run crossed, a constant length of belt will be required for a constant sum of diameters, but for an open belt of constant length, the sum of diameters of mating steps cannot be constant because there is a changing belt angle to alter the length of belt required. The discrepancy is not perceptible for ordinary lengths of open belts required for countershafts, but for such cases as foot-lathe drives and speed cones, where the cones are closer together and there is a wide difference of diameters, the sum of diameters must be varied to compensate the varying belt angle.

Fuse Blown on 3-Phase Circuit—If one fuse blows on a 3-phase line supplying a 3-phase motor, will the motor be operating 2-phase or single-phase? N. E. A.

If one fuse blows on a 3-phase line that is supplying a 3-phase motor, the motor will then be operating single-phase.



Consider the three lines *A*, *B*, and *C* of the 3-phase circuit in the figure, one phase from *A* to *B*, another from *B* to *C*, and the third from *C* to *A*. Then if the fuse blows in line *A*, the phases from *A* to *B* and *C* to *A* are dead, the one from *B* to *C* being the only one that is alive.

Water Handled by Pump—What quantity of water would be handled by a 14-in. x 36-in. duplex pump making 12 revolutions per minute? J. D.

Neglecting the reduction of cross-sectional area of plungers or water cylinders due to piston rods, the displacement per stroke would be 14 × 14 × 0.7854 × 36 = 5541.78 cu.in. There would be four single strokes per revolution and with 12 revolutions per minute the total plunger or piston displacement would be 12 × 4 × 5541.78 = 266,005 cu.in. or 266,005 ÷ 231 = 1151.5 gal. per min. The actual discharge will depend on the amount of slip or reduction of the amount of water actually handled, due to defective piston packing, leaky stuffing-boxes or valves, the delayed closing of the valves and the amount of air carried into the pump body by the water. For a pump of this size and speed in good condition and working at moderate pressure, the slip should not exceeed 2 per cent., and the amount of water handled should be 98 per cent. of 1121.5 = 1128.5 gal per min.

Conversion of Vacuum Readings to Standard Barometer—If a mercury vacuum-gage reading is 26.5 in. at a temperature of 80 deg. F., with the barometer reading 29.3 in. at a temperature 70 deg. F., what would be the equivalent vacuum with 30 in. barometer at 62 deg. F.? G. A. W.

For practical purposes, and within moderate differences of temperature and barometer, the equivalent vacuum would give the same variation from the barometer; that is, 26.5 in. vacuum with 29.3 barometer might be considered to be equivalent to 30 — (29.3 — 26.5) = 27.2 in. vacuum with 30 in. barometer. When temperatures are considered the coefficient of expansion of mercury may be taken as 0.0001 per degree on the Fahrenheit scale and 26.5 in. of the vacuum gage would be equivalent to 26.5 — [26.5 × (80 — 62) × 0.0001] = 26.4523 in. at 62 deg. F., and the actual barometer reading of 29.3 in. at the temperature of 70 deg. F. would be equivalent to 29.3 — [29.3 × (70 — 62) × 0.0001] = 29.27656 in. at 62 deg. F. Therefore the unbalanced pressure would be 29.27656 — 26.4523 = 2.82426 in. of mercury at 62 deg. F. and used for 30 in. barometer at 62 deg. F. this would be 30 — 2.82426 = 27.17574 in. vacuum.

Estimating Height of Suction Lift—When a pump operates with a suction lift, how can a vacuum gage inserted in the suction pipe at the pump show the height of the pump above the water supply? W. G. S.

Water is forced up in a pump suction pipe by the pressure of the atmosphere acting on the surface of the suction water with sufficient pressure to overcome the inertia and friction of the water entering and moving along the pipe, plus the pressure due to the height of the suction lift, plus the pressure acting on the water at the pump. When a pump moves only just fast enough to keep the water in motion, there will be little pressure lost in overcoming friction and inertia and the atmospheric pressure will have to overcome little more than the pressure due to the height or head of water plus the pressure not removed by the pump.

A vacuum gage connected with the suction pipe at the pump will show how much lower than atmospheric pressure the pump has reduced the pressure at that point and each "inch of vacuum" will represent 0.491 lb. per sq.in. less than the pressure of the atmosphere. A vacuum gage placed at the level of the suction water would indicate 0 inches of vacuum, because the pressure would be equal to the pressure of the atmosphere. When no part of the atmospheric pressure is employed for overcoming friction or inertia of the water (as would be practically the case when a pump is running only just fast enough to "hold suction") then the pressure created by the head of water in the suction pipe would be equal to atmospheric pressure less 0.491 times the "inches of vacuum" at the pump, because the sum of these pressures would balance the pressure of the atmosphere. Atmospheric pressure may ordinarily be taken as equal to 14.7 lb. per sq.in. and, as one foot head of water makes a pressure of 0.433 lb. per sq.in., the height of "suction lift" in feet would be [14.7 — (inches of vacuum at pump × 0.491)] ÷ 0.433.

[Correspondents sending us inquiries should sign their communications with full names and addresses.—Editor.]

Spring Meeting AMERICAN SOCIETY of MECHANICAL ENGINEERS

THE semiannual meeting of the American Society of Mechanical Engineers, held at Worcester, Mass., June 4-7, was the largest spring meeting in the history of the society, the registration reaching one thousand. The opening session was held in the ballroom of the Hotel Bancroft on Tuesday evening. R. Sanford Riley, president of the Worcester Chamber of Commerce and a member of the society, greeted the visitors and introduced His Honor, Pehr G. Holmes, mayor of Worcester, who welcomed them to the city. President Charles T. Main acknowledged the welcome in a few well-chosen words, and Charles G. Washburn delivered an address upon "The Growth of an Industrial City." This was followed by a reception at the Worcester Art Museum, after which dancing and refreshments were enjoyed in the nearby Tuckerman Hall.

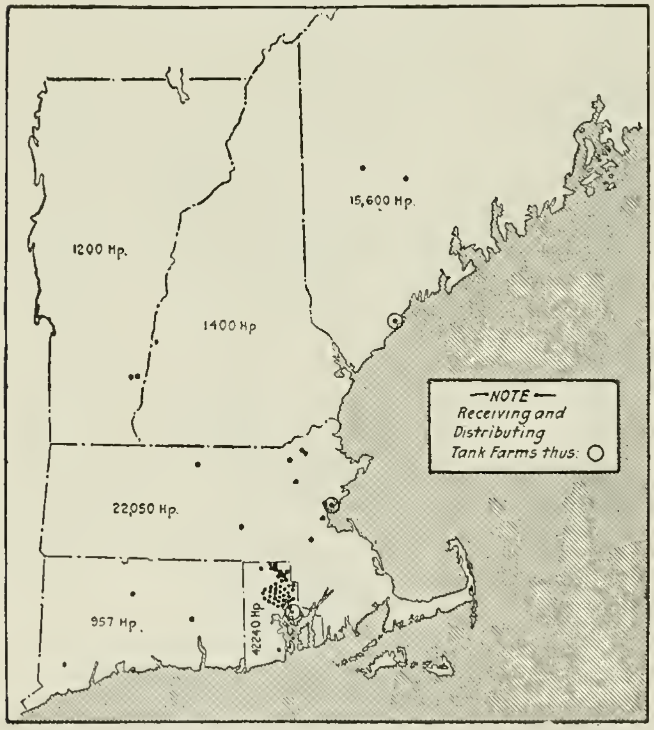


FIG. 1. LOCATION OF OIL-BURNING PLANTS IN NEW ENGLAND

Wednesday forenoon was devoted to a business session in the gymnasium of the Worcester Polytechnic Institute, at which constitutional amendments dealing with the procedure of nominating the officers of the society were considered, and the reports of committees on Screw-Thread Tolerances, Weights and Measures, and Steel Roller Chains were received. Worcester R. Warner delivered an address eulogistic of Past President and Honorary Secretary Frederick Remsen Hutton, and George H. Haynes presented a paper on "The Small Industry in a Democracy." Past President Ira N. Hollis made a plea for consecration to the task of winning the war.

In the afternoon three simultaneous sessions were held in various halls of the Polytechnic Institute. Many of the papers dealt with munitions and other war subjects. That of particular interest to *Power* readers,

OIL FUEL IN NEW ENGLAND POWER PLANTS

by Henry W. Ballou, said that oil fuel was now in use in at least 60 power plants in New England having a total of some 83,000 hp. and in about 100 low-pressure steam plants for supplying heating systems. A list of the power plants and a map of their locations, Fig. 1, are given:

OIL-BURNING POWER PLANTS IN NEW ENGLAND

Plant	Type, Number and Hp. of Boilers	Total Hp.	Year	Oil-storage Capacity, Gal.
International Paper Co., Livermore Falls, Me	B. & W., 6 (350), 10 (600)	8100	1915	300,000
International Paper Co., Rumford Falls, Me	B. & W., 12 (600)	7200	1915	300,000
Jenckes Spinning Co., No. 1, Pawtucket, R. I	B. & W., 3 (400), 1 (250)	1450	1915	50,000
Jenckes Spinning Co., No. 2, Pawtucket, R. I	B. & W., 4 (400)	1600	1917	46,000
American Woolen Co, Riverside Mills, Providence, R. I	Manning, 20 (200)	4000	1915	16,000
American Woolen Co., Bay State Mills, Lowell, Mass	H. R. T., *4(150); Manning, 1 (200)	800	1915	50,000
American Woolen Co., Wood Mill, Lawrence, Mass	H. R. T., 44 (200)	8800	1918	Concrete, 500,000
American Woolen Co., Washington Mill, Lawrence, Mass	H. R. T., 3 (300); Heine, 4 (275); 11 (300); Gunboat, 4 (600)	7700	1918	125,000
International Braid Co., Elmwood Mill, Providence, R. I	B. & W., 2 (150), 1 (250)	550	1915	35,000
International Braid Co., Fletcher Mill, Providence, R. I	Manning, 7 (175)	1225	1916	25,000
Atlantic Mills, Providence, R. I	Manning, 7 (175)	1225	1916	50,000
Manville Company, Manville, R. I	H. R. T., 10 (150); B. & W., 3 (250)	2250	1916	125,000; (165,000 being added)
Manville Company, Bernon Mill, Georgiaville, R. I	H. R. T., 4 (150)	600	1916	50,000
Manville Company, Nourse Mill, Woonsocket, R. I	B. & W., 4 (250)	1000	1917	150,000
Manville Company, Social Mill, Woonsocket, R. I	H. R. T., 16 (150)	2400	1917	320,000
Manville Company, Globe Mill, Woonsocket, R. I	Manning, 7 (175)	1225	1917	70,000
Jos. Benns & Sons, Greystone, R. I	Manning, 5 (175), 1 (125); Stirling, 1 (300), 3 (275)	2125	1916	190,000
Rhode Island Hospital, Providence	B. & W., 1 (250), 1 (175), 2 (150)	725	1916	25,000
Rhode Island School of Design, Providence, R. I	Keeler, 2 (250)	500	1916	7,000
Sayles Memorial Hospital, Pawtucket, R. I	H. R. T., 1 (200), 2 (50)	300	1916	22,000
Mexican Petroleum Corp., Portland, Me	H. R. T, 2 (150)	300	1915	8,505,000
Mexican Petroleum Corp., Allens' Avenue, Providence, R. I	H. R. T., 2 (75)	150	1915	3,885,000
Mexican Petroleum Corp., Kettle Point, East Providence, R. I	H. R. T., 2 (175)	350	1917	6,930,000
Peace Dale Mfg. Co., Peace Dale, R. I	B. & W., 4 (250)	1000	1916	50,000
Gorham Manufacturing Co., Providence, R. I	Stirling, 4 (250)	1000	1915	50,000
Fitzgerald Building, Providence, R. I.	Manning, 2 (150)	300	1916	6,500
Shepard Company, Providence, R. I.	H. R. T., 2 (150)	300	1916	7,500
Newman Hotel, Providence, R. I.	H. R. T., 2 (75)	150	1916	4,000
Boston Store, Providence, R. I.	Scotch marine, 3 (105)	315	1916	11,000
Lonsdale Bleachery, Lonsdale, R. I.	B. & W., 10 (350)	3500	1917	Concrete 130,000
Royal Weaving Co., Pawtucket, R. I.	B. & W., 6 (350)	2100	1917	75,000

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*Horizontal return-tubular

OIL-BURNING POWER PLANTS IN NEW ENGLAND—Concluded

Plant	Type, Number and Hp. of Boilers	Total Hp.	Year	Oil-storage Capacity, Gal.
Lorraine Mfg. Co., Pawtucket, R. I.	Manning, 4 (300), 9 (175)	2775	1916 and 1917	90,000
Grant Mills, Providence, R. I.	Manning, 4 (150), 1 (200)	800	1916	20,000
J. D. Lewis Dye Works, Providence, R. I.	H. R. T., 2 (150); Manning, 1 (150)	450	1915	8,000
Revere Rubber Co., Providence, R. I.	Edge Moor, 2 (250), 1 (500); Aultman-Taylor, 1 (500);	2200	1917	135,000
		....	1917	....
	Manning, 4 (175)	....	1918	....
Slater Yarn Co., Pawtucket, R. I.	Stirling, 3 (250), 1 (175)	925	1917	46,000
Grant Yarn Co., Fitchburg, Mass.	Manning, 7 (150)	1050	1917	40,000
Providence Journal Co., Providence, R. I.	B. & W., 3 (250)	750	1917	6,000
River Spinning Co., Woonsocket, R.I.	H. R. T., 2 (150), 1 (300)	600	1917	4,600
Mexican Petroleum Corp., Chelsea, Mass.	H. R. T., 2 (175)	350	1917	9,240,000
Gerald Cooper, Providence, R. I.	H. R. T., 1 (75);	250	1915	25,000
	Manning, 1 (175)	....	1918	..
Merrimac Chemical Co., South Wilmington, Mass.	H. R. T., 1 (300)	300	1917	8,000
Merrimac Chemical Co., Everett, Mass.	B. & W., 3 (250)	750	1918	....
The Thomas G. Plant Co., Boston, Mass.	B. & W., 3 (250)	750	1918	70,000
Dimond Store, Providence, R. I.	H. R. T., 3 (150)	450	1917	Concrete 7,000
Waite-Thresher Building, Providence, R. I.	Scotch marine, 2 (200)	400	1917	Concrete 7,000
Union Hand Laundry, Providence, R. I.	H. R. T., 1 (100)	100	1918	Unknown
Louttit Home Hand Laundry Co., Providence, R. I.	H. R. T., 1 (150)	150	1917	Unknown
What Cheer Laundry, Providence, R. I.	H. R. T., 2 (150)	300	1916	16,000
Springdale Finishing Co., Canton, Mass.	B. & W., 2 (400)	800	1917	46,000
Anco Mills, Wilkinsonville, Mass.	H. R. T., 5 (150)	750	1918	46,000
Versailles Sanitary Fibre Co., Versailles, Conn.	Manning, 2 (150)	300	1918	3,000 Kerosene
Jones & Lamson Machine Co., Springfield, Vt.	Stirling, 3 (250)	750	1916	25,000
Jones & Lamson Machine Co., Springfield, Vt.	H. R. T., 1 (300), 1 (150)	450	1917	20,000
Claremont Paper Co., Claremont, N. H.	Manning, 4 (300), 1 (200)	1400	1918	215,000
Robinson Bleach & Dye Works, New Milford, Conn.	H. R. T., 3 (219)	657	1917	Unknown
Young Bros. Box Shop, Providence, R. I.	H. R. T., 1 (100)	100	1917	3,500
Woodlawn Finishing Co., Pawtucket, R. I.	H. R. T., 2 (75)	150	1917	23,500
Hennessey Laundry, Providence, R. I.	H. R. T., 2 (125)	250	1916	5,000
D. Goff & Sons, Pawtucket, R. I.	H. R. T., 5 (250)	1250	1915	10,000

About one-half of the boiler horsepower served by oil is in Rhode Island. An outline drawing, Fig. 2, shows a typical power-plant equipment. Insurance requirements have ceased to be burdensome. No difficulty is experienced in pumping oil as warm as 130 deg. F. with a 10-ft. lift. About nine-tenths of these fuel-oil installations are substitutes for coal in existing plants. There is no other method of increasing the capacity of a boiler plant so quickly and cheaply as by substituting oil for fuel. In a number of cases the change to oil has made it possible to shut down one or more boilers. The simplicity and automatic action of oil meters as compared with the cumbersome methods of weighing coal are appreciated, and the keeping of power-plant records is simplified. A few plants have accomplished automatic regulation of the oil feed, but hand control is almost universal. It is inspiring to contemplate the probability that automatic regulation of the oil, the atomizing steam and the draft pressure will become a standard reality within a few years. The saving of labor due to oil firing as compared with coal has been given an exaggerated importance. Other than fixed charges, 80 to 90 per cent. of the boiler-room costs are in fuel, leaving little to be saved in labor. Crude petroleum may be divided into two classes—that with a paraffin base and that with an asphalt base. The first is so valuable for its derivatives that its price will always be prohibitive for fuel. The extremely heavy grades of asphalt-base oils from Mexico are practically the only fuel oils now available to New England. The present rapid increase in their use is but a lucky incident in the marketing of a great natural product. Immense as is its absolute volume, the insignificance of its relative volume as a source of world-wide fuel has thus far been the main obstacle to the adoption of Mexican fuel oil on the high seas. That obstacle is rapidly disappearing and, regrettable though it be, it is inevitable that its very virtues for this purpose will ultimately deprive the power plants of New England of fuel oil.

A commander of the Navy questioned a statement in the paper that the fireman could indulge in naps when fuel oil was used. Greater vigilance and more constant attention to changing conditions were necessary than with coal. Otherwise the fireman would blow oil worth many times his wage up the stack. George H. Diman told of the successful use of oil at the mills of the American Woolen Co., at Lawrence, Mass.

In the evening a general war session was held in the ballroom of the Bancroft, among the speakers being Paymaster C. E. Parsons, of the Navy, and Dr. Irving W. Clark, lately returned from the hospitals in France.

The feature of the meeting of the most interest to *Power* readers was a fuel session held in the gymnasium of the institute on Thursday morning and continued in the auditorium of the Administration Building of the Norton Companies in the afternoon. This will be reported in full in future issues.

Though scheduled to last but two hours, the fuel session continued through the day except for the interval when a most excellent lunch was given the society by the Norton Co. The following topical questions were down for discussion, but so interesting were the papers and the oral discussion that items 1 to 7 were all that could be taken up in the time available:

1. What are the Economic Effects of Impurities in Coal?
2. To What Extent is Fuel Oil Likely to be Used as a Substitute for Coal?

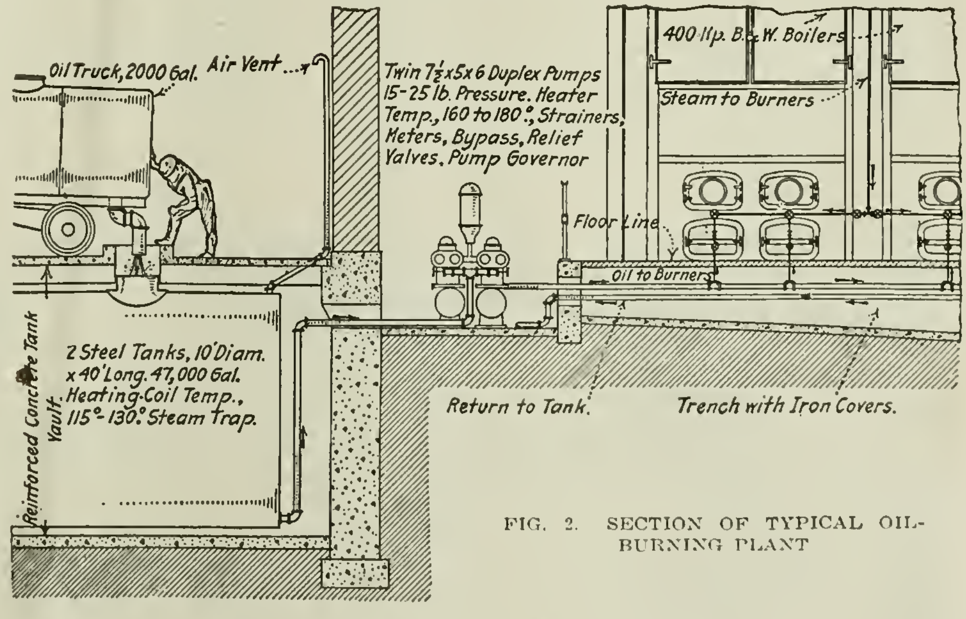

FIG. 2. SECTION OF TYPICAL OIL-BURNING PLANT

3. How Can Soft Coal be Burned Without Smoke in Marine Boilers?
4. What Are the Possibilities in the Direction of the Utilization of Anthracite Wastes?
5. What Instruments Are Useful and Desirable in the Boiler Room as Aids, Etc.?
6. What Is Essential to the Economical Operation of Hand-Fired Boiler Furnaces When Using Soft Coal?

7. To What Kinds of Plants and Coals Are the Different Types of Mechanical Stokers Adapted, and What Is the Limiting Factor to Their Use in Small Plants?
8. What Experience Have you Had in the Use of Wood as Fuel? To What Extent Is Wood Available as a Fuel?
9. What Coal Economies Can be Effected in Residence Heating?
10. What Coal Economies Can be Effected in the Small Steam Plants?
11. What Experiences Have You Had with the Storage of Coal?
12. A Few Additional Topics: (a) To What Extent and Where Will the Gas Producer be Used to Produce Economies? (b) To What Extent Is Natural Gas Being Used as Fuel for Power Purposes? (c) What Is the Relative Economy of the Locomotive of 1900 and Today? (d) What Proportion of the Coke Is Made in Byproduct Ovens? (e) What Are New and Important Developments in Methods of Burning Coal? (f) What Economies Have Resulted from Recent Practice in Making Brick Settings Leakless? (g) To What Extent Is Coke Being Used for Residence Heating? (h) Is Automatic Air Supply Correctly Proportioned to Coal Supply Possible?

The dynamic address of the session was made by E. L. Cole, secretary of the Pennsylvania Fuel Administration, who spoke, following David Moffat Myers, advisory engineer, Fuel Administration, Washington, D. C.

R. J. S. Pigott offered a resolution, which was adopted, in which the Fuel Administration was urged to do its utmost to reduce the impurities in coal. Prof. L. P. Breckenridge presided at the morning session and F. R. Low at the afternoon session.

It is the intention of the society to publish these fuel papers as a supplement to the *Journal;* this will make a valuable publication indeed.

Friday many of those attending the meeting rode out to Camp Deven despite the rain.

New Jersey N.A.S.E. Convention

The convention of the New Jersey State Association of the National Association of Stationary Engineers was held in Perth Amboy, N. J., June 2 and 3. The attendance was unexpectedly large in view of the modest exhibit of engineering equipment and supplies. The new officers are: President, James S. Heath, Elizabeth, N. J.; vice president, Val. V. Secor, Phillipsburg, N. J.; secretary, A. B. Meincke, Newark, N. J.; conductor, Henry Vail, Plainfield, N. J.; doorkeeper, J. Mack, Perth Amboy, N. J. The convention nominated John J. Reddy, the retiring president, for state deputy, Mr. Reddy having so successfully filled that office two years ago. National Secretary Fred W. Raven agreeably surprised the delegates by attending the convention. The association received with acclaim the report of its educational committee, credit for the year's work of which is due chiefly to C. L. Johnson. This committee was voted the usual appropriation. A publicity committee was created, and this work may be performed by the educational committee. A mimeograph machine will be purchased by the educational committee and by this means every member of each association in the state may be provided with study papers issued by the committee.

A resolution of confidence in the Wilson Administration was ordered sent to President Wilson. Another resolution, directed to Commissioner of Labor Bryant, Trenton, N. J., requested him to try to more thoroughly enforce the engineers' license law.

Pleasant entertainment was provided by Bobby Jones and Billy Murray, of Jenkins Bros., and Jack Armour, of *Power.* Next year's convention will be held at Bayonne, N. J.

New York City Electric Rates

The maximum electric rate in Manhattan and the Bronx, New York City, during 1916 was 8c. per kw.-hr. As a result of the activities of the Mayor and the Public Service Commission of New York City, the New York Edison Co. and the United Electric Light and Power Co. reduced their maximum rate to 7½c. on Jan. 1, 1917, and to 7c. on July 1, of the same year. This agreement was reached with the understanding that the Edison companies would continue this rate after a six-months' trial, provided it was found possible to do so, with the prevailing price of fuel, labor, etc.

On June 3, 1918, representatives of the New York Edison Co. and the United Electric Light and Power Co. appeared before the Public Service Commission and announced that the 7c. maximum rate per kilowatt-hour for electric current would be continued after July 1 of this year, despite the fact that the companies have suffered a decrease in revenue due to war conditions. However, the practice of supplying free lamps to their customers is to be abandoned and a minimum charge of 30c. made for the small-sized lamps and more for the larger sizes.

J. W. Lieb, vice president of the New York Edison Co., stated that the operating revenue of the companies had been reduced $941,654 during the first four months of this year, as compared with the same period of last year, and the reduction of the current sold amounted to 4.5 per cent. for the same period. Mr. Lieb said:

> We believe that these conditions would justify the company in going back to the 8c. rate. At the same time it is not absolutely certain that the decrease in output will continue for the rest of the year. We believe that probably the best solution would be a continuance of the present arrangement with the commission, maintaining the status quo for another six months, say, and reserving such rights as we have under the present agreements. This proposal has been accepted by the Public Service Commission.

SOME OF THOSE ATTENDING THE NEW JERSEY N. A. S. E. CONVENTION, PERTH AMBOY, N. J., JUNE 2 AND 3

Western Society Holds Fuel-Supply Meeting

On the evening of June 3 the Western Society of Engineers devoted its attention to the subject of fuel supply. Members of the Coal Conservation Committee of the United States Fuel Administration for Illinois were present to discuss the subject, and they were fortunate to have with them David Moffat Myers, consulting engineer for the Fuel Administration at Washington. Prof. H. H. Stoek, chairman, opened the discussion. From the best information that could be obtained it had been estimated that the additional fuel requirements for this year would be about 15 per cent. An increase of production of 7½ per cent. was the best that could be done, leaving a deficit of 7½ per cent. The plan would be to try and keep all industries going and if need be cut off a little of the fuel supply from each one rather than shut down any of the nonwar plants, as had been proposed at one time. It was of the greatest importance, then, to economize in fuel, and if each coal burner did his part there was a possibility that the deficit would be wiped out.

Mr. Myers Presents the Coal-Saving Plan

David Moffat Myers presented the coal-saving plan that had been prepared recently at Washington, and invited those present to join whole-heartedly in the work. In the past the manufacturer has paid very little attention to the fuel cost and the amount of fuel burned, as it was a very small item in the total cost of production, amounting to 1, 2, 3 or 4 per cent., depending on the product. To make a saving, the manufacturer usually investigated the larger items, including labor, mechanical equipment, raw products, etc., and except where power was the chief product, as in central stations, the power plant received attention last. In order to interest the manufacturer in reducing his fuel consumption, it is necessary to create an incentive, and in the plan now being adopted by many of the states the underlying motive is patriotism. In many cases this will be enough. There are other provisions in the plan to take care of those who neglect to save.

The national plan of organization for fuel conservation in power plants is the result of conference with the United States Fuel Administrators and their committees for a group of states which together consume about 70 per cent. of all the coal used in the country, exclusive of railroads. The plan has been approved also by the United States Bureau of Mines and the committee of consulting engineers on conservation and publicity representing the Engineering Council of the four large national engineering societies. The object is to establish a Government service for the elimination of needless waste of fuel in all power plants, including those in the industries, in office buildings, hotels, apartment houses, etc., and in laying the foundation for the proposed organization, it has been anticipated that this branch of work should become a permanent service of the United States Government.

It has been estimated that 10 to 20 per cent., that is, from 25 to 50 million tons of coal per year, can be saved by the correct operation of steam-power plants, using their present equipment. The effort must be made on this basis, as manufacturing and transportation facilities will not permit of reëquipping the plant. It is considered highly important that all existing fuel conservation committees, committees of chambers of commerce, and national defense, manufacturers' associations and other bodies be continued in full force, and that the work of such organizations be consolidated with the national program. The plan comprises:

1. Personal inspection of every power plant in the country.

2. Classification and rating of every power plant, based on the fairness with which owners of plants conform to the recommendations of the United States Fuel Administration.

3. Responsibility of rating the plant will fall upon the administrative engineers to be appointed by the United States Fuel Administration in each state or district, the rating to be based on information collected by a force of inspectors who will not use their judgment nor express opinions, but merely collect certain definite information included in a questionnaire that has been sent to the plants. After classification and rating of plants according to efficiency of operation, this information will be submitted by the engineer to the state fuel administrator, who shall, in accordance with his judgment, entirely or partly cut off the consumption of coal to any needlessly wasteful plant in his territory. Those plants that follow the recommendations of the Fuel Administration will thus receive the advantage due them for saving coal.

4. Work of the administrative engineers will be to supervise fuel conservation in power plants, including both mechanical and electrical problems connected with the generation and use of steam, power, light and heat, and to supervise the inspection of all power plants in their districts. Inspection will be effected by inspectors of the steam-boiler insurance companies, state factory inspectors, engineering students from technical colleges and volunteers. The rating of each client will be based on the information contained in the questionnaire. Each question will be given a numerical value depending on its relative importance to the other questions, and when the answers are obtained they will be averaged in the same way as an examination paper.

It is further proposed that a standard questionnaire uniform for all states be sent as soon as possible to every power plant in each state or district with notice to the owners that within a certain time, say 60 or 90 days, his plant will be inspected personally and the questionnaire will be checked by the inspector upon his visit to the plant. This action should tend to prepare the minds of plant owners for what will follow and will operate to induce proper care in furnishing the information called for by the questionnaire. It should also create a desire to improve the plants so that they may be rated as high as possible by the time the inspector calls to obtain the information which shall determine the class in which the plant will be rated. The actual rating of plants, however, is to be made by the administrative engineer only after verification and collection of the questionnaires by the inspectors.

Board of Engineers Recommended

In addition to the census of power plants thus obtained it is recommended that a board of competent engineers be attached to the conservation committee in each state in a volunteer advisory capacity to assist the administrative engineer in his work. In addition to numerous other functions, a member of such a board could render valuable service by a personal interview with the owner of the plant that has been given a low rating, pointing out the general causes of inefficiency and aiding the owner in securing the services of a good engineer. Each state should also have available a corps of lecturers who may arouse public interest and disseminate engineering information. To assist in this work the United States Fuel Administration has prepared a fifty-minute film of moving pictures showing good and bad operations in the steam-boiler plant, methods of testing boilers, fuels, etc. The administration is also preparing a series of official bulletins on engineering phases of steam and fuel economics. Also, a list of competent engineers for each state has been prepard in Washington and is available for use by the local administration.

The slogan of the campaign is maximum production with minimum waste. In other words, the object is to operate all industries at full capacity, but at the same time to make a pound of fuel perform its maximum service in power, light and heat.

Dr. F. C. Honnold, fuel distributor of Illinois coal, spoke of the zoning system and how it had affected the distribution of coal from the mines. Illinois had been asked to supply 5,000,000 tons out of the state in substitution for Eastern coal. To do the same work it required from 15 to 25 per cent. more Illinois coal owing to the higher ash and lower heat value. Recently, many Government orders have been placed in the West requiring more fuel for war work, and due to the fact that the Government is going farther and farther west to get smokeless coal for the transports and naval vessels, there will be shortage of coal for Lake movement so that Illinois will have to step in and supply much of the coal to the Northwest.

Primarily, the speaker had been directed to care for railway work first, war work second, and householders third. In purchasing coal, the householders have shown the proper spirit. They have placed orders for their coal promptly as requested, and as a result the mines are shipping more coal for householders than in any previous month in their history. There has been delay in the railway situation. The question of car supply to the mines has not been settled. There are not cars enough to go around to supply fully all the mines. The average provision in the Illinois territory has been 65 per cent. and in the East the supply is considerably less. The price that the railways are to pay for coal will be settled within a few days.

C. W. Naylor expressed impatience over the delay in formulating the plan for coal conservation. He said they had been waiting since January for this plan and to follow it out as outlined would mean such a tremendous amount of work that all the engineers in the country could not carry it out in time to influence this year's consumption of coal. People were ordering coal now, but could not get it. It was his opinion that if the Fuel Administration would spend less time in zoning and in the preparation of such plans as the one presented, and devote more time to loading, shipping and to the car supply, it would be much more to the purpose. The consumer would take care of the coal when he got it.

Osborn Monnett limited his remarks to low-pressure heating, and A. L. Langtry spoke on coal specifications. He referred to Government supervision of all contracts and the restriction that coal companies shall not contract with their customers for more than 65 per cent. of last year's requirements. The Fuel Administration can take the remaining 35 per cent., if needed, and place it somewhere else. Variations in coal last winter had been partly caused by the coal coming from different districts, and not from the same mine. Data were presented to show that in some cases there was wide variation in ash and in others there was very little difference. The tendency, however, is toward more ash and slate, and this is due to mining conditions which have now been corrected.

Educational Work in Iowa

Royal H. Holbrook, of Cedar Rapids, Iowa, spoke of the educational work that had been conducted in that state last winter. A half dozen of the best operating engineers in the state visited every plant that gave them an invitation. Owing to the shortage, it had been necessary to burn more Iowa coal than usual, and it was necessary to teach users how to burn it. In visiting a plant they always called in the owner so that he could learn first-hand the results of the inspection. Their method was to look first for the absence of pipe covering, then to inspect the system and apparatus for cleaning flues, see that the blowoff was working properly and test the setting for air leaks. At the close of the season they had a fairly good record of all plants visited. The weakness was that they could not enforce their suggestions. Next fall they will be ready to start work again to complete the data required by the new Government plan. It was the speaker's opinion that without an immense number of volunteers the Government plan could not be carried out successfully in Illinois. There are 100,000 plants in Chicago alone, and throughout the state there are many more. It is an enormous task and will require the services of a great many competent engineers.

A. Bement was of the opinion that the greatest difficulty would be experienced in the miscellaneous small plants where CO_2 machines were not in favor. A large number of instruments would be required and many difficulties would arise. In his opinion the better plan would be to employ experienced men who could inspect the fire and the plant, diagnose conditions and prescribe the remedy. Not many men would be competent for such work, and if all the combustion engineers in the country were employed they would still be short of help. In explanation Mr. Myers stated that the incentive would be all that was necessary in eight out of ten cases. The mere fact that the plant was to be inspected and its rating determined from the result of this inspection would induce the owner to put it in the best possible condition.

Robert Kuss expressed the opinion that the engineer would come across in the big patriotic way desired and that as soon as the plan goes out he will be ready to back it up. According to estimate it takes 49½ tons of coal to keep one soldier going for the period of a year and with such tremendous requirements as our growing army will impose, it will be necessary for all to give their undivided support to the movement.

Duty of the Employer in Reconstruction of the Crippled Soldier

By Douglas C. McMurtrie

Director Red Cross Institute for Crippled and Disabled Men, New York City

We must count on the return from the front of thousands of crippled soldiers. We must plan to give them on their return the best possible chance for the future. Dependence cannot be placed on monetary compensation in the form of a pension, for in the past the pension system has proved a distinct failure in so far as constructive ends are involved. The pension has never been enough to support in decency the average disabled soldier, but it has been just large enough to act as an incentive to idleness and semidependence on relatives or friends. The only compensation of real value for physical disability is rehabilitation for self-support. Make a man again capable of earning his own living, and the chief burden of his handicap drops away. Occupation is, further, the only means for making him happy and contented.

Soon after the outbreak of hostilities the European countries began the establishment of vocational training schools for the rehabilitation of disabled soldiers. They had both the humanitarian aim of restoring crippled men to the greatest possible degree and the economic aim of sparing the community the burden of unproductivity on the part of thousands of its best citizens. The movement had its inception with Mayor Edouard Herriot, of the City of Lyons, France, who found it difficult to reconcile the desperate need for labor in the factories and munition works while men who had lost an arm or a leg but were otherwise strong and well were idling their time in the public squares. He therefore induced the municipal council to open an industrial school for war cripples which has proved the example and inspiration for hundreds of similar schools since founded throughout France, Italy, Germany, Great Britain and Canada.

The disability of some crippled soldiers is no bar to returning to their former trade, but the injuries of many disqualify them from pursuing again their past occupation. The schools of training prepare these men for some work in which their physical handicap will not materially interfere with their production.

The education of the adult is made up largely of his working experience. The groundwork of training in his past occupation must under no circumstances be abandoned. The new trade must be related to the former one or be, perhaps, an extension or specialization of it. For example, a man who had done manual work in the building trades may by instruction in architectural drafting and the interpretation of plans be fitted for a foreman's job, in which the lack of an arm would not prove a serious handicap. A trainman who had lost a leg might wisely be prepared as a telegraph operator, so that he could go back to railroad work, with the practice of which he is already familiar. Whatever training is given must be thorough, for an adult cannot be sent out to employment on the same basis as a boy apprentice. He must be adequately prepared for the work he is to undertake.

The one-armed soldier is equipped with working appliances which have supplanted the old familiar artificial limb. The new appliances are designed with a practical aim only in view; they vary according to the trade in which the individual is to engage. For example, the appliance for a machinist would be quite different from that with which a wood turner would be provided. Some appliances have attached to the stump a chuck in which various tools or hooks can interchangeably be held. The wearer uses these devices only while at work; for evenings and holidays he is provided with a "dress arm," which is made in imitation of the lost natural member.

An important factor in the success of reëducational work is an early start, so that the disabled man shall have no chance to go out unemployed into the community. In even a short period of exposure to the sentimental sympathy of family and friends, his "will to work" is so broken down that it becomes difficult again to restore him to a stand of independence and ambition. For this reason, therefore, the plan for his future is made at as early a date as his physical condition admits, and training is actually under way before the patient is out of the hospital.

In the readjustment of the crippled soldier to civilian life, his placement in employment is a matter of the greatest moment. In this field the employer has a very definite responsibility. But the employer's duty is not entirely obvious. It is, on the contrary, almost diametrically opposite to what one might superficially infer it to be The duty is not to "take care of" from patriotic motives, a given number of disabled men, finding for them any odd jobs which are available, and putting the ex-soldiers in them without much regard to whether they can earn the wages paid or not.

Yet this method is all too common. A local committee of employers will deliberate about as follows: "Here are a dozen crippled soldiers for whom we must find jobs. Jones, you have a large factory; you should be able to take care of six of them. Brown, can you not find places for four of them in your warehouse? And Smith, you ought to place at least a couple in your store."

Such a procedure cannot have other than pernicious results. In the first years of war the spirit of patriotism runs high, but experience has shown that men placed on this basis alone find themselves out of a job after the war has been over several years, or in fact, after it has been in progress for a considerable period of time.

A second weakness in this method is that a man who is patronized by giving him a charity job comes to expect as a right such semigratuitous support. Such a situation breaks down rather than builds up character, and makes the man progressively a weaker rather than a stronger member of the community. We must not do our returned men such injury.

The third difficulty is that such a system does not take into account the man's future. Casual placement means employment either as a makeshift job as watchman or elevator operator such as we should certainly not offer our disabled men except as a last resort—or in a job beyond the man, one in which, on the cold-blooded considerations of product and wages, he cannot hold his own. Jobs of the first type have for the worker a future of monotony and discouragement. Jobs of the second type are frequently disastrous, for in them a man, instead of becoming steadily more competent and building up confidence in himself, stands still as regards improvement and loses confidence every day. When he is dropped or goes to some other employment, the job will have had for him no permanent benefit.

Twelve men sent to twelve jobs may all be seriously misplaced, while the same twelve placed with thought and wisdom and differently assigned to the same twelve jobs may be ideally located. If normal workers require expert and careful placement, crippled candidates for employment require it even more.

The positive aspect of the employer's duty is to find for the disabled man a constructive job which he can hold on the basis of competency alone. In such a job he can be self-respecting, be happy, and look forward to a future. This is the definite patriotic duty. It is not so easy of execution as telling a superintendent to take care of four men, but there is infinitely more satisfaction to the employer in the results and infinitely greater advantage to the employee. And it is entirely practical, even in dealing with seriously disabled men.

A cripple is only debarred by his disability from performing certain operations. In the operations which he can perform, the disabled man will be just as efficient as his nonhandicapped colleague or more so. In the multiplicity of modern industrial processes it is entirely possible to find jobs not requiring the operations from which any given type of cripples are debarred. For such jobs as they can fill the cripples should be given preference.

Thousands of cripples are now holding important jobs in the industrial world. But they are men of exceptional character and initiative and have, in general, made their way in spite of employers rather than because of them. Too many employers are ready to give the cripple alms, but not willing to expend the thought necessary to place him in a suitable job. This attitude has helped to make many cripples dependent. With our new responsibilities to the men disabled in fighting for us, the point of view must certainly be changed. What some cripples have done, other cripples can do if only given an even chance.

The industrial cripple should be considered as well as the military cripple, for in these days of national demand for the greatest possible output there should not be left idle any men who can be made into productive workers. With thoughtful placement effort, many men can be employed directly on the basis of their past experience. With the disabled soldiers who profit by the training facilities the Government will provide, the task should be even easier.

This, then, constitutes the charge of patriotic duty upon the employer: To study the jobs under his jurisdiction to determine what ones might be satisfactorily held by cripples; to give the cripples preference for these jobs; to consider thoughtfully the applications of disabled men for employment, bearing in mind the importance of utilizing to as great an extent as possible labor that would otherwise be unproductive; to do the returned soldier the honor of offering him real employment, rather than proffering him the ignominy of a charity job.

If the employer will do this, it will be a great factor in making the complete elimination of the dependent cripple a real and inspiring possibility.

Meeting of National Coal Association

At the opening of the first annual meeting of the National Coal Association in Philadelphia, on May 28, the principal address was made by J. D. A. Morrow, Director General of the United States Fuel Administration. The following excerpts are taken from his address:

Every country that has gone into this war has promptly found itself faced with a difficult coal problem. In Great Britain, within six months after war had been declared, 250,000 coal miners had enlisted, and the production in Great Britain fell off 25,000,000 tons. The railways were congested with traffic, and the country faced an industrial crisis.

The important French coal fields were overrun by the enemy at the outset of the war, and production was cut squarely in two. The supply there has been cruelly short, and every pound has been distributed by the government. That has been the case also in Italy.

Thus it is nothing unusual for us to have a coal crisis in this country. You are all familiar with the insatiable demand for coal that coincided with congested traffic on our lines, and within six months after the declaration of war the United States had set up a Federal Fuel Administration, the industry was under Governmental control, and we had followed to that extent at least in the footsteps of other important belligerents.

When I took up the work of directing the distribution of coal, it appeared to me that one of the first things we needed to know was what the requirements for coal would be. To get that information we obtained reports from more than 100,000 industrial concerns, stating the exact quantity they consumed yearly. We obtained reports from 40,000 retail dealers covering their annual deliveries. We obtained reports from the Shipping Board, the War and Navy Departments, and from other Government sources, regarding the building of new factories and extensions to old ones, and the increase of activity in other plants. We also called upon private sources of information. When we had those figures together, we found that to run the United States on a war basis this year we need 735,000,000 net tons of coal.

It seems likely that the production of anthracite cannot exceed the output of the past year, namely 89,000,000 gross tons. The difference must be made up out of the bituminous mines. The bituminous mines of the United States this year are called on to produce 85,000,000 more tons than they produced last year, which was a record year.

Under these circumstances, then, we clearly and definitely face the prospect of a slight shortage of coal this year. Under these conditions we are trying to see that the domestic consumer is taken care of; that the supreme important users of coal get their supplies, and that if any is left that can go to the less important consumers there is where it will go.

In order to make sure that an equitable distribution is had between these important branches we have to get some very definite information about where the coal is going. We intend to require every industrial consumer of coal in the United States to register and to report weekly his exact amount on hand, his consumption, his receipts and the amount that is moving to him. If we have all this information it will enable us to act intelligently; for we will know, at any time, how any given plant or industry or section of the country stands with respect to its coal supply, and it will then be possible to prevent trouble before it occurs in many instances, rather than to try to cure it afterward.

Distribution Division of Fuel Administration

The Fuel Administration is organizing a conservation division which is to inspect the plants and teach the users of coal better methods of burning it in order that tonnage may be saved. It is estimated that if this can be done on a large scale this year it will be possible to save perhaps 20,000,000 tons of coal. Unless this is done many plants necessarily will be without coal and to some extent will have to curtail operations.

I want to make it clear that the Distribution Division of the Fuel Administration intends to be sufficiently in control of the situation to make sure that the domestic consumer gets his supply, that the railroads have theirs, and that the important war plants are all running, and that our ships get back and forth across the Atlantic. If we do that, if we take care of the domestic consumer and keep these plants running, it will be possible for us to avoid the suffering that occurred last winter and the working machinery of the United States will not lose one single stroke for lack of coal.

The zone system of distribution has proved beneficial to the railroads. The vice president of the Norfolk & Western R.R. gives some idea of how it is helping that road. He says: "A comparison of the movement of loaded coal cars in our coal districts during the seven-day period, May 4 to 10, 1918, to determine the advantages derived from the zone regulations, indicates that there was a saving in loaded car mileage in coal fields of 15.2 per cent. or 6982 loaded car-miles in seven days. This is simply the saving of car miles in the coal regions on our lines and does not take into account the saving that has been effected between the origin zones and the points of destination by the elimination of cross hauls."

This is indicative of the important saving in transportation that was effected by the zoning of coal. That zoning no doubt interfered with customary trade relations, it interfered with the customer in getting his supplies. We have this evidence of the fact that the sacrifices made have greatly helped our transportation problem at a time like this, when that is all-important.

To date we have been most admirably supported by the coal men themselves. There have been times when we have made mistakes, made lots of them; we will probably make a good many more. Nobody knows everything about the coal business nor even a small part about all of it, but we are trying to get together in Washington a personnel of leaders in this business in positions of responsibility, men that the coal industry can follow with confidence and respect.

We now understand that for modern war to be anywhere near successful the armies in the field must be supported by equally effective and magnificent war machines built up in the industrial life of the country behind the armies. Germany had exactly that kind of an industrial machine completed before ever this war began.

It is equally necessary for us to build up here an industrial war machine that will support our military war machine just as effectively as does Germany's. Just as the soldier has to subordinate his wishes to the general plan, so the coal man will find it necessary in many respects to lay aside personal desires and privileges and submit his wishes to the general plan for the industry as a whole in support of the war program.

Engineers Wanted for the Army

Engineers are once more in demand for officers in the army. For the last six months or more all applicants for engineers' commissions have been met with the statement that the quota was full and that except for special work, generally at the direct request of General Pershing, no more commissions would be given in the engineers to men now in civil life. Such vacancies as would exist were to be filled by promotions of men already in the service. Our enormously increased army, both in being and in prospect, has changed all this. Under date of June 3, Gen. W. M. Black, Chief of Engineers, U. S. A., issued a call for approximately 2000 additional first lieutenants and captains in the Engineer Reserve Corps, to be immediately commissioned, sent to training camp and as soon as possible thereafter sent overseas to the Expeditionary Forces.

Qualification restrictions are mainly those of age. There are no commissions available in the grade of major or higher or in that of second lieutenant. The higher grades will be filled by promotions of well-qualified men now nearly a year in the service, the lower grades will be filled from the ranks or from the recent college graduates, members of the Engineer Enlisted Reserve. The age limits are 32 to 36 years for first lieutenant and 36 to 42 years for captain. These limits may be slightly increased, or decreased, in certain cases, except that no one within the draft age will be considered.

No set rules as to professional qualifications and experience have been established, except that the applicant must be engaged in the active practice of the engineering profession, in one of its various branches. An examining board will pass upon the candidate's fitness.

All applicants accepted by this examining board will be commissioned within a week or ten days of the examination and a few days thereafter will receive orders to report at an Engineer Officers' Training Camp, either at Camp Lee, Petersburg, Virginia, or Camp Humphries, Virginia, just down the Potomac from Washington. After a course of training in military engineering, they will be assigned to duty with the engineer troops for eventual service abroad. The commission is not final, however, because a candidate may in camp prove not to have the necessary qualities of a military leader. In such a contingency he will be honorably discharged. Each man's case will be carefully considered just previous to the completion of his course of instruction by a board of officers of the Corps of Engineers, U. S. A.

The Government will allow traveling expenses at the rate of 7c. per mile to applicants who may be commissioned, and they will also receive while in training camp the full pay of an officer of their rank. They must provide themselves with the usual Engineer Officer's uniform outfit while at camp.

Applications for these commissions should be made as soon as possible to the office of the Chief of Engineers, Washington, D. C. The office will send back a series of blanks to be filled out with a general personal description designed to indicate the fitness of the applicant for a more searching examination in person by the examining board Those selected will be notified when and where to appear before the board for the further examination.

Chicago's Technical Men Unite for War Work

Representing an effort to coöperate effectively and vigorously for war work, an important joint war committee has been formed by representatives of technical societies centered in Chicago. The movement was started by the Military Committee of the Western Society of Engineers, and, at the invitation of that committee, several meetings have been held at the Chicago Engineers' Club. As the result, the "War Committee, Technical Societies of Chicago," to quote the official name, was organized June 4, 1918.

The purpose of this organization is "to enable the technical societies of the Chicago zone to call into play the efforts of the members of the various societies herein represented as occasion may arise, and to coördinate their activities in the most effectual manner to help win the war." It is not intended to attempt any novel "stunts," but rather to place at the disposal of the United States Government, and other authorized agencies, the combined strength and resources of the Chicago technical societies for war work, as need may arise.

The following member societies are coöperating in the new War Committee: Western Society of Engineers; Structural Engineers' Association of Illinois; Society of Industrial Engineers; Illinois Society of Engineers; Illinois Society of Architects; The American Railway Engineering Association; The Swedish Engineers' Society of Chicago; Illinois Chapter, American Institute of Architects; Chicago Section, American Society of Mechanical Engineers; Chicago Section, American Institute of Electrical Engineers; Chicago Section, American Chemical Society; Chicago Section, American Institute of Mining Engineers; Mid-West Section, Society of Automotive Engineers; Illinois Association of American Society of Civil Engineers; Chicago Section, American Society of Heating and Ventilating Engineers; Chicago Section, American Society of Refrigerating Engineers; Chicago Section, Steel Treating Research Society; Chicago Section, Illuminating Engineering Society; and Chicago Chapter, American Association of Engineers.

Officers of the War Committee have been elected as follows: Chairman, F. K. Copeland; vice chairman, W. L. Abbott; secretary, Edgar S. Nethercut; treasurer, William A. Fox. The executive committee consists of F. K. Copeland, W. L. Abbott, William Hoskins, C. A. Keller, Charles E. Lord, C. F. Loweth, Isham Randolph and Richard E. Schmidt. The address of the secretary of the War Committee is 1735 Monadnock Block, Chicago, Ill.

Largest Smokeless Powder Plant in the United States

The largest smokeless powder plant in the United States, known as "Old Hickory," located near Nashville, Tenn., and building by the du Pont Engineering Co., at a contract price of one dollar, has swung into line back of our boys "over there."

The first sulphuric-acid unit has already been started, and the progress which this marks assures the delivery of powder before July 1, three months ahead of the original schedule, in quantities sufficient to keep a steady flow going to the battlefront in France.

This marks the first completed step of a monumental task which sets a record for engineering and construction work in the United States. The original contract with the United States Government for the building of this plant was signed with the du Pont Engineering Co. on Jan. 29 of this year. It called for a daily output of 500,000 lb. of smokeless powder with the first unit to operate in eight months, or Oct. 1, succeeding units, four in number, to come into commission every six weeks.

On Mar. 23 a new contract was entered into which turned the plant over to the du Pont Engineering Co. as contractors for the Government. Under its terms the contractors were to construct a plant based on their knowledge and experience complete in every detail to turn out 900,000 lb. of powder a day. Under this new arrangement the contractor agreed to bring the first unit into operation on Aug. 1, two months ahead of the previous schedule, and to bring the other units in thirty days apart.

Under this final plan the contractors agreed to do the construction work for a consideration of one dollar. This work included giving to the Government the benefit of all the du Pont skill and knowledge in the design and construction of powder plants gained through long years of actual operating and exhaustive experimental work, and rendered all the more valuable because of the experience gained in the building of modern war plants to supply the powder demands of the Allies before this country entered the war.

With the freedom of action obtained under the final contract, such rapid progress was made that two months ago, when the powder situation became acute, the contractors promised the Government to again put forward the schedule and to produce powder on July 1, bringing into operation the successive units twenty-five days apart. To meet this schedule it would have not been necessary for the sulphuric-acid plant, which started June 1, to have been put in operation for another ten days, so that there is every prospect that some additional time may be saved even on the close schedule finally adopted.

Each one of these units is practically complete within itself and is approximately eight times the size of the largest smokeless-powder plant in the United States prior to the war. The entire plant is approximately seventy times the size of the largest smokeless powder plant in the United States prior to 1914.

There will be a complete power plant for generating electric power and steam. This plant will have eight stacks, 15 ft. in diameter and 200 ft. high.

The plant will consume 4500 tons of coal every operating day of twenty-four hours. This is equivalent to 100 carloads or two trainloads. The completed plant will require 100,000,000 gal. of water every twenty-four hours, or as much water as is used by a city of 1,000,000 population; 65 per cent. of this water must be treated and filtered. The central power plant will contain 68 boilers, each with a rating of 825 hp. These will be operated at an overload, developing approximately 90,000 boiler horsepower, supplying steam for generating 12,000 kw. of electrical power as well as steam power for the treatment of guncotton and other purposes.

In addition to the railroad which is built into the plant, it was necessary to reconstruct the highways leading from Nashville, and within the plant itself many miles of standard railroad track and narrow-gage lines are in operation. The finished plant will contain approximately 33 miles of broad-gage track and 46 miles of three-foot gage track for narrow-gage locomotives and cars.

Wisconsin Modifies Second-Hand Boiler Ruling

It has come to the attention of the Industrial Commission that several manufacturers of this state have found it difficult to obtain new boilers to assist in increasing the production of the factories, and this condition is the result of the scarcity of steel plate which is largely being used in the manufacture of war materials. Consequently, buyers are obliged to make use of second-hand boilers.

With this in mind, the commission at its last regular meeting, May 20, 1918, voted to modify until further notice Order 4208, page 12, Code of Boiler Rules, to the extent that it will be satisfactory to admit for operation with a factor of safety of (5) any second-hand boiler whose longitudinal seam is of the butt type and with double covering plates, with the understanding that the boiler does not conform strictly to all the requirements of Part III of the rules which apply to boilers installed after July 1, 1916.

For example, a second-hand boiler as described may be a trifle short in bracing; have only single lugs for support; blowoff pipe 4 in. in diameter; manholes smaller than required on new boilers; or it may have a dome which would not conform to Order 4348.

Illinois State Convention N.A.S.E.

On June 5-7 the Illinois State Association of the National Association of Stationary Engineers held its fourteenth annual convention at Ottawa. Owing to the busy times, when the engineer in particular must be on hand to keep the wheels going, the number of delegates and visitors attending was less than usual, and although about the same number of booths had been taken, the exhibits were few and none of them elaborate, due to overcrowded transportation facilities and the rush of war work. Headquarters and the exhibit hall were at the Clifton Hotel and the business sessions of the convention were held in the K. of P. Hall.

At 2 p. m. Wednesday W. F. Kirschenberg called to order the first session of the convention. Rev. C. A. Briggs, Jr., opened with prayer. Mayor E. F. Bradford extended an earnest and cordial welcome and presented a large gilt key giving access to anything in the city. He said that he had been impressed by the aims and objects for which the association had been formed. that the idea was splendid and should bear fruit in these times when efficiency in the power plant meant so much. He expressed the hope that their stay would be so pleasant and profitable that Ottawa would be their favorite convention city.

DELEGATES AND THEIR GUESTS ATTENDING THE FOURTEENTH ANNUAL CONVENTION OF THE ILLINOIS

In his response John F. McGrath expressed the appreciation of the delegates for the kind reception. He dwelt briefly on the educational features of the association and on the wonderful success of the lantern-slide lectures. The organization tried to keep the men abreast of the times, not only mechanically but socially as well, so that they might feel that they were on an equality with men in any walk of life.

Joe O'Connell was always pleasantly impressed by the fact that public men such as the mayor or the governor never failed to recognize the value of the engineer to the community. They were students of human nature and understood the engineer better than most other men. With water-works, lighting and power plants of all kinds, street railways, locomotives and marine plants under their control, the engineer had it in his power to create terrible hardships, if he so willed and organized for that purpose. To the credit of the profession the present organization had been formed for fraternal and educational purposes.

J. F. Farrell, ex-mayor, referred to the previous convention in Ottawa and expressed the wish that it might become a permanent issue to meet in the city every year. Upon request the speaker read a paper on "Economy of Coal and Fuel Conservation," by C. W. Naylor, who had been unable to attend. It was Mr. Naylor's contention that in one way the present war was a blessing. It had opened the eyes of the people to the fuel situation and the need for economy in this natural resource. During the coming year it would be impossible to increase much if any, the output of coal. Consequently the user must secure greater economy, the mines must be kept busy the year around and the coal be equally distributed in accordance with the needs. Each individual must wake up to the situation. The householder will be forced to burn mostly Illinois coal and it was up to him to order it now instead of waiting with the hopes of getting anthracite or Pocahontas. Reference was made to ways of saving, such as the elimination of needless lights, shorter working days for those engaged in nonwar work and rigid economy in the power plant. It was possible to get help from the fuel administration. Lecturers were to be sent all over the state and there would be men and literature to show how to burn Illinois coal. To help win the war Mr. Naylor urged general storage of fuel during the summer months and made a special plea to the engineer to spread the gospel of fuel conservation.

Lee O'Neil Browne, an honorary member of the association and the representative of the state legislature who had twice helped the engineers in trying to put through a license bill for Illinois, spoke briefly. He referred to the previous convention at Ottawa eight years ago when he had become a member, and to the great help certain engineers had given him in a boiler explosion case in Lee County. He reviewed the efforts made to pass the license bill against the opposition of certain labor organizations in Chicago and sawmill and other small interests in the southern part of the state. In the second attempt the bill had been passed in both the House and the Senate, but had been vetoed by the governor for the averred reason that it contained too many restrictions. In his opinion the bill could be passed again, but before it reached the governor there would be need of concerted effort to arouse public interest and to create a demand backed by powerful influences that could not be overlooked.

With the official opening of the convention and appointment of committees by John F. Alt, state president, the session closed.

In the evening the exhibit hall in the Clifton Hotel was opened officially, with J. F. Alt presiding. Short talks were made by Messrs. Thayer, Fiske, Lane, McGrath and Roberts on the educational advantages offered by the exhibits. The latest equipment, or literature dealing with it, was on display and valuable information could be obtained from the various salesmen.

Thursday morning the session was given over to routine business and reports. The secretary-treasurer's statement disclosed a comfortable working balance and a net loss in membership of 23 for the state. Mr. Roberts, of Cleveland, a member of the National License Committee, discussed the possibilities of eventually passing the Illinois bill. He thought the conditions favorable. Recent experience showed what must be overcome and they were fortunate in having a representative who had their interests at heart. The speaker warned against trying to get all that was wanted in the bill. It would be policy to get the best bill possible on the statute books and after that amendments would be comparatively easy. To be constitutional the bill must have uniform application throughout the state and there should be no restrictions as to qualifications of the chief examiner. It would be better to let the appointive power assume the responsibility. Sources of objection could be eliminated by giving without further examination, state licenses to men who already possess a city license and to engineers who have been operating for a certain period and can verify it by a statement from their employers. One of the causes of the veto of the last bill was the exemption clause expressing the limit below which a license would not be necessary, in square feet of heating surface rather than in horsepower. To the layman the former meant nothing while all were familiar with the horsepower.

Mr. Roberts had a pamphlet giving proper information to bring before the public and a skeleton bill after the Massachusetts and Ohio plans which might serve as the fundamental basis for the Illinois bill. Incidentally, the national license committee in conjunction with the national president, had decided to limit their efforts to those states where the possibilities of license legislation were most favorable. For 1918-19 Illinois and Kansas had been selected.

Thursday afternoon the entire delegation had a most pleasant outing at Starved Rock State Park, getting back in time to attend the smoker that evening at the headquarters hotel. The latter was a most enjoyable affair and the best attended session of the convention. With Fiske as toastmaster the program was conducted with despatch. Patriotic talks by President Griggs, of the Chamber of Commerce, and ex-Mayor Farrell were interspersed with songs by the audience. John Lane responded and in brief talks was followed by T. W. Roberts, W. E. Hill and Charlie Fiske. Mob singing led by Tilley and dancing were the final features.

At the Friday morning session, State Deputy Hill spoke of the difficulty all organizations have in holding their membership during war times. The draft and enticing positions opened up by the Federal Government were responsible and it required a great deal of intensive work for an association to hold its own.

In the discussion on educational work, Messrs. Hill, Misostow and Harris emphasized the difficulty the state body had in learning what the smaller associations needed. Lectures suitable for locals in large cities often were not appropriate for towns where the membership did not exceed 20 or 30. Questions and answers and traveling lecturers had been tried and in numerous cases did not seem to meet the requirements.

In choosing the officers, John F. Alt and J. E. Noden were reëlected as president and vice president, respectively. On account of war work Gus Anderson was replaced by W. E. Hill as secretary-treasurer and M. E. Harris was recommended for state deputy. The officers were installed by Past Presidents Parker and Misostow. The selection of a convention city was left for later determination by the president and secretary.

The following firms had space in the exhibit hall: Anchor Packing Co., V. D. Anderson Co., W. A. Blonck & Co., Crandall Packing Co., Dearborn Chemical Co., Garlock Packing Co., Hawk-eye Compound Co., Hays Instrument Co., Jenkins Bros., H. W. Johns-Manville Co., Lunkenheimer Co., National Atomizer Co., *National Engineer*, Perolin Co. of America, Wm. Powell Co., *Power*, S. C. Regulator Mfg. Co., Rhodes Metallic Packing Co., John A. Roebling Sons Co., United States Rubber Co., Thayer & Lynn, Tilley-Gillette Co.

STATE ASSOCIATION OF THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS AT OTTAWA, ILL.

Bituminous Coal Consumption

Following is a statement by the Fuel Administration on coal consumption and requirements. Note the large increase in coal required by industrial plants.

ESTIMATED CONSUMPTION OF BITUMINOUS COAL IN THE UNITED STATES IN 1917 AND REQUIREMENTS FOR 1918–19, IN NET TONS

	1917 Tons	1918–19 Tons	Per Cent. Increase 1918–19 Over 1917
Industrial	204,907,000	242,024,000	18
Domestic	66,915,000	75,678,000	13
Gas and electric utilities	33,038,000	37,941,000	15
Railroads	155,000,000	166,000,000	7
Exports	24,000,000	24,000,000	0
Beehive coke	52,450,000	52,450,000	0
Bunker—Foreign	7,700,000	10,000,000	30
Bunker — Domestic including Great Lakes	5,000,000	5,000,000	0
Used at coal mines for steam and heat	11,000,000	12,500,000	14
Total	560,010,000	625,593,000	12
Used from storage	4,375,000	....	
Exports	907,000	....	
Estimated production	554,728,000	....	
Substitution of coal for oil, mainly in west	....	2,000,000	
To increase stocks of industrial plants and public utilities outside of New England by ten days' supply	....	7,000,000	
Total requirements for 1918 without allowance for estimated conservation		634,594,000	
Production, 1917	554,728,000	....	
Production, 1918, required for needs	634,594,000	....	
Increase required	79,866,000		
Percentage	14.4		

Thirty-second Convention A.O.S.E.

The American Order of Steam Engineers held its thirty-second annual convention at Philadelphia, June 10-12, with headquarters at the Hotel Vendig. The several sessions were held at the Parkway Building, on Broad Street. The attendance was not as large as usual, owing to war conditions; there were fifty delegates present. The business of the convention was conducted with harmony and dispatch. The treasurer's report showed that the organization is in a sound financial condition. The Supplymen's Association held its exhibit in a large hall adjoining the meeting room of the delegates. There were 46 firms represented. This year a small table display took the place of the customary elaborate exhibit. The entertainment features were a smoker in the Parkway Building on Monday evening and an entertainment and dance at Moose Hall on Tuesday night. The following supreme officers were elected: J. William Pairent, chief; Eugene Enderle, first assistant chief; Harry Dunn, recording engineer; William S. Wetzler, corresponding engineer; William H. Tyson, treasurer; James G. Steigerwalt, senior master mechanic; C. F. Eisele, junior master mechanic; Harvey Berger, inside sentinel; John Orean, outside sentinel; James Lightfoot, chaplain; James K. Holland, trustee. The executive committee consists of George W. Richardson, Clifford P. Williams, and Franklin R. Moore.

At the meeting of the Supplymen on Tuesday the following officers were elected: Horace A. Smith, president; Porter G. Jones, vice president; Roy C. Downs, secretary; John W. Armour, treasurer; William Lindenfelser, Jr., director of exhibits. The date and place of the next meeting will be decided later by the supreme chief.

Coal Trade of Southern Chile

Consul John R. Bradley says, in *Commerce Reports*, that at this time there are no stocks of imported coal in Magallanes. For domestic consumption a lignite to the amount of about 3500 tons per month is produced locally, an analysis of which (perhaps a picked sample) is: Moisture, 18.752 per cent.; volatile matter, 37.892 per cent.; fixed carbon, 31.5 per cent.; and ash, 11.785 per cent. I am told, however, that the ash content is nearer 25 than 11 per cent. This coal retails now at the equivalent of $10 per ton, United States currency.

Prior to the war (and occasionally since its outbreak) practically all steam coal used here came from Cardiff and sold around $12 per ton. Most of that used here is now secured at Coronel, Chile, and is said to be a fair grade of bituminous. The yearly consumption of steam coal at Punta Arenas is estimated to be 15,000 tons, used by about twenty small steamers in the coasting trade, with this as their home port, and one freezing works, which uses about 2000 tons per annum. The other freezing works in this district burn wood, as does the electric-light plant, which pays about $10 per cord. Many of these plants would use coal if available at a reasonable price.

There are no facilities at Punta Arenas for handling coal, and it is unloaded by means of canvas slings and steam winches. Five or six hundred tons a day is about the usual progress made in unloading.

Coal Production Highest This Year

Bituminous-coal production for the week ended May 18 was estimated at 11,732,000 net tons, compared with 11,825,000 for the week ended May 11. The daily average for the week was 1,955,000 tons, compared with 1,971,000 tons for the week preceding, according to the reports issued by the United States Geological Survey.

Anthracite shipments were reported as 41,011 cars during the week of May 18, an increase over the previous week of 2244 cars, or 6 per cent.

The reports made by the United States Fuel Administration showing the working condition at the mines during the week of May 11 are especially interesting in that they reflect the operations of the mines for the weekly period showing the highest production since the organization of the Fuel Administration. The total losses from all causes during the week is recorded at 22.4 per cent. The losses were reported as follows: Car shortage, 11.2; labor shortage and strikes, 5.4; mine disability, 3.6; no market, 1; all other causes, 2.2. The percentage of production to total capacity for week ending May 11 was 76.6 per cent., the highest point attained this year.

Good Suggestion for Home Use Also

Every man that we send to France, whether for the firing line or behind it, will have to be supplied with electric service. The shops for repairing our rifles and guns in France will probably be larger than our munitions plants in this country, according to the *Electrical World*. As France has no coal to spare, we must either make use of some of our ships for transporting our own fuel to produce this power or obtain the power from other sources. The American way is pointed out. Hydro-electric power will not only provide for our own needs in France better than it can be done by sending over American coal, but the very large power needs of France herself can be met by American electrical plants.

Present development of hydro-electricity in France consists chiefly of small generating stations on streams, distributing current to a few near-by towns and villages. With American practice, it would be possible to develop all the available water power on a range of mountains and distribute it through several provinces. The sum of money required to build two 5000-ton steel colliers would build a 10,000 hp. hydro-electric plant in France, according to the estimates. Two such ships could easily take over all material required for construction. A plant of that character would require fewer than half a dozen men for operation. American electrical apparatus is now so practical and diversified that some of it can be set up outdoors with little shelter, and units of 1000 to 10,000 hp. can be located according to water power available and energy needs by American emergency construction which would have them in place and deliver power in from six to nine months.

Fuel Administration Warns Against Unnecessary Lighting

United States Fuel Administrator Garfield has warned the public against prodigal and unnecessary use of electricity for outdoor advertising purposes and other display illumination. Statistics obtained by engineers of the Fuel Administration reduced to terms of coal show the necessity for the utmost fuel economy during the summer as well as the winter, requiring the strictest conservation of fuel-generated electricity. The Administration expects that there will be no extravagant or unnecessary use of electricity for display purposes. If there is, the so-called lightless night order will be suspended and even more stringent restrictions will be ordered against all forms of outdoor lighting and display illumination. The consumption figures just compiled reveal the necessity for the utmost economy in fuel consumption during the summer as well as the winter and require the earliest enforcement of the strictest economy in all fuel-generated electricity.

Ancient Aeronautics

When floods washed away two bridges over the Nisqually River, the Standard Oil Co. of California had to revert to primitive methods to get oil supplies to the eastern half of Lewis County. A large cable was strung across the river, and for three weeks this aërial ferry was the only line of communication. An automobile was used to furnish power at one end, while strong men operated the device from the other. Oil was sent over in 5-gal. cans, and from these filled into barrels. Factories and motorists of Lewis County were thereby permitted to continue using gasoline and other oil products uninterruptedly. — *The Wall Street Journal Straws.*

New Publications

THE STORAGE OF BITUMINOUS COAL. By H. H. Stock. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill. Paper, 6 x 9 in.; 192 pages. Price, 40c.

This book, which is a bulletin of the University of Illinois and designated as Circular No. 6, is perhaps the most comprehensive publication yet written on the subject of the storage of coal. There are 63 illustrations and 7 tables. It is the purpose of this circular to present a review of modern practice covering the storage of coal and a statement of the facts that have developed in the experience of those who have successfully or otherwise undertaken to store coal. The discussion is confined largely to bituminous coal, which has given so much trouble, owing to its tendency toward spontaneous combustion while stored, and to storage systems and mechanical devices.

MODERN LOCOMOTIVE VALVES AND VALVE GEARS. By Charles L. McShane. Published by Griffin & Winters, Chicago. Cloth, 317 pages; 5 x 7½ in.; 113 illustrations. Price, $2.50.

In writing this book the author has assumed that the reader has no previous knowledge of valves or valve gears, and so he begins with fundamentals. He describes the working of the plain slide valve with neither lap nor lead and then proceeds to show the effects produced by giving lap and lead to the valve and angular advance to the eccentric. From a study of the plain slide valve he passes naturally to special forms of slide valves, balanced valves and piston valves. A striking feature of the book is the omission of the valve diagrams so commonly used in books on valve gears for the solution of valve-motion problems. Instead, a simplified displacement diagram is employed to show the relative positions of valve and piston at admission, cutoff, etc. Apparently this diagram does not take into account the effect of connecting-rod angularity. The Walschaert, Baker-Pilliod, Southern and Young types of valve gear are taken up in detail and instructions are given for setting each and for making the necessary repairs in case of breakdown on the road. The language of the author is simple and direct, and the text is supplemented and explained by a large number of excellent illustrations. A commendable feature is that the various diagrams are pertinent to the discussion and no illustrations are used merely for the purpose of adding to the length and appearance of the book. A full list of definitions of terms forms part of the work, which is thoroughly practical throughout and should be of value to apprentice, fireman, engineer and mechanic.

ELEMENTS OF MACHINE DESIGN. By Henry L. Machman. Published by John Wiley & Sons, Inc. New York. Cloth, 245 pages; 5¾ x 9 in.; illustrated. Price, $2 net.

The contents of this volume are arranged under three headings, the first relating to the strength of material, the second to fastenings, which include screw fastenings, riveted joints, keys and cotters, and shrink-and-force fits. The third section is devoted to transmission machine parts. This includes the chapters on shafts and axles, couplings and clutches, journals and bearings, belts and pulleys, friction wheels, tooth gears, rope transmission, chain gearing, pipes and cylinders, valves, flywheels, crankshafts, crankpins, and eccentrics, connecting-rods, piston rods and eccentric rods, pistons, crossheads and stuffing-boxes, hoisting-machinery data and springs. There are 22 chapters in all, the last one being devoted to the materials of machinery.

This book is intended primarily as a classroom textbook and is of more use to the student on the whole than it is to the operating engineer, although the latter will find much of value if he is interested in figuring out or designing machine parts. The author has developed the equations for the design of the more common machine elements, which have been done concisely, and frequently only an outline of the deduction has been given. Empirical formulas and rule-of-thumb methods have been avoided as far as possible.

Illustrations have been chosen to show typical construction rather than a great variety. Each subject treated is designated by black-face type, which makes it convenient to the reader when looking for any particular subject.

MECHANICAL LABORATORY METHODS OF TESTING MACHINES AND INSTRUMENTS. Second Edition. By Julian C. Smallwood. Published by D. Van Nostrand Co., New York. Leather, 399 pages; 5 x 7¼ in.; 114 illustrations. Price, $3.

This second edition has been revised and enlarged to a considerable extent. As the title of the book implies, it is devoted to methods employed in testing various apparatus found in power plants as well as for laboratory uses. In dealing with the various classes of instruments this volume briefly explains the principle of design and operation. The illustrations used to assist in such explanations are diagrammatic so as to make a simple presentation. Such instructions as to how to operate engines, boilers, etc., have been omitted, as the reader is supposed to know about such matters.

In enlarging this volume, the section dealing with instruments contains a number of subjects not covered in the previous edition, and this especially applies to recorders. Furthermore, the section treating on valve setting and steam-engine testing has been enlarged and improved. Engineers will be interested in the section devoted to the testing of condensers and feed-water heaters and other auxiliaries; also in the new section that has been added on the testing of refrigerating machinery, ammonia, absorption and compression systems. Another added feature relates to the testing for the horsepower output of electric motors which should be convenient in connection with the testing of motor-driven units. In all there are twelve additional tests.

Owing to the manner in which the text matter has been got together, the volume is not above the head of the average engineer, and although there are numerous formulas, none are of such character as to prevent one with a common knowledge of mathematics from working them out. In fact, numerous problems have been worked out to assist in their comprehension.

MANUFACTURING OPPORTUNITIES IN THE STATE OF WASHINGTON

Issued by the Department of State through its Bureau of Statistics and Immigration, setting forth the manufacturing opportunities in that state. The book has 240 pages, 5½ x 8½ in., 75 illustrations and several maps. It is the result, as set forth in the preface, of a more or less complete survey of conditions favoring the establishment of additional manufacturing plants in the state, but the broadness and diversity of the subjects discussed preclude the presentation of details. Additional information and any possible assistance will be gladly furnished by the State Bureau of Statistics and Immigration, the Industrial Bureau of the State University, and the Departments of Science and Engineering of the State University and State College.

Personals

F. F. Espenschied, who has been assistant engineer with the Hydro-Electric Power Commission of Ontario, Canada, and prior to that was general manager of the Interstate Light and Power Co., Galena, Ill., has joined the forces of the Combustion Engineering Corporation, 11 Broadway, New York City.

Engineering Affairs

The Society of Automotive Engineers will hold a meeting at Dayton, Ohio, June 17-18. The papers will treat on refining of petroleum, aëronautic engineering, tractor engineering and the design of heavy fuel engines.

Miscellaneous News

A Boiler Exploded in an automobile and bicycle rim factory at Onaway, Mich., on May 30, killing one person.

A Boiler Exploded on a mine engine used at Jackson mine, Lonaconing, Md., on June 1, injuring an engineer and a miner who were riding to the mine.

A Boiler Explosion in the plant of the Monogram Laundry Co., at Muskegon, Mich., on May 30, practically wrecked the building. Although the explosion occurred during working hours, nobody was injured.

A Flywheel Exploded in the electric light and water plant of Clay Center, Kan., on May 26, killing the chief engineer and completely wrecking the electrical and water-works plants, causing a damage estimated at nearly $40,000. Parts of the flywheel were found one block from the plant. The engine was a Skinner Unaflow, and a defective governor is thought to have caused the trouble.

Two Boilers Exploded at the Hammer Lumber Co.'s mill, 25 miles east of Conway, S. C., on May 27, killing five men and injuring five others. The explosion is the worst recorded in the county, and the cause is given as being high steam pressure. The boilers were hurled 300 yards, one piece being thrown nearly a mile. Beside the loss of life considerable damage was wrought upon the plant.

A Boiler Explosion in the plant of the Bartlett Lumber Co., at Shelldrake, in an isolated part of Chippewa County, Michigan, on June 3, is reported as having caused the deaths of ten men and injuries to a number of others. As there is no direct wire communication with the settlement and to reach it involves a boat trip of nearly 50 miles, the authorities, at this writing, were having difficulty in obtaining definite information concerning the cause of the explosion.

The Chicago Wireless Institute, the object of which is to prepare men to pass the United States Government examination necessary to obtain a first-grade radio operator's license, is at 220 South State St., 800 Consumers Building. Day classes are held five days a week from 1 to 5 o'clock, and evening classes from 7 to 10 o'clock. The instructing engineer is R. R. Haugh, of Detroit, who is a member of the American Institute of Radio Engineers. The tuition fee is $50 for the entire course.

The College of the City of New York is giving a special course in shipbuilding and navigation under the direction of John Martin, formerly nautical expert, Hydrographic Office, U. S. N., which began Tuesday, June 18 and will close Sept. 14. In this intensive course the instructor will attempt to prepare students who have had the necessary fundamentals of the service, mathematics and elementary mechanical drawing, for positions of tracers and draftsmen in Government shipyards. These workers are much needed, and the pay varies from $25 to $40 per week. Those desiring to take this course should communicate with the college, Room 16, Main Building, 139th St. and Convent Ave., New York City.

Trade Catalogs

"Centrifugal Boiler-Feed Pumps." The De Laval Steam Turbine Co., Trenton, N. J. Bulletin N; 8½ x 11 in. Describes the De Laval combined steam turbine and centrifugal boiler-feed pump, and also electric motor-driven units.

The Wheeler Condenser and Engineering Co., Cartaret, N. J., has, under agreement with the Sugar Apparatus Manufacturing Co., acquired the exclusive right to manufacture and sell evaporating apparatus under the patents of S. Morris Lillie, president of that company.

The Lillie Evaporator. The first booklet relating to the Lillie Evaporator, published by the Wheeler Condenser and Engineering Co., Carteret, N. J., is just off the press. The device is now manufactured exclusively by this company under agreement with the Sugar Apparatus Manufacturing Co., owners of the Lillie patents. This new booklet calls attention to the factors which make the evaporator especially suited to the concentration of waste waters or liquors in numerous industries. Five pages are devoted to tables that are of especial value in the evaporation industry. A folding page insert gives instructions for operating Lillie quadruple effects.

Scientific Industrial Illumination is the title of a 36-page illustrated booklet recently issued by the Holophane Glass Co., 340 Madison Ave., New York City. It is divided into four parts. The first part shows the need for scientific illumination and discusses its economic advantage. The second discusses the fundamental principle of scientific illumination. The third describes and illustrates new types of industrial lighting units manufactured by the company for shop, factory, office and drafting room illumination and for yard and protective lighting. The fourth contains a collection of general engineering data which should make this booklet valuable for ready reference.

NEW CONSTRUCTION

Proposed Work

Mass., Lawrence—The United States Worsted Co. plans to build a steel boiler house. Estimated cost, $25,000.

Conn., New Britain—The State Board of Education, Capitol, Hartford, will receive bids until June 18, for the installation of a modulation and heating system in the State Normal School on Prospect St. Davis & Brooks, Lewis & Gold Sts., Hartford, Arch.

N. Y., Amsterdam—J. Kayser and Co., 34 Elk St., plans to build an addition to its power plant in connection with its proposed 4 story, 100 x 200 ft. silk mill. W. Higginson, 13 Park Row, New York City, Arch.

N. Y., Central Islip—The State Hospital Commission, Capitol, Albany, received an only bid for installation of a heating system in the Central Islip State Hospital, here, from the W. B. Armstrong Co., 3 Fulton St., Albany, $36,588 and for the lighting system, from the Babcock and Wilcox Co., 85 Liberty St., New York City, $66,933.

N. Y., Newark—A. W. Beaven, Pres. of the Board of Managers, New York State Custodial Asylum for Feeble Minded Women, Newark, will receive bids until June 28, for the installation of a heating plant and equipment for same. Noted Apr. 30.

N. Y., Brooklyn—The Lasky Motor Car Co., 17 Grahm Ave., is in the market for electric motors, etc., to be installed in its garage.

N. Y., Long Island City—L. Gold, 44 Court St., Brooklyn, will install a steam heating plant in its proposed 2 story, 95 x 100 ft. garage to be erected on Webster and 5th Ave. Total cost, $75,000.

N. Y., Long Island City—The Racich Asbestos Co., 609 West 55th St., New York City, plans to install a steam heating and steam piping system, boilers, 3 electric motors, etc., in its proposed 3 story factory on Hancock St. and Harris Ave. Total cost, $60,000. E. Richardson, 100 Amity St., Arch.

N. Y., Warwick—The Board of Inebriety, 300 Mulberry St., New York City, plans to build an Institution group. Various units include dormitories, power house, etc. Total cost, $200,000. S. Levy, Pres. C. B. Meyers, 1 Union Sq., New York City, Arch.

N. J., Jersey City—R. W. Sailer, Arch., 76 Montgomery St., is receiving bids for the installation of electric lighting, heating and power systems in the proposed 4 story factory on Montgomery St., for the National Grocery Co., Montgomery St.

Md., Baltimore—The Mallory Machinery Co., 522-524 Light St., is in the market for a 150 K. W. or 200 kw. d.c. direct-connected generating set; 250 volt with field rheostat.

W. Va., Kingwood—The Hoffman Coal Mining Co., recently incorporated with $30,000 capital stock, plans to build an electric power plant in connection with its mine. O. Hoffman, Pres.

N. C., Hiawasse—The Carolina Tennessee Power Co., c/o Bertrom Griscom & Co., 421 Chesnut St., Philadelphia, Penn., has received court's permission to erect a hydro-electric plant on Hiawasee River. The project involves developing 60,000 hp. for transmission by electricity.

La., Rayne—City issued $35,000 bonds to improve the electric-light plant and water-works.

Ohio, Lorain—The W. S. Automatic Co. plans to build a 40 x 120 ft. power plant in connection with its proposed new factory. Total cost, $100,000.

Ill., Chicago—The Board of Local Improvement is in the market for electrical power equipment in connection with its proposed Michigan Ave. improvement project. Total cost, $2,000,000. C. O. Hill, Engr.

Ill., Chicago—The Bunting Boiler Co., Lowell Ave., is having plans prepared for the erection of a 1 story, 75 x 200 ft. boiler plant on 16th St. Estimated cost, $30,000.

Ill., Woodstock—The Woodstock Typewriter Co., North Dearborn St., Chicago, plans to build a 1 story, power house here. Estimated cost, $10,000.

Wis., Milwaukee—A. C. Downing, 787 Shepard Ave., is in the market for boilers, engines, generators, motors, etc., in connection with its proposed 225 x 250 ft. plant. Total cost, $150,000. O. C. Uehling, 511 First National Bank Bldg., Engr.

Colo., Loveland—City issued $79,000 bonds for the erection of an electric lighting plant.

Wash., Vancouver—The Columbia River Interstate Bridge Commission, Clarke Co., will receive bids until June 28, for the erection of a transformer house on Washington St.

Man., Gladstone—City plans to build an electric lighting plant soon. About $15,000 is available for the project.

CONTRACTS AWARDED

Mass., Boston—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has awarded the contract for improvements to its power plant at the Navy Yard, here, to Rideout Chandler and Joyce, 178 High St. Estimated cost, $31,000. Noted June 11.

Mass., Boston—The United States Government has awarded the contract for the installation of electricity in the Boston Quartermasters Terminals, South Boston, to E C. Lewis ,Inc., 21 Federal St. Estimated cost between $1,000,000 and $1,500,000.

N. Y., Buffalo—The Buffalo General Electric Co., 206 Electric Bldg., has awarded the contract for the erection of a 1 story, 100 x 110 ft. power sub station, on State St., to Huntley & Derdinger, Electric Bldg. Estimated cost, $25,000. Noted June 11.

N. Y., Buffalo—Cousins & Co., 74 Wabash St., has awarded the contract for the erection of a 1 story, 95 x 125 ft. boiler shop, to B. I. Crocker, 57 Builders Exchange. Estimated cost, $35,000. Noted May 28.

N. Y., Mineola—The Curtiss Aeroplane Co., 1927 Elmwood St., Buffalo, has awarded the contract for the erection of a 1 story, 100 x 260 ft. factory, to the J. W. Cowper Co., Fidelity Bldg., Buffalo. Estimated cost, $35,000. Electric traveling cranes will be installed in same.

N. J., Newark—The Board of Education will soon award the contract for the installation of heating, ventilating and electric systems in all public schools in the city.

N. J., South Amboy—The Board of Education has awarded the contract for the installation of a heating system in its proposed 3 story, 90 x 150 ft. school on John St., to the Johnston Heating Co., 131 East 26th St., New York City. Estimated cost, $10,500.

Ohio, Caledonia—City has awarded the contract for the construction of an electric transmission line from here to Marion, to Kelly & Pommert, Caledonia.

Ohio, Cleveland—The Board of Education has awarded the contract for the erection of a 3 story, brick and concrete shop, boiler and coal room addition to the school at 2486 East 46th St., to H. F. Juergens Co., East 49th St. and Gladstone Ave. Estimated cost, $79,300.

Ohio, Cleveland—The Steel Products Co., 2196 Clarkwood Ave., has awarded the contract for the erection of a 1 story, 45 x 70 ft. power house at 2188 East 65th St., to S. W. Emerson, 1900 Euclid Ave. Estimated cost, $17,000.

Wis., De Pere—The De Pere Manufacturing Co. has awarded the contract for the erection of a 100 x 100 ft. brick boiler shop, to A. J. Beauregard, De Pere. Estimated cost, $15,000. Equipment will be installed by the owner. Noted June 4.

Wis., Kenosha—The Simmons Manufacturing Co., Pearl St., has awarded the contract for the installation of a heating system in the proposed office building, to the Downey Heating and Supply Co., 613-5 Clybourn, Milwaukee.

Iowa, Clinton—The Climax Engineering Co., c/o C. B. Stebbins, foot of 4th St., has awarded the contract for the erection of a 1 story, 50 x 90 ft. power house, to Haring Bros., 402 Wilson Bldg.

Iowa, Fonda—The Fairburn State Bank has awarded the contract for alterations to a 2 story, 25 x 80 ft. bank, to A. Moorman & Co., 501 Minneapolis St., St. Paul, Minn. A low pressure steam heating plant will be installed in same.

Iowa, Pomeroy—The First National Bank has awarded the contract for the erection of a 1 story, 27 x 50 ft. bank building, to A. Moorman & Co., 501 Minneapolis St., St. Paul, Minn. A low pressure steam heating plant will be installed in same.

Mo., Carthage—The Board of Education will soon award the contract for the installation of ventilating plants in two ward schools. Plans include engines, motors, fans and heating coils. Estimated cost, $10,000. J. H. Felt & Co., 802 Grand Ave., Temple, Kansas City, Mo., Arch.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania..	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.10	$4.35	$4.00
Barley	2.15	1.90	2.40	2.15
Buckwheat ..	3.15	2.90	3.75	3.80
Rice	2.65	2.40	2.65	3.40
Boiler	2.45	2.20	3.55	3.30

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes..	$2.55—2.70	$3.25—3.40
Mine-run	2.35—2.50	3.00—3.15
Screenings	2.05—2.20	2.75—2.90

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump ...	$2.55-2.90	$2.55-2.70	$2.55-2.70
2-in. lump ...	2.55-2.90	2.55-2.70	2.55-2.70
Steam egg ...	....-....	....-....	2.20-2.40
Mine-run	....-....	2.35-2.50	2.00-2.20
No. 1 nut....	2.55-2.90	2.55-2.70	....-....
2-in. screen ..	2.05-2.20	2.05-2.20	....-....
No. 5 washed.	2.05-2.20	2.05-2.20	....-....

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$2.05	$2.35	$1.75
Pratt, Jagger	2.25	2.55	1.95
Corona	2.30	2.65	1.95
Black Creek, Cahaba.	2.75	3.00	2.35

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.


THEY CALL THEM DEVIL-HOUNDS
BUT THEY ARE SIMPLY
HOUNDING
THE DEVIL
OUR MARINES
Victor Perard

POWER

Vol. 47 NEW YORK, JUNE 25, 1918 No. 26

THE WAR'S BENEDICTION

FATE sits on the rim of Heaven writing a New Genesis. Here a line with the blood of heroic dead, there a line with the tears of sorrowing women.

The words are the nebula of Human Aspirations. And the composition assumes form by force of the gravity that is Brotherhood.

We shall read it by the light of a sun that is the New Purpose, for the past is Ptolemaic and the future Copernican.

In this Apocalypse there are no chosen people. The rich, the poor, the toiler and the master alike are led from the bondage of the Past's insecurity.

The pathway is bloody and appalling. Yet from it rises a mighty hallelujah of Deliverance.

FEAR NOT,
ye Kings of Capital!
STRIKE NOT,
ye Toiling Millions!
BE PATIENT,
ye Engineers!

YE are the New Trinity that is come with one mind, one heart, one purpose—to conduct as one unit this machine called Civilization; not for wealth or vain aggrandizement, but to make the world a better place to live in. And in the living and the service find the true reward.

By CHARLES H. BROMLEY

Operation and Maintenance of Elevators—Geared Traction Machines

BY R. H. WHITEHEAD

The construction and operation of the geared type of traction-elevator machines are discussed. Three types are considered: The overhead machine using a secondary-idler sheave; basement type using a secondary idler sheave; and overhead type without a secondary idler sheave, but employing a traction driving sheave having V-shaped grooves.

WITH the winding-drum type of elevator machine, the limitation of car rise is determined by the drum dimensions and these fix the car travel to about 150 ft. To meet the elevator problems evolving as the result of modern skyscraper buildings, another type of elevator machine had to be developed. This is known as the traction type and derives its name from the fact that instead of the ropes being wound upon a drum to give the car motion, as in the winding-drum type, motion is obtained by means of the traction existing between the driving sheave and the hoisting ropes.

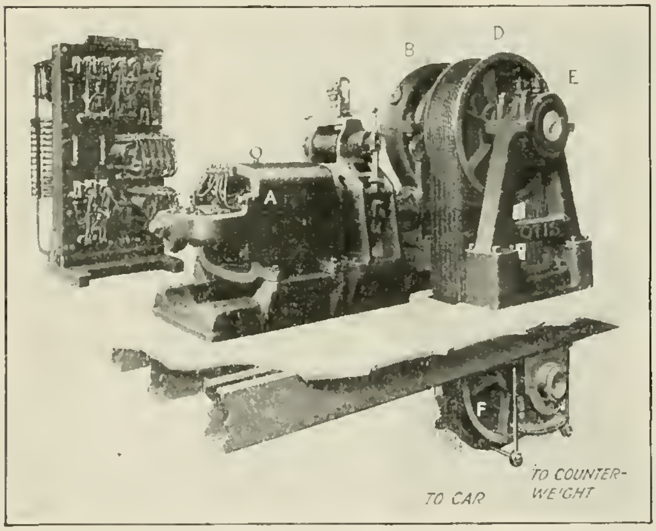

FIG. 1. GEARED TRACTION ELEVATOR MACHINE

There are two general types of traction machines—geared, Fig. 1, and gearless, Fig. 2. The geared type is used for low and medium rises and car speeds up to about 350 ft. per min., while the gearless type is used for high lifts and car speeds up to 600 and 700 ft. per min. Two of the gearless-traction elevator machines in the Woolworth Building, New York City, have an actual car travel of 680 ft. Geared-traction machines are also frequently used for low lifts in place of the drum type of machine.

It will be seen from Fig. 1 that the geared type of traction machines is similar in appearance to the winding-drum type, having a motor *A*, worm and worm gear in the case *B*, and a brake wheel and brake *C* mounted between the gear and motor. However, instead of the spirally grooved drum used on the winding-drum machine, a multi-grooved driving sheave *D* is keyed to what is the drumshaft in the drum-type machine. The grooving on a drum-type machine forms a helix starting from one end of the drum and running to the other end or ending at the center, as the case may be. On the traction machine the grooves on the sheaves form closed circles about the sheave, the number of grooves depending upon the number of ropes, generally two grooves for each rope.

In passing, attention might be called to the arrangement of the gearless type of machine, Fig. 2. It will be seen that, as the name would indicate, no gears are used, the driving sheave being mounted directly on the motor shaft, along with the brake wheel. This means that a very slow-speed motor must be used. This type of machine will be given further consideration in another article.

The geared-type traction-elevator machine, as shown in Fig. 1, is the equivalent for load and speed to the drum-type machine, using the same motor, brake and gears, the main difference being, as previously mentioned, that the geared-traction machine uses a driving sheave instead of a spirally grooved drum of the same diameter. The general type of traction machine employs the use of a grooved secondary idler sheave *F*, as shown in Fig. 1, to obtain sufficient tractive effort.

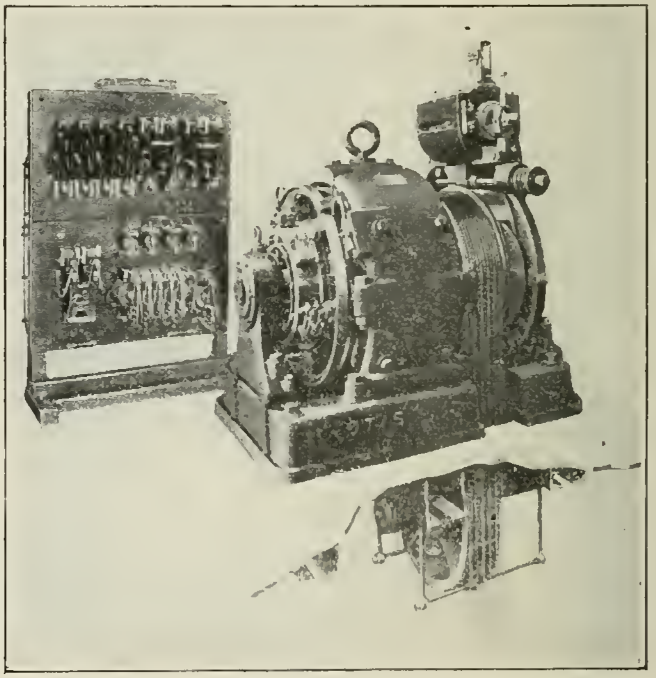

FIG. 2. GEARLESS TRACTION ELEVATOR MACHINE

In the traction type of installation the ropes are continued from the car to the counterweights, just as the car-counterweight ropes are in the drum type, but in the former only one set of counterweights is used. The roping for an overhead machine of the general type is shown in Figs. 3 and 4. The ropes pass

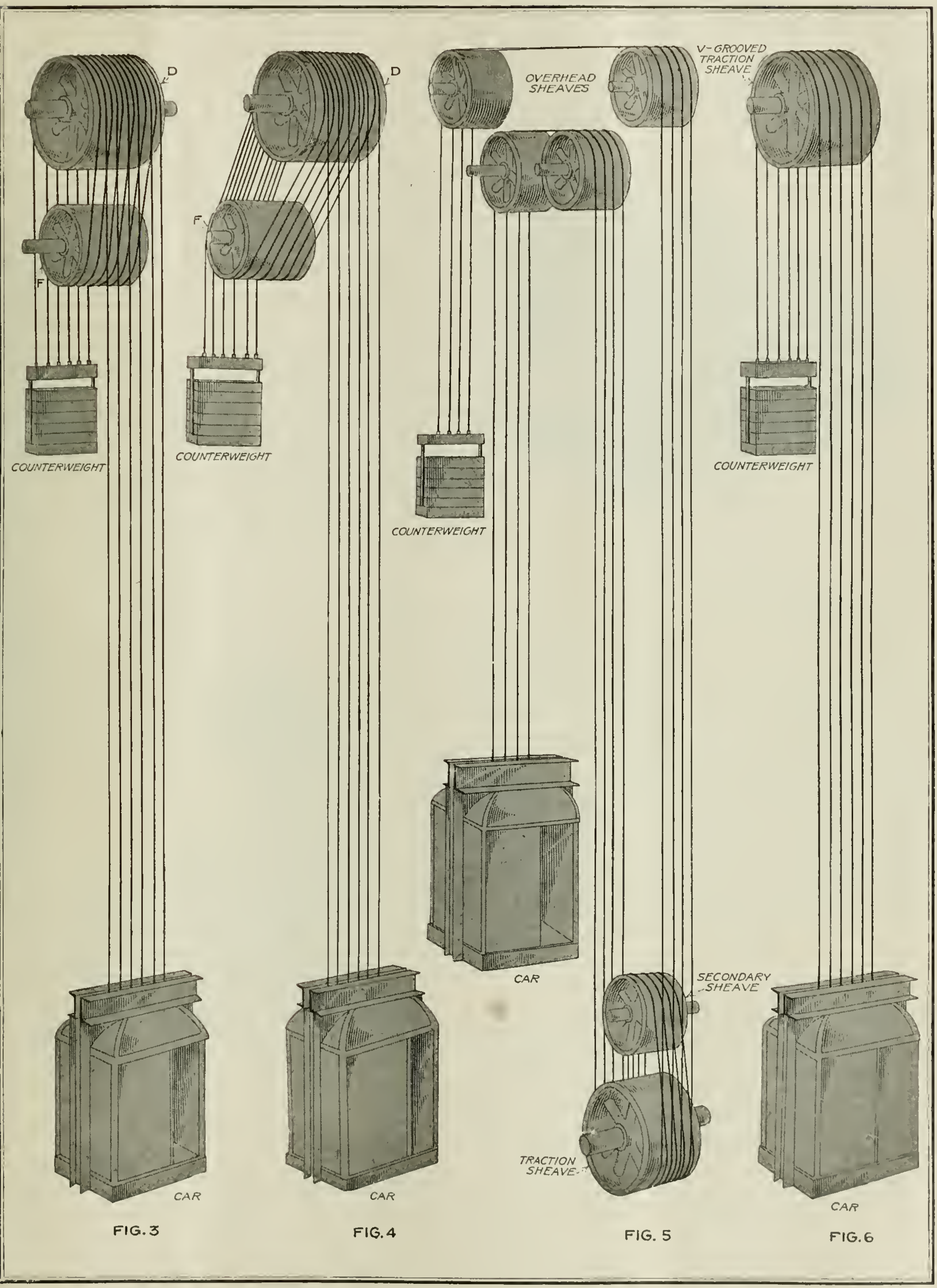

FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 3 TO 6. DIFFERENT ARRANGEMENTS OF ROPING UP TRACTION ELEVATOR

Figs. 3 and 4—Cable arrangement when machine is located overhead. Fig. 5—Roping scheme when machine is located in the basement. Fig. 6—Roping up when a V-grooved traction sheave is used.

from the car over separate grooves in the driving sheave *D* down and around under the idler sheave *F*, up over the traction sheave *D* again and then down to the counterweights. It is seen from this that the car is connected to one end of the cables and the counterweights to the other. This scheme of roping up the car and counterweights gives sufficient friction between the sheave and rope to get the proper tractive effort for all conditions of load.

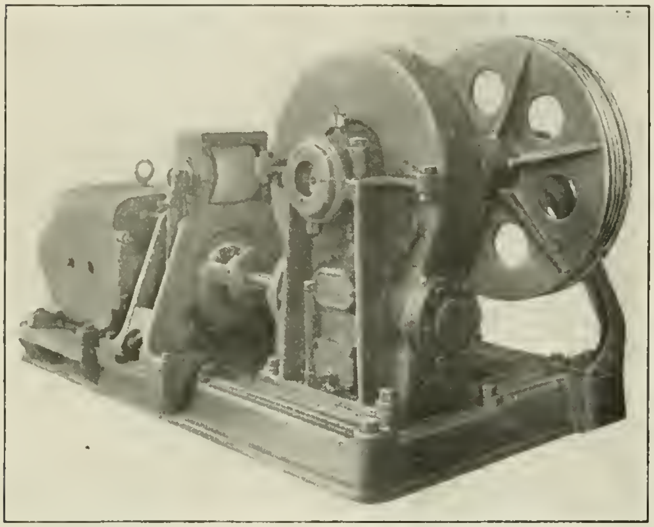

FIG. 7. V-GROOVED DRIVING-SHEAVE TYPE TRACTION ELEVATOR MACHINE

In Figs. 3 and 4 there are six cables. To accommodate them on the sheaves there must be twelve grooves in the sheaves. These six cables as they come from the car fall into every other groove on the driving sheave; that is, starting from one end of the sheave, say in grooves 1, 3, 5, 7, 9 and 11, they pass down around in grooves of the same number in the secondary sheave and up into the remaining grooves in the driving sheave. This would bring rope No. 1 into grooves 1 and 2 of the driving sheave and in groove No. 1 in the secondary sheave, leaving groove No. 2 in the secondary sheave unoccupied when this sheave is located directly under the driving sheave, as in Fig. 3.

Where the driving sheave spans the distance between the center of the car and counterweights, as in Fig. 3, the use of the secondary sheave permits of having slightly more than two complete half-turns of contact with each rope on the driving sheave. This is on account of the idler sheave being somewhat smaller in diameter than the driving sheave. When the driving sheave does not span the car and counterweight centers, as in Fig. 4, the secondary sheave is also used as a deflector sheave, but doing this results in losing a small amount of rope contact on the driving sheave, consequently some traction. From Fig. 4 it will be seen that the same number of grooves are occupied on the secondary sheave as on the traction sheave.

Experiments made with well-lubricated ropes and also with dry ropes on traction sheaves of this type show that with an installation properly designed there is no slippage of rope on the driving sheave under any condition of loading excepting a slight slippage which sometimes occurs when the car is suddenly stopped or started.

In some cases a V-shaped groove is used instead of the regular semicircular rope-shaped groove on the driving sheave. This groove is shaped like the letter V as implied by the name, and the traction is obtained on the driving sheave without the use of a secondary sheave, from the wedging action between the grooving and the ropes. A geared traction machine of this type is shown in Fig. 7. This is similar to the winding-drum type in every detail, except in place of the drum a sheave having a number of V-shaped grooves in its periphery is used, as shown in the figure. The ropes run directly from the car over the driving sheave down to the counterweights, as shown in Fig. 6.

The V-grooved machine costs less to build than the semicircular-grooved type, Figs. 1 and 2, since not only is the secondary sheave omitted, but in addition it is possible to use lighter construction on the driving sheave and shaft as the downward strain is only one-half as much. The driving sheave is only one-half as wide, as the ropes are not doubled back as in the case of the type using a secondary sheave.

The V-grooved type, however, gradually loses its tractive effort due to the wearing of the groove by the rope. This wear tends to make the grooving semicircular and when this occurs, the ropes will start to slip, as they no longer wedge in the groove. With the secondary-sheave type the tractive effort does not decrease with increased usage, since the grooves remain the same shape and the rope contact therein remains the same.

The traction type of elevator machine should always be installed overhead if possible, as shown in Figs. 1 and 2. The basement type of geared-traction machine is shown in Fig. 8. The roping of such a machine is given in Fig. 5. A comparison of Fig. 5 with Figs. 3 and 4, for an overhead installation, shows that for the same rise about twice the amount of rope is required for the basement-type installation, and in addition the rope must be deflected over several extra sheaves. This results in shorter rope life and higher

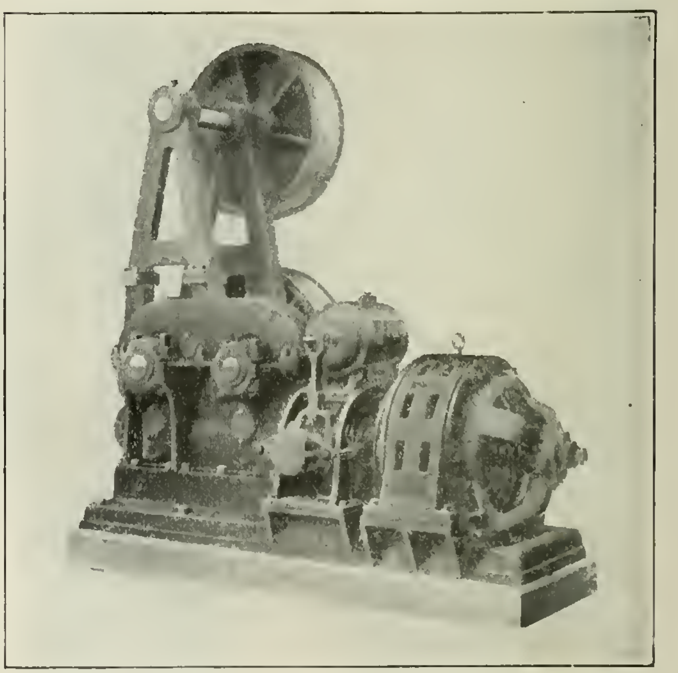

FIG. 8. BASEMENT TYPE OF TRACTION ELEVATOR MACHINE

power consumption, and the first cost of the installation is greater, not only on this account but also for the extra overhead sheave.

In Figs. 1 to 4 it will be noticed that there are six independent ropes leading up from the car to the driving sheave, then to the secondary sheave and back to the driving sheave and to the counterweights. These ropes are usually steel and are $\frac{5}{8}$ in. to $\frac{3}{4}$ in. in diameter. With this type of installation it is important that the strain be kept equal in all ropes by adjusting them with the take-up arrangement provided on the car crosshead and counterweight frame. When any one of the ropes takes less than its share of the load, this particular rope loses its traction and a loss of traction results as a whole.

Each rope is provided with a swivel hitch of the ball-socket type. This prevents any twisting strain on the ropes and relieves them of the bending strain at the hitch. With the general type of traction machine using a secondary sheave, the minimum traction under any condition is such that the rope will not slip until the load on the heavy side is about twice that on the light side, which means that with the machine 40 per cent. over-counterweighted the load on the car must equal about 200 per cent. rated capacity before there is any danger of the cables slipping on the driving sheave.

Slippage a Point in Favor of This Type

The fact that slippage will occur is a very strong point in favor of this type of installation, because when the car bottoms in the pit the traction is lost and the counterweights cannot travel farther; even though the driving sheave continues to turn, it cannot exert sufficient tractive effort on the ropes to haul the counterweights into the overhead work. This also applies when the counterweights bottom in the pit; the driving sheave cannot pull the car up into the overhead work.

A machine automatic like that used on the drum machine for stopping the car at the top and bottom landing cannot be used on the geared-traction machine, because of a possible slippage of the cables under the conditions enumerated. Consequently, additional switches instead are provided, similar to the hoistway-limit switches, at the top and bottom of the hoistway. These switches are operated by the cam on the car that operates the hoistway-limit switches and fulfills the same function as the automatic located on the drum shaft of the winding-drum type of machine.

The first limit brings the car down to slow speed, in the case of a direct-current motor, by opening the circuit to the magnet coil, which weakens the shunt field, thereby increasing the field strength to normal value, and with an alternating-current motor slow-down is accomplished by disconnecting the high-speed winding of the motor from the line and in its place connecting the slow-speed winding. The next limit switch generally opens the direction switch for the direction of car travel, and farther travel of the car will open the hoistway-limit switch, which opens the main potential switch. High-speed installations, where the control is more complicated, will be discussed in a future article.

The limit switches, wherever conditions permit, should let the reversing switches open automatically when the car is level with the top and bottom landings, and a normal automatic stop with any load in the car should not operate the hoistway limits.

The rope length should be adjusted so that the counterweight does not bottom until after the top hoistway-limit switch opens. Conditions of overhead car and counterweight clearance sometimes necessitate deviation from the foregoing and make it necessary for the reversing switches to open automatically before the terminal landings are reached, the inertia of the machinery being depended upon to bring the car to the landing. This is objectionable inasmuch as the operator tends to stop the machine on the limits instead of the automatics, and if he uses the car switch and stops the car before the floor level is reached, he must go back and make another trial.

Geared-traction cars are sometimes provided with appliances used ordinarily on the gearless type; that is, stopping switches mounted on the car, operated by a cam in the hoistway, instead of the limit switches previously described; and oil buffers instead of spring buffers for both car and counterweight are used.

Ordinarily, however, the geared-traction installation is a duplicate of the winding-drum type except for the difference as shown in this article, and with this type of machine it is possible with either alternating or direct current to meet the elevator problems in high-rise installations for moderate speeds.

As pointed out in the foregoing, the geared-traction machine is generally used only for car speeds up to 350 ft. per min., and for speeds of 400 to 700 ft. per min. the gearless type is used.

As in the winding-drum type of machine, the driving-sheave shaft is equipped with marine collared bearings in the outboard stand and in the wormwheel case to resist the side thrust of the wormwheel. The geared-traction machine is also built either on the single-screw type, Fig. 1, or the double-screw type, Fig. 8. Thrust bearings are provided on the wormshaft of the single-screw machine to take the thrust between the worm and gear. In the double-screw type no thrust bearings for the wormshaft are required as a right and a left worm on the same shaft engages a right and a left wormwheel, which in turn mesh as spiral gears, thus forming a three-point drive.

Pollution of Streams

"The court knows judicially that modern science has demonstrated that the use of water in power plants and for other purposes where human beings must of necessity be in attendance about it seriously endangers its purity, rendering it unfit for human consumption," declared the Washington Supreme Court in the recent case of City of Raymond vs. Willapa Power Co., 167 Pacific Reporter, 914.

Accordingly, the court rendered the decision that plaintiff city, having acquired the right to use the waters of a stream in operating a water-supply plant, was entitled to enjoin defendant from interfering with this right by impounding the waters of the stream above the city's intake for use in developing electricity, although the waters were returned to the stream by defendant company.

Pitch as a Fuel for Power Generation

By JOHN B. C. KERSHAW

A summary of the most recent patents and experiments relating to the use of coal-tar pitch as a fuel for steam boilers and for internal-combustion engines.

THE great increase in the number and capacity of the byproduct coke ovens in the United States and in the number of works for the distillation of coal tar (in order to obtain "toluol," the chief raw material for explosive manufacture) has led to an overproduction of pitch and to accumulations of this material in all tar-distillation works. This overproduction will continue when peace is declared and the demand for explosives falls to its normal level, for the products of tar distillation will then be absorbed in the organic color industry.

In the past, coal-tar pitch has been employed chiefly as a roofing, waterproofing and paving material, its comparatively low melting point and high percentage of volatile hydrocarbons having prevented its use on any considerable scale as a fuel, with the one exception of its application as a binding agent in the manufacture of anthracite briquets.

The increase in the output of pitch in the United States during the war and the fact that over two million tons of this solid hydrocarbon is now produced annually in the tar-distillation works of the country have led to a revival of interest in the possibilities of pitch as a fuel, either for burning in the solid state under steam boilers or for use in the liquid state in internal-combustion engines.

CHEMICAL PROPERTIES OF PITCH

Before dealing with the practical methods of utilizing pitch as a fuel, it will be advisable to review briefly its chemical and physical properties, since the question of its successful application as a source of motive power hinges largely upon a correct appreciation of the difficulties attending its proper combustion, either in the solid or the liquid state.

When coal tar is heated in the usual type of 20-ton still in order to separate and recover the more valuable constituents, with boiling-points below 270 deg. C., there remains in the still a residue known under the trade name of pitch.

Chemically, pitch is a mixture of hydrocarbons containing oxygen, nitrogen and sulphur. The constitution varies with the source of the tar and also with the temperature to which the distillation has been pushed in order to recover the oils of lower boiling point. One ton of an average tar under ordinary conditions of distillation will yield the following products: Benzol, ⅓ gal.; toluol, ⅔ gal.; solvent naphtha, 1½ gal.; heavy naphtha, 1 gal.; carbolic acid (crude), 2-3 gal.; crude cresylic acid, 2 gal.; creosote oils, 20 gal.; anthracene oils, 34 gal.; naphthalene, 112 lb.; pitch, 10 cwt.

The light oils distill at a temperature below 170 deg. C., the carbolic or middle oils at temperatures lying between 170 and 230 deg. C., and the heavy or creosote oils from 230 to 270 deg. C. The anthracene oils come over only at higher temperatures (from 270 to 400 deg. C.), and the distillation is not always carried so far as to remove these oils entirely from the pitch. A large portion of the pitch, 10 to 50 per cent., consists of finely divided carbon, but from 50 to 90 per cent. consists of solid unsaturated hydrocarbons of the aromatic type, which give the pitch its distinctive properties. According to Martin, the elementary analyses of hard and soft pitch yield the following: Hard pitch, 93.2 per cent. carbon, 4.4 per cent. hydrogen; soft pitch, 91.80 per cent. carbon, 4.60 per cent. hydrogen.

The calorific value of pitch is extremely high; a sample tested by the writer in the bomb type of calorimeter having shown 15,928 B.t.u., or a higher value than that of the best Welsh steam coal. This high calorific value is, however, counterbalanced by the production of a high percentage of volatile hydrocarbons when it is heated, the following being an approximate analysis of a north-country pitch: Moisture, 0.05 per cent.; ash, 0.60 per cent.; volatile matter, 66.85 per cent.; coke, 33.15 per cent.; fixed carbon, 32.55 per cent.

ITS PHYSICAL PROPERTIES

As regards the physical properties of pitch, the specific gravity varies from 1.20 to 1.35, the hard pitch produced when the distillation of the tar has been carried to a high temperature having the higher specific gravity.

The melting point likewise varies within wide limits, but it must be noted that the term melting point when applied to pitch is an arbitrary one, since the material when heated gradually softens and passes by almost imperceptible stages into the liquid state. The limits of melting point noted are 37½ deg. C. in water and 174 deg. C. in air, but a pitch melting at 37½ deg. C. (100 deg. F.) would hardly deserve to be classed as a pitch, since this low melting point would signify that the distillation had only been carried far enough to drive off the water, lighter oils and some portions of the carbolic oils.

Pitch, as shown by the analyses previously given, is composed chiefly of free carbon and of hydrocarbons which become volatile on heating above 400 deg. C. It is therefore combustible and under proper conditions can be burned to CO_2 and H_2O vapor, with the production of heat equivalent to 15,900 B.t.u. per lb. of pitch consumed. The very high percentage of volatile hydrocarbons which are evolved when it is heated above its melting point, however, renders it difficult to burn pitch without the production of smoke, for even if the problem of keeping the air supply adequate for the proper combustion of these hydrocarbon gases be solved, there is still the difficulty of securing a proper admixture of the air and of the evolved combustible gases. These gases also are liberated at a lower temperature than in the case of bituminous fuel, and this signifies that they require further heating before they reach the ignition point, otherwise they may escape from the furnace unconsumed, without yielding any of their heat value. This analysis of the difficulties of burning pitch as a solid fuel under steam boilers shows that special arrangements are necessary and that it is useless to simply shovel the lumps of pitch mixed with the coal into the furnace and expect good results from the mixture.

In fact, when such attempts are made to burn pitch in the ordinary furnace under Lancashire steam boilers, the pitch softens and melts, and closes the air spaces in the grates before the liberation or the ignition of the gases has occurred. Dense volumes of black smoke are therefore produced by this cutting down of the air supply at the time when a large excess of air is required for efficient combustion, and the fire side of the tubes of the boiler and economizers becomes covered with a thick, oily deposit of soot, which enormously reduces the transmission of heat to the water. The hydrocarbons contained in coal pass from the solid to the gaseous state on the application of heat without assuming this intermediate or liquid stage, and for that reason coal is much more easily burned than pitch.

The conditions required for burning solid pitch are therefore three in number: An adequate supply of air, above or through the grate; an adequate admixture of this air and the evolved gases, and means for raising this large volume of air and hydrocarbon gases quickly to the ignition point of the latter.

Burning Pitch Under Lancashire Boilers

The managers of certain gas works are reported to have solved the problem of burning pitch under Lancashire steam boilers, with the aid of forced draft and a special type of channeled solid fire-bar, known as a pitch-bar.

Some of the ordinary fire-bars of the furnace are removed, and the pitch-bar substituted, the number and distance apart of the latter depending upon the character and volatile matter contained in the fuel that is being consumed on the other portions of the furnace grate. The pitch, broken to a convenient lump size, is fed onto the front end of these special pitch-bars, preferably by some type of mechanical feed, which will maintain a regular supply without opening the furnace door. The heat of the surrounding fire causes the pitch first to melt and to flow down the channel of the bar and then to volatilize. The rate of such volatilization is said to be controlled by the form of the bars, and the forced draft supplies the surplus-heated air which is required to secure the combustion of the hydrocarbon gases produced from the molten pitch. The partly coked residue which remains after the more volatile constituents have been driven off and burnt, is then pushed to the rear portion of the grate, where its combustion as ordinary coke offers no special difficulties. Details of this method of burning have been published.[1]

Pitch is also being burned in a tar-distillation works in the North, in conjunction with breeze and coal under Lancashire steam boilers, in the proportions of 75 per cent. breeze, 18 per cent. pitch and 7 per cent. coal, without any trouble from smoke. The boilers in this case are hand-fired and work under natural draft. It will be observed that the proportion of pitch is only about one-sixth of the total weight of fuel used, and as the breeze evolves only a comparatively small amount of hydrocarbon gases, the final volume of combustible gas to be consumed is not large.

At one time a mixture consisting of 45 per cent. crushed pitch and 55 per cent. breeze was employed. The steam-raising value of this mixture was good, but it produced smoke, and in time resulted in an oily deposit of soot on the economizer tubes. This deposit could not be removed by the scrapers and eventually had to be burnt off. Probably if forced-draft apparatus had been installed with a preheated air supply, this half-and-half mixture of pitch and breeze could have been burned without any trouble, since a deficient air supply was undoubtedly the cause of the sooty deposit.

The possibilities of using pitch as a liquid fuel under steam boilers do not appear to have been yet investigated upon a practical scale, although this method of employing pitch would probably prove the most efficient and the least costly to work when once the necessary apparatus had been installed. The distillation of the tar in this case would be stopped when the light and middle oils had been distilled (that is, at 200 deg. C.) and the soft pitch which remained in the still would be utilized in the semi-liquid state in a modified form of the usual atomizing injector, using superheated steam or hot air under pressure, as motive power. The preheating of the air supply and the thorough admixture of the minute globules of liquid pitch and the air could be most effectively carried out by this system of combustion, and since coal tar has already been utilized successfully in this way, the atomizing of a material that is only slightly more viscous at ordinary temperatures would not offer insuperable difficulties.

In this connection the patent of Arnold Philips, an Admiralty chemist at Portsmouth, England, for reducing the viscosity of thick oils, may be referred to. In this patent (No. 14,778 of 1913) the addition of 8 per cent. of naphthalene is specified for rendering certain thick oils more suitable for fuel purposes. If the naphthalene be left in the pitch, it is reasonable to suppose that it will also have the same effect in rendering the latter more suitable for atomizing purposes. Should difficulties from cooling and partial solidification occur in the spraying nozzle, these no doubt will be overcome by inclosing the latter in a heat-insulating jacket, through which the preheated air or superheated steam would be passed before entering the atomizing nozzle.

Recent Patents Dealing With the Subject

As regards recent patents dealing with this subject English patent No. 101,444 of 1916, granted to G. H. H Bölling, of Christiania, describes a method of melting the pitch by means of the heat of a steam coil and introducing it through similarly heated pipes into the furnace, where it is atomized by a jet of steam or air. The steam jackets, pipes and valves are so arranged that any incrustation may be removed. German patent No. 290,708 of 1914, granted to Robert and Trinyi, relates to the similar use of powdered pitch as a fuel, the pitch in this case being blown into the furnace in the form of dust. Finally, the English patent of G. Heyl (No. 110,023 of 1916) may be referred to, according to which liquid fuels suitable for firing furnaces and for use in high-compression oil engines, can be manufactured with the aid of pitch, by treating mineral oils and heavy creosote oils with solid caustic soda, to neutralize the acids present and to remove sul

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[1] "Chemical Trade Journal," Nov. 4, 1916.

phur compounds. The oil is cooled to eliminate the naphthalene (a mistaken proceeding in the light of Philips' discovery) and is then heated with pitch. It is stated that up to 50 per cent. of the latter by weight can be dissolved by this method of procedure.

One method of rendering pitch sufficiently fluid to be used in internal-combustion engines is described in the foregoing, and it is highly significant that the Controller of the Mineral Oil Production Department of the Ministry of Munitions is now arranging for trials of mixtures of pitch and creosote, in order to test their suitability for this particular purpose. The writer has been informed, however, by an electrical engineer who has had some experience in the use of such mixtures for Diesel engines, that used in the ordinary way they are not very satisfactory, owing to starting difficulties and to incomplete combustion in the engine cylinder. When burned, however, with the aid of a pilot ignition apparatus, they give quite good results. With this apparatus 5 per cent. of petroleum oil is injected into the cylinder just before the creosote and pitch mixture enters, and this pilot charge of a more easily ignited oil enables the temperature to be kept sufficiently high to obtain proper combustion of the composite heavier oil.

The chief difficulty in using heavy oils in gas engines is of course to prevent imperfect combustion, and the consequent choking of valves, etc., with carbon. Should this occur, the use of a mixture of wood alcohol and ammonia has been used for removing these deposits without the application of heat, but the writer is unable to state whether this mixture has proved satisfactory in practice. Burning off, the usual plan, is of course efficacious, but it is troublesome, and a liquid agent which would act in the cold would have much in its favor.

PROGRESS IS BEING MADE

This summary of the most recent patents and experiences relating to the use of coal-tar pitch as a fuel for steam boilers and for internal-combustion engines, shows that some progress is being made. The methods of rendering pitch sufficiently fluid to be used in atomizers are in the opinion of the writer the more hopeful, and he is less confident that pitch can be used economically in the solid and pulverized condition for firing steam boilers.

The fact that pitch softens at a comparatively low temperature means that the heat generated by friction in the pulverizing apparatus will have to be dissipated by artificial cooling, to prevent the grinding surfaces becoming clogged with half-melted pitch, and this artificial cooling must add considerably to the costs of the grinding operation. In the methods of rendering pitch more fluid, the heat added to the material is of direct service later in accelerating and improving the combustion in the boiler furnace or engine cylinder; consequently, the heat is not wasted, but is preserved and made effective at a later stage of the combustion process.

It would seem, however, a waste of time and heat energy to first separate the constituents of coal tar by distillation into four or five separate portions and then to recombine some of these portions in order to obtain a mixture suitable for use as a liquid fuel. The writer considers that the future line of development will be to carry the distillation only far enough to win the lighter oils and the phenols from the raw tar, and that the residue from the stills, containing the heavy creosote oils, the naphthalene and the pitch, will be sold and utilized as a liquid fuel. The anthracene oils, which are the last constituents of the raw tar to distill over (270 — 400 deg. C.), would in this case be left in the pitch, and only when the demand and price offered for the anthracene made its extraction profitable would the complete distillation of the raw tar and separation of all the possible classes of its constituents be carried out.

The Use of Metallic Gaskets

BY W. B. HAYNES

When a gasket of any description is offered to you with the assurance that it will stand air, oil, gas, water, steam of any temperature, expansion and contraction, electrolysis, etc., you smile sweetly, and while you try to be polite and say "very interesting," it occurs to you that someone has a lot to learn about gaskets. Let me set down my belief regarding metallic gaskets, their uses and limitations, reserving the right to change my mind on these points if I am wrong.

The ordinary corrugated copper gaskets are approximately $\frac{1}{64}$ in. thick and are generally used as a ring inside the bolt circle, and two in a joint, because when only one is used the flanges are apt to spring enough under the strain of the bolts to touch, iron to iron, outside the bolts, permitting a leak. In other words, one thin copper gasket is not enough for the ordinary commercial flanges to "get a bite on." When two gaskets are used, they should be meshed the same way of the corrugation. Metal gaskets should be coated with pipe cement, graphite and oil, or lead and oil, and bolted up before the coating has dried, so that each corrugation flattening under the pressure forces a ring of this filler concentrically around the flange, and the copper gasket practically acts as a binder. There are, however, exceptions to this rule of two gaskets, especially on low-pressure work. Copper gaskets should be annealed soft and pliable, as the final process, because in the process of corrugating it becomes hard, stiff and springy. This is because in corrugating, the fibers of the metal are strained and thrown out of harmony and mesh. Annealing brings these fibers back into harmony and restores the strength of the metal, therefore always mark orders for soft gaskets "to be annealed after making."

A steam-fitting contractor doing bad work, if he only wants to "get an acceptance of the job, get his money and get out," looks with disfavor on gaskets of the thin variety because he has to do a good job to get an acceptance.

The ideal gasket is one that covers the pipe ends as well as the flange, if the pipes are faced off flush with the flange, because such a gasket will save thread leaks. If, however, the pipe does not come out flush with the flange, this cannot be accomplished with any gasket. The following trite saying of a purchasing agent is worth repeating: "We have joints in our power plant that cannot be opened for replacing gaskets for a less cost than ten dollars. We cannot, therefore, afford to put in a poor gasket as it is putting on a mortgage that will be foreclosed with a blowout."

Conditions in the Power Industry

BY L. W. SCHMIDT

A digest of the reports of United States consuls on the power situation in various parts of the world and the influence of the war on this important industry. Also see "Power," June 4, 1918.

BY ENFORCING increased economic activity over practically the whole world, the war has widened the field of electric power. Lack of man power has probably been the principal factor in this development, but there is plenty of evidence that electric power will be used after the war in many places where before it was only in the experimental stage. The report comes from England (C. R. 78)[1] that extensive use may be made in agriculture of the so-called electrification of crops, which consists in exposing growing crops to electric light. This treatment adds largely to the productive power of the plants according to extensive experiments made before the war. There has been formed in England the Electric Discharge Co., which enterprise intends to treat not only growing crops, but also the seeds. Plants for the treatment of seeds have been erected at several places in England, and it is said that the increase in the yield from seeds so treated is between 25 and 80 per cent.

WIND MOTORS FOR CHEAP POWER

If the method generally proves successful, it will open a new field for the power industry. Cheap power, of course, will be needed for the purpose, and it has been suggested that electric power generated by wind motors be used for the purpose of crop electrification. The argument in this case is that power generated in this way costs practically nothing beyond the expense of the installation and its upkeep, and that any power that can be obtained by wind comes handy for crop treatment, since there is no need for maintaining a regular supply of power.

England feels more and more the effect of the high cost of living on power production. Following the example of other cities, Birmingham has increased the cost of electric power to consumers. The rate of increase affects both light and power and amounts to between 10 and 15 per cent. To prevent electrical consumers from changing over to gas consumption and so putting undue stress on the gas works of the city, the municipal authorities also have raised the gas rates (C. R. 81).

Much of the increased cost in the power stations has been caused by the rapid rise in wages necessitated by the corresponding increase in the cost of living. Nearly all private and municipal enterprises have been compelled to add to their wage scales, and recently it became necessary to increase the wages paid to the employees of the Nottingham tramway corporation, following arbitration by the Ministry of Labor. About 450 employees of the corporation were affected by the decision (C. R. 83).

Italy has just taken a step that has already been taken by several other countries in the war and that may become necessary in this country. It has made an exact census showing the unemployed machine power of all kinds that may be put to use when needed. The census includes locomotives, boilers, motors, power plants and general power machinery. The forms that had to be filled out by the owners of the machines specified the kind of fuel necessary and the number of workmen employed in running the machines (C. R. 82). Germany made such a census in 1915 and many motors and other power machines have been transferred from parts of the country where they could not be employed to advantage to districts where there was an urgent need.

LONGEST TRANSMISSION-LINE SPAN IN WORLD

In a preceding article[2] on this subject, mention was made of the work done on the new power transmission line from Florli to Stavanger in Norway and the erection of the power plant at Florli. The transmission line is now ready, and the power plant will be completed in the near future. In that way 12,000 hp. will be made available for the Stavanger Electric Co. Incidentally, the erection of the transmission line involved crossing the Hogsfjord by a single span of 1514 yd., which is said to be the longest in the world. The span is composed of three cables of crucible steel, since copper or aluminum would not be able to stand the strain. Copper-sheathed cable would have been preferable to prevent loss of voltage, but under present conditions it could not be obtained. Each cable has a diameter of 0.63 in., is composed of 19 strands and has a tensile strength of about 210,000 lb. per sq. in., or a total of about 25 tons for the whole cable. The slack of the cable is 87.5 yd. and in a strong wind it will oscillate 54.7 yd.

The effect of the new installation has begun to show in the neighboring cities, especially in Stavanger and Haugesund, by an increase in the demand for electric installations. Electric current is used quite generally for domestic purposes, and Consul Henry C. A. Dunn, in Stavanger, advises American manufacturers of great sales opportunities in the district (C. R. 104).

DENMARK BEGINS ELECTRICAL DEVELOPMENT

The rapid development of the natural-power resources of the northern Scandinavian countries also exerts its influence on Denmark. Not only is this country buying electric power from its northern neighbors, but it has also begun to develop some of its own. Denmark has little water power available, and to provide cheap electric power it may become necessary to use the great peat beds. These are situated in the western part of the country and will be developed as soon as the necessary capital can be found. In the meantime steps have been taken to make use of 1000 hp. of water power from the Gudenaa, a small river near Aarhus. The cost of this development is estimated to be approximately $1,000,000, and it will be a year before the plant can be put into operation (C. R. 72).

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[1] C. R. indicates "Commerce Reports" of 1918.

[2] "Power," Dec. 11, 1917.

Another country which has felt heavily the effect of the war, although remaining neutral, is Switzerland. It is a peculiar fact that Switzerland, having possibly the best natural-power resources of the world for so small a territory, has until recently made very little use of hydro-electric power. For many years gas has been the mainstay for street lighting in many cities. Now the difficulty of obtaining coal has impressed upon the Swiss communities the necessity of making better use of the nearer and cheaper resources at home. So the consumption of electric power is growing rapidly in Switzerland, and during the last year most of the existing stations have reported increasing demands on their producing capacity. The result is that it is now contemplated to enlarge the existing stations and to add a number of new ones in the near future, so as to make Switzerland increasingly independent of foreign coal.

Future Industrial Activity in Spain

After the war, and possibly even now, Spain should attract the attention of our power specialists looking for foreign investments. Spain is an industrially active country which in the future will play a considerable part in the production of many commodities of the cheaper kind. Cheap electric power will be necessary for that purpose, but the numerous schemes now under way may come to nothing owing to the lack of capital. This will have to come from the outside, and America should be able to supply it together with the necessary machinery and equipment.

Vice Consul Asel D. Beeler writes from Bordeaux about the great resources of the Pyrenees. What he says about the French side of the mountain range applies also to the southern side. "The mountain region is supplied abundantly with swift and powerful currents of water, readily adaptable to the development of hydro-electric power, a desirable feature where the coal supply is limited. Many of the industries of the cities in the Pyrenean country, as shoe factories, woolen mills and railways, are now operated by electric power which is abundant in a considerable area of the Midi section. The general development and industrial utilization of electric motive power is more characteristic of the industry in the departments of Basses- and Hautes-Pyrenees where the most railroads, the largest rivers and the most populous cities are."

Developments in French Pyrenees

On the French side of the Pyrenees, on the Ariège River near Las Mijanes, a power plant of an average development of 2500 hp. is being erected. The owner of this enterprise is the Société Métallurgique de l'Ariège which recently bought the stock of the Société Hydro-Electrique des Pyrénées, owning a plant at Castelet with a waterfall 90 ft. high and permitting the installation of four turbines of a capacity of 800 hp. each (C. R. 92)). The company also owns rights to develop power on the Nagear, where there is a waterfall of 1200 feet.

The City of Sofia, in Bulgaria, intends to build an electric central station, although it is doubtful whether American power interests will feel much inclined to make use of an opportunity to extend their connection in that field just now.

By cutting off the usual supplies reaching South America from European countries, the war has forced industrial expansion everywhere in Latin America, with the result that there has been an increasing demand for electric power. This has been supplied by extending existing enterprises and by adding a number of new ones. During the last few months several of the leading power enterprises in South America have made their annual reports, which in each instance seem to show a considerable expansion in power distribution and also increased takings.

One of the most representative enterprises, doubtless, is the Lima Light, Power and Tramways Co., of Lima, Peru. This company reports a gross revenue of $2,142,480, as against $1,986,360 during the year 1916. The net revenue amounted to $964,250. There has been, however, a noticeable rise in the yearly expenses amounting to $76,740. Increased employment of electric power is given as the chief reason for this good showing and also an increase in the tramway traffic. High cost of materials, which in many cases had to be imported from the United States at any price, has added largely to the increase in operating expenses. The company made several extensions of its plant during the year 1917, which included the installation of a 2500-hp. turbo-generator and a 2000-hp. Babcock & Wilcox boiler. New installations have been made at Chosica, Yanacota, Barranco, Chorillos, Miraflores and Lima (C. R. 105).

Increased Rates for South American Plants

In Chile electrical enterprises have been suffering much from the lack of coal. Several Chilean power plants are burning wood, which is cheaper than coal. The scarcity of fuel and its high price have forced most of the power plants in South America to increase their rates, and this action has not always been accepted in a very friendly spirit by the consumers, already exasperated over the high cost of living.

In Uruguay the government has just authorized the governmental power plants to increase their rates. This step is explained to the public principally on the ground of increased cost of fuel. Many Uruguayan power plants, by the way, are burning oil imported from the United States (C. R. 96).

The exceptional activity in the power industry reported from other parts of the world has also been noticeable in eastern Asia and India. In Japan it has found expression in an increased demand for hydro-electric power, which doubtless has been caused by the high prices that had to be paid for coal. The rising operating cost, however, so far has not allowed the hydro-electric power companies to take full advantage of the situation, with the result that so far none of them report materially increased earnings.

In China the electrical industry is suffering a good deal from the lack of new machinery. The demand for new installations is great, but as it is practically impossible to get new machines, repair work and additional construction are much delayed. This condition is leading to an increase in the manufacture of power machinery in China, especially in Hongkong—a piece of news which doubtless will interest American manufacturers. If it should turn out that Chinese and other Asiatic concerns get into the habit of building complicated power machinery in their own plants during the war, they may continue the practice after the war, with the result that much trade will be lost to American and European manufacturers of such machinery. This is one of the dangers caused by the present interruption of foreign trade. However, it is not probable that a Chinese machine-building industry much better developed than that which now exists will be able to meet the demand for power machinery which is to be expected from China in the near future. Even with such national competition, therefore, there may be expected a healthy demand from that country after the war.

In both Hongkong and Shanghai, by the way, a considerable increase in takings is reported by the local tramway companies. The Shanghai Street Car Corporation, which in 1909 carried 11,750,000 passengers, is now carrying 73,500,000 per year, and its takings have been trebled. Electrical engineers in China are of the opinion that the future of electrical enterprise is extremely bright. Proposals are now made for a more scientific development of the existing opportunities and also for the creation of machinery which later will allow the linking up of existing systems so as to make them mutually supporting (C. R. 89).

In Madras, British India, there are at present 54 industrial establishments operated by electric power. The total sale of current, which amounted to 5,086,609 units during 1916, has now reached 5,693,807 units, and the increased demand for energy has led to the erection of two new substations. There are today 126 electric plants in operation in the Madras Presidency.

Causes of Vacuum Trouble

By L. F. Forseille

Previous to the application of the little device herein described, considerable trouble was experienced at times in maintaining a normal vacuum on a 10,000-kv.-a. turbine unit equipped with a jet type of condenser.

The small turbine driving the air and removal pumps is loaded to its maximum capacity, thereby affording very little reserve for any additional effort that it might be called upon to exert. After carefully watching its performance, I found a number of causes of the trouble, each being accompanied by a partial loss of vacuum, the extent of this loss being governed by the time required by the attendant to correct the trouble. The most frequent causes were obstructed strainers in the air-pump supply line. These instances were invariably preceded by racing of the pump turbine.

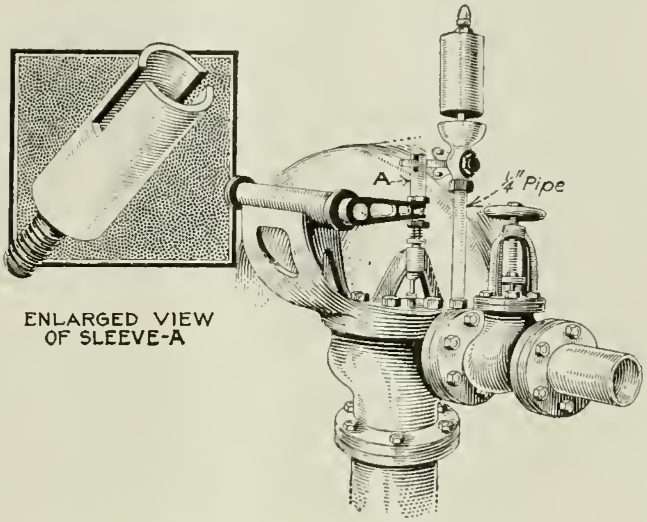
Following is a list and a brief explanation of each of the contributing causes:

Too much injection water being used, thereby overloading the pump turbine.

A sudden reduction of load on the main unit would immediately result in the turbine racing. This I believe can be accounted for as follows: A reduction in load will result in a rise in vacuum, increasing the velocity and consequently the amount of water entering the condenser. This is further augmented by a drop in temperature of the discharge water and an increase in the working head. Summing up the different changes that take place, I believe that the reduction in the amount of steam flowing to a condenser is more than compensated for in the increased amount of injection water, leaving the pump to discharge as much, if not more water, than with a full load on the main unit, and this at a greatly reduced temperature. This latter item must be considered, owing to the fact that the discharge is approximately 18 ft. above the center line of the pump. Of course the only remedy, as in the preceding case, is to cut down on the injection water. Too much water going to the air pump has about the same effect and can be overcome only by cutting down the amount.

Obstructed strainers in the air-pump supply line will cause the turbine to race violently. This, I think, is caused by the pump alternately picking up slugs of water and air. The remedy is to change over to the clean strainers.

Wet steam coming over from the boilers will cause racing and a momentary loss in vacuum, which usually rights itself without any further trouble. However, in extreme cases it is necessary to cut down on the injection water until the trouble has passed, when it can be gradually brought up to normal volume.



ARRANGEMENT OF SIGNAL WHISTLE

A vacuum leak in any part of the system, including the water-supply line, will also cause racing, and if serious, racing will continue until the leak is stopped. It will be noticed (as I have previously mentioned) that any irregularity in the pump turbine is a sure sign that something is wrong. On the other hand, as long as the turbine is going smoothly one can rest with a fair degree of certainty that this part of the equipment is working all right. This fact became so apparent to the attendants that they formed the habit of watching the governor arm on the pump turbine at all times when not actually engaged in performing their other duties.

The apparatus mentioned in the beginning of this article simply acts as a warning to attendants and can be heard from any part of the turbine room or basement. It consists of a small whistle screwed into the top of the governor valve and actuated by the governor arm (see illustration). It has been in operation about a year, and the results have been most gratifying, so good in fact that the vacuum on this unit has not been lost since from any of the foregoing causes, due to a timely warning and good work by the attendants. It is so constructed that it can be adjusted to sound an alarm whenever the governor arm comes within any desired distance from the stop. The sketch is self-explanatory.

Yarway Adjustable Spray Head

When cooling water for condensing purposes can be obtained from a convenient river or lake, there is no necessity for installing means for cooling it. But when the supply is limited, so that it is necessary to use the water over and over again, artificial recooling must be employed. There are two common methods of cooling circulating water—one by means of cooling towers, the other by means of cooling ponds in which the water is stored after passing through a number of spray nozzles that break up the water that comes to them under pressure.

In Fig. 1 is shown a spray pond[1] the spray nozzles of which are adjustable. They are known as the "Yarway" adjustable spray heads and are manufactured by the Yarnall-Waring Co., Chestnut Hill, Philadelphia, Penn. Details of their construction are shown in Fig. 2. The distinctive feature of this spray head is that it is adjustable with regard to the fineness of the spray obtained at any given pressure. Therefore it can be set to secure the maximum cooling range under any condition of temperature or humidity, for a minimum loss of water by driftage due to wind and for maximum efficiency of partial loads. Because of these features the full area of the pond can be used with all of the nozzles nearly closed, Fig. 1, before it is necessary to cut any of them out of service.

Referring to Fig. 2, the head consists of a cast-iron body *A*, in the top of which a 3¼-in. o. d. bronze tube *B* is secured which carries a cap through the center of which the stem *D* passes. A helical opening of coarse pitch is cut in the tube *B*, the water to be sprayed leaving the nozzles through this slot. The opening is cut at an angle of about 60 deg. with the axis of the tube so that the water is thrown upward at the same angle.

The rod *D* is adjusted to the cap *C* by a locknut *E* and moves in a close clearance brass bushing *F* that is provided in the body casting. A pin in the end of the stem engages a bell-crank lever *G*, pivoted at *H*. The lever end of the vertical arm is attached to the main adjusting rod at *J*. By moving this rod one way or the other, the stem *D* is raised or lowered, thus opening or closing the spiral slot in the cylinder *B*.

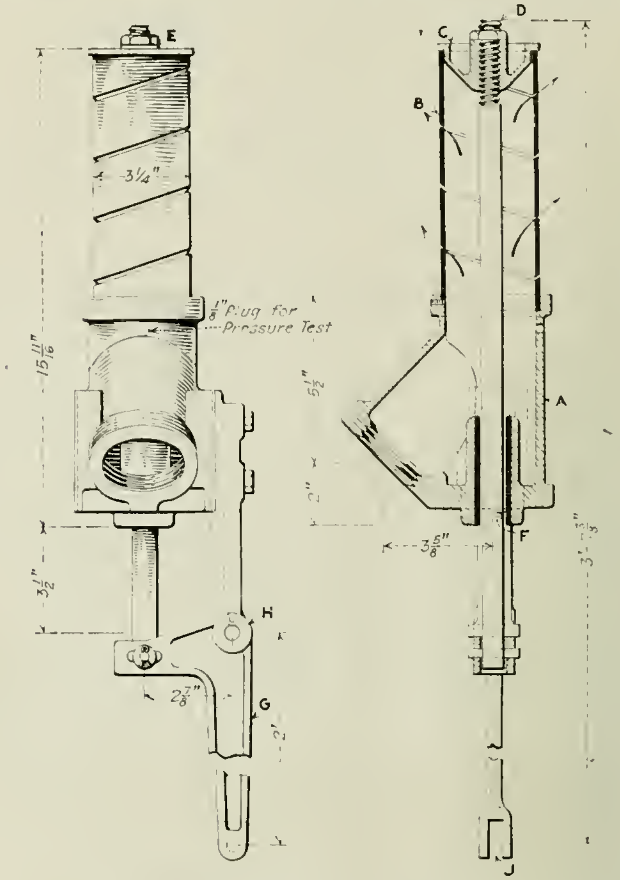


FIG 2. DETAILS OF THE "YARWAY" SPRAY HEAD

The result of this is to increase or decrease the fineness of the flow of water as it leaves the head. The water is discharged in an upwardly inclined direction in a continuous sheet which becomes finer as it spreads and finally breaks up into a uniformly fine spray or mist, or into a large number of small drops, depending upon the size of the opening to which the head had been adjusted. The method of connecting the spray-head levers to the operating rod is shown in Fig. 3.

As shown in Figs. 1 and 4, the spray heads are secured to branch pipes which connect with a main header, the branches being of succes-

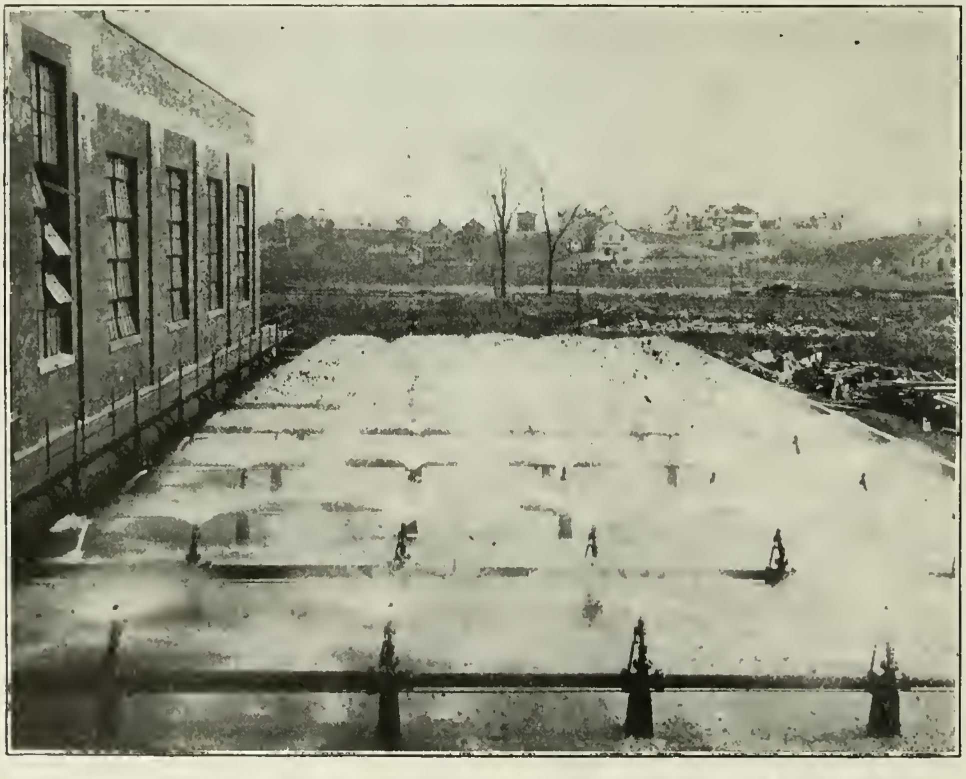


FIG. 1. "YARWAY" SPRAY-HEAD INSTALLATION, HEAD COMPRESSED

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[1] Reproduced by courtesy of Walter Kidde & Co., Inc., engineers and constructors, New York City.

sively decreasing diameters. The adjusting lever of each row of spray heads is connected to a main ¾-in. iron pipe, to the end of which is fitted a saw-tooth regulating lever, the saw teeth being for the purpose of holding the rod for any adjustment of the spray head. This lever extends to the shore, and by a pull or a push on it all the heads in that row are either closed or opened. These rods can be seen in Fig. 4, where the spray heads are adjusted for a greater spraying capacity than in Fig. 1, where the spray is throttled. The spray pond, Fig. 4, is at the plant of the Moore Steam Turbine Corporation, Wellsville, N. Y.

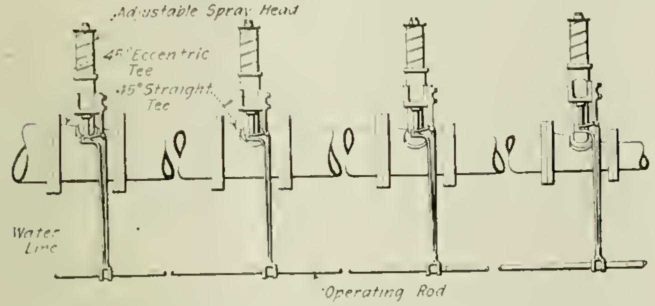


FIG. 3. ARRANGEMENT OF THE OPERATING ROD

In Fig. 1 there are shown nine spray heads with a total of 45 spray nozzles. The cooling pond is about 75 ft. wide and 180 ft. long. The main branch is 24 in. diameter and the branch pipes begin at 8 in. diameter and reduce to 4 in. These 45 spray nozzles with a 23-ft. head take care of the water necessary for condensing the steam from three 750-kw. turbines at the plant of the American Hard Rubber Co., Akron, Ohio, and are sufficient for about 35,000-kw. turbine capacity.

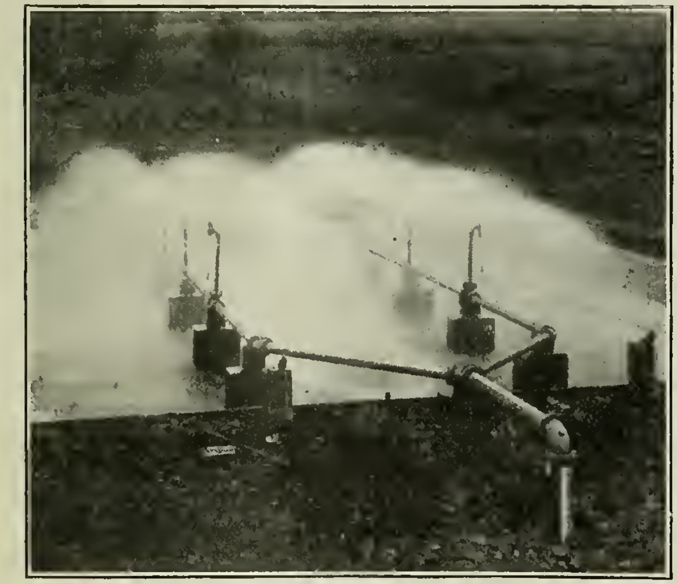


FIG. 4. A SMALL INSTALLATION SPRAYING UNDER NORMAL CONDITIONS

Gas-Engine-Valve Problems

By G. W. Muench

The buying and selling of used gas engines is a business of enormous proportions at the present time. Hundreds of these engines are bought by men who know nothing about them. A demonstration is asked for, the engine runs without knocking, and apparently everything is as it ought to be. Even the man who knows something about internal-combustion motors, however, often gets misled by one serious trouble, the valve setting. The engine may be working very well without a load or with a light load, but will not carry anywhere near full load. There are many possible causes for poor valve settings, such as wrong meshing of the gears; wrong adjustment of the push-rods; worn push-rods, cams, valve stems, gear teeth and other parts of a valve gear. The valve setting of a gas engine is about as follows:

The inlet valve should open 5 to 15 deg. past the inner dead-center and should close from 20 to 35 deg. past the outer dead-center. Exhaust valve should open about 30 to 40 deg. before the outer dead-center and should close at about inner dead-center to 10 deg. past.

Frequently, an attempt is made to make a gas engine develop a greater power than it is designed for, by changing the governor adjustment to allow the engine to operate at a higher speed. This can be done to only a limited extent. After the speed has been reached at which engines will develop maximum effort, the power of the engine will decrease if the speed is increased beyond this point. The reason for this is, the valve can take care of only a certain amount of gas in a given time, since the speed of the gases passing through the valves is limited. There is a difference of opinion as to this limit. One good authority gives the limit of the ingoing gases at 6000 ft. per min. and the exhaust gases 5000 ft. per min. These figures refer especially to stationary engines.

Assuming that the gases in the cylinder travel as fast as the piston, it is easy to figure the velocity of the gases through the valve opening as follows:

$$v = \frac{D^2 V}{d^2}$$

where v equals velocity of gases through valve passages in feet per minute, D equals diameter of cylinder in inches, d equals diameter of valve passage in inches, and V equals velocity of piston in feet per minute.

The foregoing affords a means of finding what approximately would be the speed limit of a particular engine. For example, an 11 x 12 engine having 4-in. valve openings and rated at 300 r.p.m., is to be increased in speed 10 per cent.; that is, to 330 r.p.m. The engine has a 12-in. stroke and is to operate at 330 r.p.m. This is equivalent to a piston travel of 660 ft. per min. In calculating the velocity of the gas in the valve chambers, it is assumed that in the cylinder the gas is traveling at piston speed, in this case 660 ft. per min. Then, by substituting the foregoing values in the formula, the velocity of the gases through the valve opening is

$$v = \frac{11^2 \times 660}{4^2} = 4991\,ft.$$

or approximately 5000 ft. per min.; therefore this increase in speed might be permitted, as it brings the speed about up to the allowable figures for the exhaust valve. Of course other factors enter as to the advisability of increasing the engine speed, especially the safe flywheel speed.

If the speed of an engine is materially changed, it might also be advantageous to somewhat change the valve setting. However, this may not be an easy matter, since, in many heavy-duty stationary engines the setting cannot be changed. Sometimes both valves are adjustable, but oftentimes only one can be changed. In resetting the valves, it must also be remembered that when a valve is adjusted by changing the length of the push-rods, if the valve is made to open earlier it will close later and vice versa, but if the valves are made to open and close earlier or later by changing the setting of the camshaft gear, all the valves will be affected the same in both closing and opening.

Another interesting valve problem is the division of the cycle according to the valve setting. Since it requires four strokes to complete the cycle of a 4-stroke-cycle gas engine, it is often thought that each performance of the cycle requires one stroke. This is, however, not the case. Take for example, the following setting. Intake opens 15 deg. past inner dead-center, intake closes 25 deg. past outer center; exhaust opens 40 deg. before outer center and closes 10 deg. after inner center. The complete cycle is 720 degrees. The intake opening at 15 deg. after inner dead-center and closing 25 deg. after outer dead-center is an angle of 190 deg., or about 26.4 per cent. of the cycle in suction. Between the closing of the intake and inner dead-center is the compression, 155 deg., or about 21.5 per cent. of the cycle. From dead-center to the exhaust valve opening 40 deg. before outer dead-center is the power stroke, 140 deg., or nearly 20 per cent. of the cycle. From exhaust opening to closing at 10 deg. past inner center is the exhaust stroke, 230 deg., or nearly 32 per cent. of the cycle. From this it is seen that almost one-third of the entire cycle is devoted to exhaust.

Air-Compressor Troubles

By Ray J. Bailey

Some time ago a small motor-driven vertical air compressor was installed in a certain boiler-room where there was considerable dust due to handling coal and ashes. It was necessary to extend the 1½-in. inlet pipe outside of the building. As the unloader *A* was of sensitive construction and as the least bit of dirt would make the pistons stick, causing poor regulation, considerable power was wasted because of the safety valve on the receiver releasing continually.

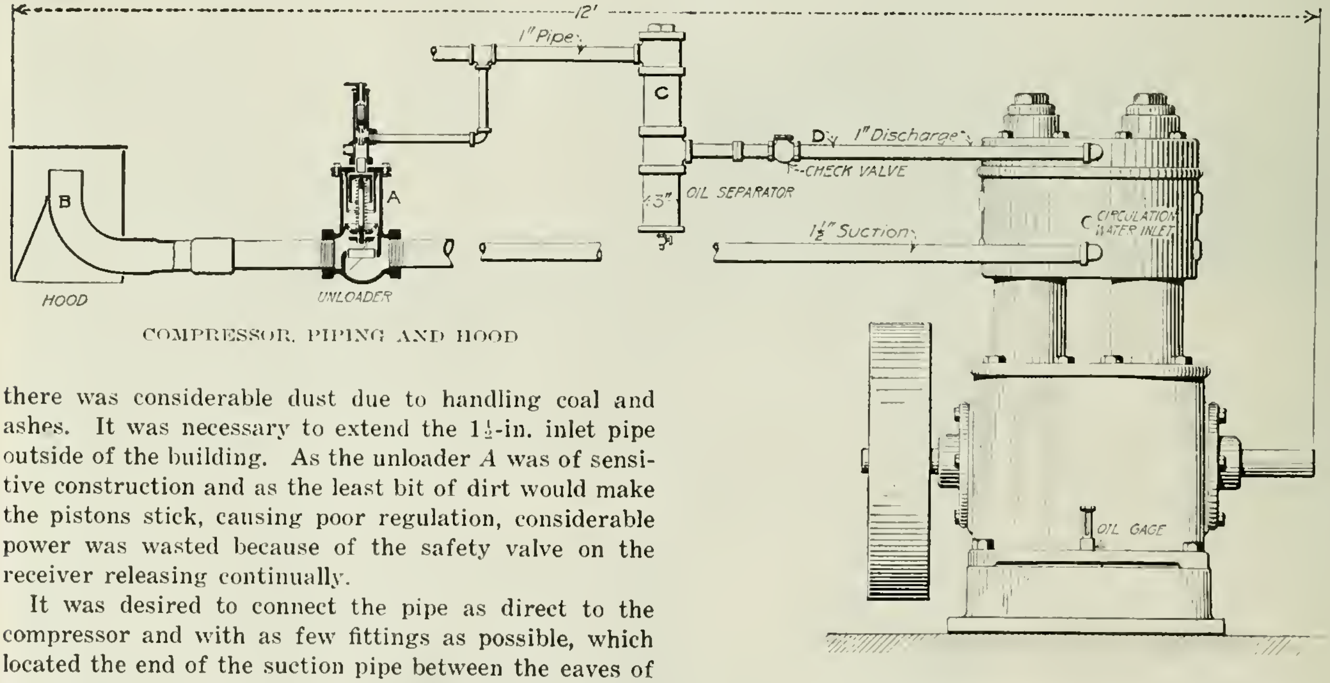
It was desired to connect the pipe as direct to the compressor and with as few fittings as possible, which located the end of the suction pipe between the eaves of three roofs. To keep it free from water and other obstructions, a hood was made, as shown at *B*, from 6-in. galvanized sheet-metal pipe with a 2-in. sheet-metal pipe on the inside soldered to a 2-in. galvanized pipe nipple. These parts were all taken from used material found about the factory. This arrangement has worked satisfactorily for nearly a year, and it has never been necessary to clean out the unloader nor has there been any trouble from poor regulation.

For lubricating the cranks, crosshead pins and pistons, four or five gallons of a certain quality of engine oil was put in the crank case when the machine was first installed. After a few days the oil was found unsuitable for this class of work, because, being thin, it would work past the pistons—which are exposed at the crank end—to the oil reservoir and about one pint per ten-hour run would pass through the valves and discharge pipe, burning on the valve stems and springs and causing them to stick and hold away from their seats. A portion of the burned oil would work into the unloader and make trouble.

An oil separator *C* was made from pipe fittings and two 3-in. nipples, each 6 in. long. A special air-compressor oil was used, and no further trouble has been experienced; less than one ounce of oil gets into the separator in thirty days.

Considerable advantage was gained by using a check valve in the 1-in. discharge pipe *D* when it was necessary to shut the machine down to examine the valves or to do work on the machine under pressure. It also serves to take the strain off the discharge valves due to the hammering effect when closing.

Several swing checks were used, which lasted but a week or ten days before the disk and seat had to be faced off and fitted so they would not leak. A horizontal globe check valve was then used, with the disk guided by a stem above and another below the seat. After being in service about four weeks, an examination showed that the stem and guide under the disk had worn away, the disk and upper stem and guide being in fairly good condition.



COMPRESSOR, PIPING AND HOOD

A check valve of the dashpot type is recommended as the best for this service, in which the upper part of the valve disk is connected to a dashpot, which will prevent its slamming.

Ethics of Sales Engineering

By WALTER G. STEPHAN

A sales engineer represents both the purchaser and the manufacturer, and although it is his business to sell, it is just as consistent with good ethics to counsel against a purchase of his apparatus when conditions are not suitable as it is to advise the purchase of his apparatus when it will supply the needs better than anyone else's. The ethics of salesmanship is discussed from various interesting angles.

THE tremendous industrial expansion in the United States during recent years has brought a most interesting and profitable field of work to the technically educated engineers; namely, the work of the sales engineer. So many new devices and improvements in the various arts have been developed that the manufacturer has gladly called into his organization men with engineering training, who have initiative, confidence in themselves and the ability to persuade others to buy and properly use new things possessing merit. As a result many able young men are successfully following this profession and securing through their work much of the satisfaction that should come to a man through a useful business life.

HIS DUTIES DIFFERENT FROM THOSE OF THE ORDINARY SALESMAN

This army of young salesmen are mostly men who wish to transact business on a sound business basis and who are following a code of ethics of their own which is more or less the result of their previous training and experience. So far as is known, there is no treatise on engineering salesmanship that covers satisfactorily the work of the sales engineer. His duties are sometimes quite different from those of the ordinary salesman. For example, occasionally he has to deal through a consulting engineer, an intermediary between his company and the ultimate purchaser, with whom other salesmen do not come in contact.

Sales experience has gradually formulated a code of ethics regarding the right and wrong way to try to sell first-class power-plant equipment, and this article is an endeavor to provoke a discussion of the subject for the benefit of the selling fraternity as well as the buying public.

The sales engineer represents two parties, each of which is equally concerned in the sale—the purchaser and the manufacturer. And he should be equally concerned to see that both receive fair treatment and that neither is taken advantage of by the other. If there is to be any preference, he should favor the purchaser, for the reason that no obstacles should be permitted to grow up in the path leading from the buyer to the sales office. The door for future business should be easy for the purchaser to open, and he should feel that it is a pleasure for him to open it.

A purchaser is naturally inclined to buy from the seller with whom it is pleasantest to do business. The same line of reasoning applies in the case of the hotel management which uses as its motto in matters of dispute, "The guest is always right." It is not meant by this that the salesman should permit the purchaser to take a great advantage in the transaction, but it is meant that if there is a reasonable question of doubt, the purchaser should be given the benefit of that doubt.

The importance of giving the buyer the benefit of a salesman's experience cannot be emphasized too strongly. It is just as consistent with good ethics for him to advise a prospective purchaser not to buy his apparatus when he knows from experience that the conditions are not suitable, as it is to advise the purchase from the company he represents when he knows he can supply the buyer's needs better than anyone else or equally as well. In fact, it is frequently found that by conscientiously advising a purchaser to buy just the right thing from a competitor, the salesman can and has immensely strengthened his hold upon the buyer's confidence.

HIS WORK JUDGED BY SERVICE RENDERED RATHER THAN BY SALES MADE

If a salesman is merely interested in selling and is not desirous of performing some real service to society, he will fail to get all he could out of his work. After all is said and done, his work will be measured by the "service rendered" and not by the sales made. The man who is concerned only with making the sale is a mere "peddler," and not worthy of the name of sales engineer. His vision is not broad enough to see the transaction from the viewpoint of the purchaser as well as from that of his firm. He sees only his own immediate remuneration and not his ultimate gain. He should be quick to recommend against a bad purchase and should just as carefully avoid a bad sale. He should seek to carry through transactions that will be mutually advantageous to the purchaser and the manufacturer.

It sometimes happens that, notwithstanding a conscientious recommendation against the purchase of a sales engineer's apparatus, for apparently good and sufficient reasons, conditions obtain later which would have justified the sale. For example, the entrance of the United States into the present war has already changed conditions in many plants beyond the imagination of the most astute business minds. In such instances the salesman can console himself with the knowledge that he followed the dictates of his best judgment.

It sometimes happens that an operating engineer learns that one of the plants in his neighborhood is about to purchase certain equipment. Knowing that a certain salesman's machinery has given him splendid service and wishing to help both his neighbor's plant and himself, he offers to assist in making a sale, provided the salesman is willing to pay him for such service. It is a question of ethics whether it is right to agree to do this. If the engineer can conscientiously recommend the apparatus, he is honestly entitled to remuneration for his assistance in selling. However, it is much better for all concerned not to enter into such negotiations. The danger lies not in this transaction, but in possible future affairs. Some subsequent negotiation may come up between the engineer's company and the salesman for a purchase, which will embarrass one or the other and will make the engineer feel under some obligation to buy from the salesman whether it be fully to the advantage of his employer to do so or not.

Whenever it becomes necessary for the manufacturer's representative to sell through the office of a consulting engineer, other problems present themselves for solution along ethical lines. It is taken for granted that when a manager employs a consulting engineer to build or extend his power plant, he delegates him to recommend what kind and make of apparatus is to be bought. In other words, he says to the consulting engineer: "I don't know a thing about boilers, stokers, engines or turbines. You do. Tell us what we should buy and see that a plant such as we will need is built."

His Statements to the Consulting Engineer Should Be Perfectly Frank

The consulting engineer, in preparing specifications for bidders, sometimes calls in several sales representatives in order to discuss the specifications with them or the limiting features of his plant and to make sure that the work of the various contracts will join together to make a complete whole.

Under such circumstances the salesman will find a perfectly frank statement from him to be most acceptable to the broad-minded engineer. If he finds that the consulting engineer is making inadequate provisions anywhere or that his apparatus is not suited to the conditions, a free discussion of the matter will be appreciated. To a certain degree the consulting engineer is somewhat analogous to the general practitioner in medicine, and the experienced salesman corresponds to the specialist. He is, therefore, the specialist or one of several specialists. Very few consulting engineers are buying all kinds of power-plant equipment so continuously that they are able to keep strictly "up to the minute" on the latest developments in the art. The salesman is, or should be, one of the best-posted men in his line, with some such motto as this before him:

> "If a cobbler by trade, I'll make it my pride
> The best of all cobblers to be;
> And if only a tinker, no tinker on earth
> Shall mend an old kettle like me."

A salesman should not endeavor to see that the engineer's specifications are so worded as to give him great preference or advantage in the bidding. Specifications should be written so as to exclude such articles as are not suited to the plant and should permit of a choice by the purchaser between not less than three reputable manufacturers, if possible. Honest competition hurts no one, and if an apparatus can't stand on its own merit in fair and open comparison, don't waste time trying to sell it. Life is too short.

Going Over the Engineer's Head

There is great temptation, after specifications have been issued by the consulting engineer, for the salesman to seek an interview with the ultimate purchaser in order to secure additional influence in favor of his equipment. This is commonly called "going over the engineer's head" and, naturally, is resented by him. The only ethical way to proceed, if there is any reason whatever for desiring to talk to the man who will finally sign the order, is to go to the consulting engineer, state the case frankly and take his advice. While in some cases one may be able to secure business by going over the engineer's head, it certainly will not help to get further specifications to bid upon from the engineer's office. Consulting engineers are just as human as are others.

If for any reason it becomes evident to the salesman that he is repeatedly being discriminated against by the engineer's specifications, and he has endeavored courteously on several occasions to dissuade the consulting engineer from this course, then there is no further reason for avoiding an interview with the ultimate purchaser in which can be stated diplomatically but frankly the reasons for taking such a step.

The most difficult problem for the sales engineer is undoubtedly the prospective sale to a municipality. Most men "hate a municipal job." The reason for this is that so many incompetent persons are usually concerned with the municipal purchase, and so many conflicting interests are involved, that there is no reasonable probability that the best bidder will get the contract. Boards of public service composed of several men and sometimes councilmen in addition, interest themselves in a large contract for power equipment—and very properly so—but they do not leave the decision as to the technical merit of differing bids to the proper person, namely, their engineer. Consequently, there is frequent accusation of graft in connection with the public letting of contracts. It is believed, however, that there is, at the present time, very little of the old-time "grafting" for the very good reason that a higher code of ethics obtains among both public officials and salesmen. Engineers in public office are showing a commendable courage in writing specifications so as to permit only those who manufacture suitable apparatus to bid. It is a weakness on the part of an engineer to write specifications so open that anybody and everybody can bid. It is a confession of his inability to specify.

The Sales Engineer Should Be Governed by a Sense of Public Duty

Furthermore, it is wrong to encourage a manufacturer to spend the time and money necessary to make up a bid when he has no chance whatever to benefit by it. Therefore, a salesman should urge engineers to limit the bidding to manufacturers of suitable apparatus even though by so doing he excludes his own company from bidding. Let him be prompted by as fine a sense of public duty as he can muster in matters that concern the American municipalities and frown down all attempts to misappropriate public funds.

Finally, let him bear in mind that the work that he is doing is a splendid work of education and that he is really doing pioneer service by educating able, wide-awake managers and engineers to practice better economies in natural resources, in labor and in time. Let him also uphold the dignity of his profession by giving fair and courteous treatment to others and by insisting upon fair and courteous treatment himself.

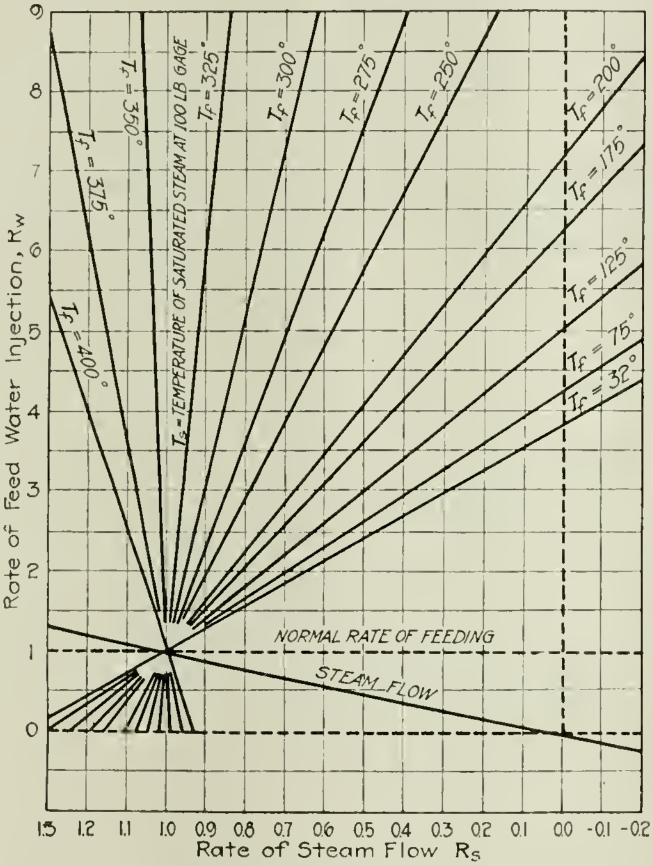
The remarkable effect of the buying of War-Savings Stamps has been the development of a finer sense of thrift and economy among the people.

Effect of Feed-Water Temperature and Rate of Injection Upon Steam Flow

By FRANK G. PHILO*

The author has plotted an interesting chart showing the effect on steam flow of the feed-water temperature and rate of feeding. Under any given condition the actual output of the boiler, expressed in B.t.u. absorbed per unit of time, is constant regardless of the rate of feeding and the temperature of the feed water.

INTERESTING data upon the changes of rate of steaming due to varying rates and temperatures of feed-water injection are shown upon consulting the steam tables and plotting results in graphical form shown by the chart accompanying this article. Under any given condition the actual output of the boiler expressed as B.t.u. absorbed per unit of time is constant, regardless of the rate and temperature at which the boiler feed water is injected. However, boiler output expressed in pounds of steam per unit of time varies widely with changing feed-water temperature and rate of feed-water injection, being highest when no water is being fed to the boiler and lowest when the feed-water temperature is very low and the water is injected at a high rate. When the feed water is fed into the boiler at the same rate at which the boiler is steaming, the normal condition will be considered to exist and the amount of water in the boiler will be constant. Any rate of feed-water injection above or below normal will increase or decrease the rate of boiler steaming and the amount of water in the boiler. Shutting off completely the supply of feed water will appreciably increase the rate of steam flow. On the other hand, any increase above the normal rate of feed-water injection will reduce the rate of steam flow; in fact, if the water is fed fast enough, steam flow will cease entirely. A still greater rate of injection will cause a reversal of steam flow from the line if the boiler is not equipped with nonreturn valves. If nonreturn valves are used, the pressure on the boiler being fed at this abnormally high rate will drop below line pressure. The aforementioned effects are most noticeable when very cold water is used and when the rate of steaming is low. An interesting example of the reverse effect of temperature of feed water is in cases where economizers are used and the temperature of the feed water is equal to or greater than, in some cases, the temperature of water in the boiler.[1] When the feed temperature is the same as the temperature of the feed water in the boiler, feed-water injection does not affect the rate of steaming. When the feed water is actually higher in temperature than that in the boiler, an increase in steam flow occurs upon feeding water into the boiler. The following formulas and the



EFFECT OF FEED-WATER INJECTION ON STEAM FLOW

Feed Water Temp., Deg. F.	B.t.u. at 100 Lb. Gage H	B.t.u. at 100 Lb. Gage L	B.t.u. at 100 Lb. Gage h	Rs, Rate of Steaming								Rs When Rw Is Zero
				−0.20	0.00	0.20	0.40	0.60	0.80	1.00	1.20	
				Rw, Rate of Feeding								
32	1,189	880	309	4.41	3.84	3.28	2.71	2.14	1.57	1.00	0.43	1.35
50	1,171	880	291	4.63	4.03	3.42	2.81	2.21	1.61	1.00	0.39	1.33
75	1,146	880	266	4.97	4.31	3.64	2.99	2.32	1.66	1.00	0.34	1.30
100	1,121	880	241	5.38	4.65	3.92	3.19	2.45	1.73	1.00	0.27	1.27
125	1,096	880	216	5.89	5.07	4.24	3.44	2.63	1.81	1.00	0.19	1.24
150	1,071	880	191	6.53	5.60	4.68	3.76	2.84	1.92	1.00	0.08	1.22
175	1,046	880	166	7.36	6.30	5.24	4.18	3.12	2.06	1.00		1.19
200	1,021	880	141	8.49	7.24	5.99	4.74	3.49	2.24	1.00	......	1.16
225	996	880	116	10.10	8.59	7.06	5.55	4.03	2.50	1.00	......	1.13
250	971	880	91	12.60	10.67	8.73	6.81	4.87	2.93	1.00	......	1.10
275	946	880	66	16.91	14.36	11.66	9.00	6.33	3.66	1.00	......	1.07
300	921	880	41	26.76	22.46	18.17	13.88	9.58	5.26	1.00	......	1.04
325	896	880	16	67.00	56.00	45.00	34.00	23.00	12.00	1.00	......	1.01

Feed Water Temp., Deg. F.	H	L	h	Rs, Rate of Steaming						Rs When Rw = Zero
				1.00	1.20	1.40	1.60	1.80	2.00	
				Rw, Rate of Feeding						
350	871	880	−9	1.00	20.55	40.11	59.64	79.22	98.77	0.99
375	846	880	−34	1.00	6.18	11.36	16.54	21.71	26.89	0.96
400	821	880	−59	1.00	3.98	5.96	9.94	12.92	15.90	0.93

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*Chief Engineer, Station A, New York Steam Co., New York City.

[1] Possible, due to the higher water pressure in the economizer.

accompanying chart and table will show the magnitude of the foregoing effects.

H = Total heat above feed-water temperature of one pound of steam;

L = Latent heat of one pound of steam under given conditions plus B.t.u. for superheating one pound of steam (if superheated):

h = Heat of feed water from feed temperature to boiler temperature;

R_s = Rate of steaming:

R_w = Rate of feed-water injection.

1. With feed water shut off entirely, $R_s = \frac{H}{L} = 1 \quad \frac{h}{L}$.

2. The rate of feed-water injection that would decrease steam flow to the rate R_s would be $R_w = 1 + \frac{L - R_sL}{h}$.

3. The rate of feed-water injection that would cause steam flow to cease, $R_w = 1 \quad \frac{L}{h}$. ($R_s$ = *zero.*)

4. Under any given condition the sum of the heat absorbed by the feed water and the heat used in boiling the water equals the total heat, or H absorbed by the boiler. As a formula this would be written $R_s L + R_w h = H$.

For examples of the foregoing take the conditions of 100 lb. gage, saturated steam, and 60 deg. F. feed-water temperature. Then $H = 1189 - (60 - 32) = 1161$ B.t.u.; $L = 880$ B.t.u.; and $h = 281$ B.t.u.

1. $R_s = \frac{H}{L} = \frac{1161}{880} = 1.32$, the rate of steaming with no feed.

2. Let $R_s = 50$ per cent., then $R_w = 1 + \frac{L - R_sL}{h} = 1 + \frac{880 - (0.5 \quad 880)}{281} = 2.57$, the rate of feed required to reduce the rate of steam flow to 50 per cent. of normal.

3. $R_w = 1 + \frac{L}{h} = 1 + \frac{880}{281} = 4.13$, the rate of feed required to stop steam flow.

As shown by the table and chart, variable feed-water injection with a steady load is disastrous to uniform steam pressure. Variable steam pressure, in turn, causes juggling of fires and short periods of loafing with consequent loss in efficiency of boilers and auxiliaries. However, with loads that have a periodic fluctuation, as in rolling mills, variable feed-water injection, if properly handled, aids the maintenance of the steam pressure. When the load is high the feed is decreased, and as the load drops the feed is increased, utilizing the heat absorbed by the boiler and admitting of fairly constant furnace conditions. This condenser action or heat-storage effect of the feed water is quite appreciable and is taken advantage of by intelligent water tenders. The matter of correct boiler feeding in the majority of cases is not given the attention it deserves, as the results of improved methods of boiler feeding are felt in the operation of the whole station as well as in the size of the coal pile.

The Fuel Administration points out the serious fuel shortage; careful feeding of water to boilers has its share in making up for this shortage of 80 million tons.

Reminiscences of a Boiler Inspector

By R. E. McNamara

While on the road making boiler inspections in the usual way, I once mailed a form card to a certain boiler user, giving notice of my intended visit, and designating the boilers I desired prepared for internal inspection on a certain date, about seven days later. I named a legal holiday and took special pains to see that nothing should interfere with my plans.

Arriving in the village in the evening I called up the superintendent of the plant and asked him if he had received my card and if the boilers would be ready, also if the plant would be running next day. He said that the plant would be running next day as usual notwithstanding the holiday, that the boilers were hot and could not be spared, that he had received my card, but that no arrangements could be made for inspection at that time. I therefore decided to make an external inspection only, so I walked out to the plant next morning, giving myself just about time enough to make an external inspection and catch the morning train. Passing the office of plant on the way, I dropped in. The superintendent was in, and I recalled the telephone conversation of the previous evening, remarking that as it was then only about 7 o'clock perhaps the engineer was not yet at the plant, but was told that the engineer was there and that there would be no trouble in getting in. Arriving at the plant imagine my surprise at finding that the group of boilers I especially desired to inspect were not only not hot, but had been idle for two months. The plant was not running, and there was not a man excepting the watchman to be on the premises that holiday. I routed the engineer out by telephone, and after his arrival he informed me that if he had known of my visit, the two remaining boilers could have been cooled off for inspection as well as not, for they were simply kept warm for emergency.

It is hard to imagine a superintendent, in daily and actual contact with a plant, not knowing more of the details than that. My first and very strong thought was that he had deliberately ignored my card and wilfully misled me in his statements, for it does not seem reasonable that any sensible and intelligent man could or would try to give plausible excuses for apparent contradictions of this kind. From what I afterward learned, however, I am convinced that he was honest in his statements and that it was a peculiar combination of circumstances that need not now be entered into that caused him to tell me what were in reality misstatements and grossly erroneous answers to my questions. Marvelous is the product known as human nature.

At another time, I recall, the date for the internal inspection of a plant had been set for a certain Sunday; that is, we had mailed the owner a card giving that date, for we knew that Sunday was the regular washout day. Arriving at the plant (which was about four miles from the regular path of travel, requiring a livery rig to reach it), I found the place locked up, with high brick walls all round and no apparent mode of entrance. Scouting around the neighborhood, which was new to me, no information concerning the superintendent or engineer could be had. Returning and walking around the premises again, I noticed that the cleanout door of the combustion chamber opened directly to the commons or field and that the combustion chamber had been cleaned that morning or at least very recently.

Not wishing to lose the time and trip, I made a change of clothes in the buggy, opened the combustion-chamber door and took the risk of being able to crawl over the grates into the boiler room. Fortunately, no trouble was experienced and entrance to the engine and boiler room was easy. The top manhole was open and a ¾-in. hose was pouring city water into the boiler which, from the appearance of the floor, had been washed that morning, and judging from the small amount of water in the boiler the cleaners had just left. I drained the boiler, made the inspection and thought to myself what a joke it would be on the management when they discovered what I had accomplished and how. I replaced the hose, turned on the water, crawled out, cleaned up the best I could and returned to the city.

I suppose my readers expect me to relate how I chalked my name on the inside of the boiler as proof or left my card in a conspicuous place to indicate my visit. I regret that this oversight came very near leading to serious complications, for it transpired that the management had not received the notification card and when the internal report reached them, they referred back to the date and at once notified the company that it was impossible for an inspection to have been made for the plant and boiler house were locked up and although it was true that the boiler had been washed on that date, the engineering force had seen nothing of the inspector. My company at once referred the matter to me, and I then saw what a mistake I had made, for it was not at all likely that, ordinarily, one would have used the method and made the inspection as I did, and it was equally as improbable that anyone else could be made to believe that I had resorted to this expedient. I suggested in my letter containing a full statement of the case that the livery-stable driver might add his testimony if asked. I never heard more of the incident other than a warning from my company which at least indicated a doubt on their part. Since then, whenever I find myself in a plant alone or without witnesses when an inspection is made, as a precautionary measure I post my card as proof of my presence. I doubt very much, however, if I will ever again make such a back-door entrance to make a boiler inspection.

Heating System Returns Connected Wrong

By T. W. Reynolds

Connecting heating-system returns as shown in Fig. 1 caused considerable difficulty in a certain large railroad station. There was a 6-in. return from the station proper and a 4-in. return from the express company annex, the 6-in. main running under ground all the way around the building to drain the various radiators. Its elevation was somewhat above the receiving tank except for the portion that ran along the boiler-room floor to connect with the receiving tank. Radiation in the annex is overhead, and the 4-in. return from these coils is also overhead and at a considerably greater elevation than the 6-in. return to which it is connected at its lowest point near the receiving tank as shown in Fig. 1. The boiler-feed pumps take their suction from this tank, 3 ft. 6 in. in diameter and 5 ft. high. Any necessary makeup water is admitted to the tank by means of an automatic feeder. Steam is circulated throughout the heating systems without interference; that is, there are no steam traps or automatic valves on the returns and there is therefore practically the same pressure in the return as in the supply.

The annex is a narrow, low building about 500 ft. long, the front of which is practically all doors, so that during the rush hours from 4 to 6, morning and afternoon, these doors are all opened and the heating requirements are greatly increased. Because of this demand for steam the pressure is lowered, consequently the condensate does not flow back freely when retarded by the higher pressure within the station return. This resulted in flooded radiators with hot water as a heating medium rather than steam and at a rapidly decreasing temperature. Therefore, when most needed, the heating system failed to heat the annex. Furthermore, the flooding extended to the lower portion of the station return until the static head in the 4-in. return balanced the greater steam pressure in the 6-in. main. Later, the flow of condensate surging back to the tank would cause it to overflow and waste through a pipe leading to a sump. This sump contained a cellar drainer of insufficient size for such large quantities of water, so that the boiler-room floor was soon flooded.

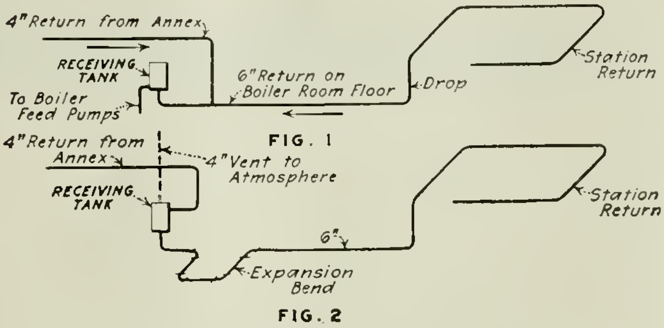


FIG. 1

FIG. 2

FIGS. 1 AND 2. CHANGES IN RETURNS FROM TWO BUILDINGS

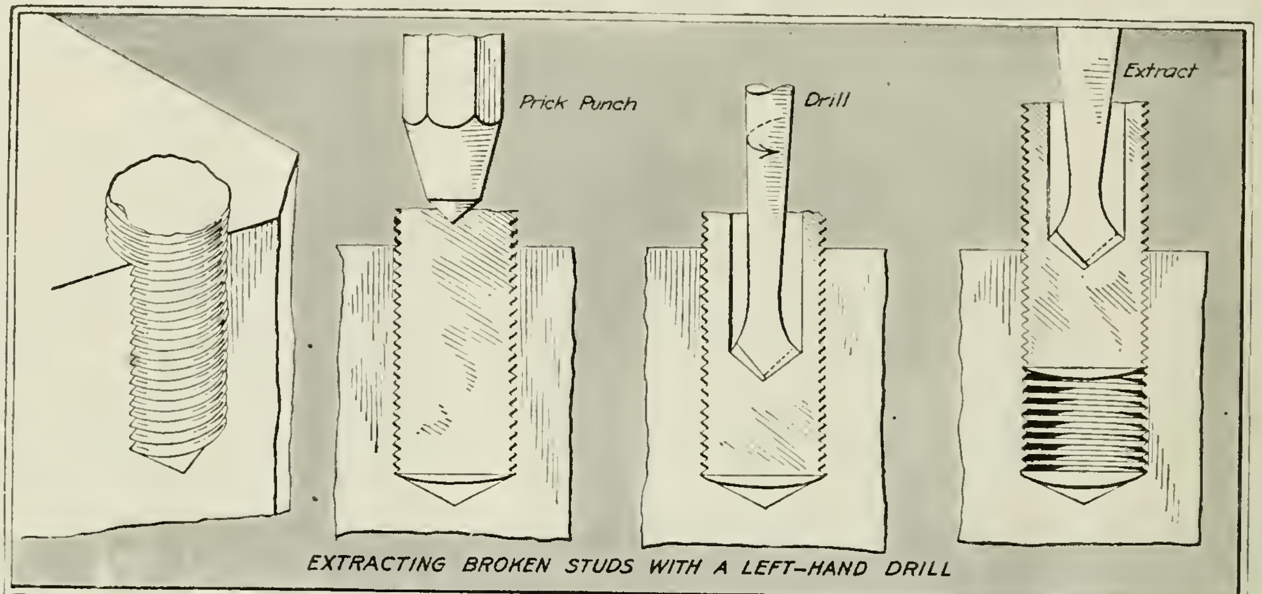
Fig. 1—Returns join before entering receiving tank. Fig. 2—Return lines connected to tank separately

Under such conditions the colder water from the annex mingling with the hotter water from the station created extreme water-hammer, sometimes extending to remote points within the building, and the movement of the 6-in. return caused a considerable stress. The water-hammer was greatest at the receiving tank and was of such force as to cause alarm; the brick foundation under the tank cracked and spread; fittings and joints leaked or were cracked, requiring frequent renewals.

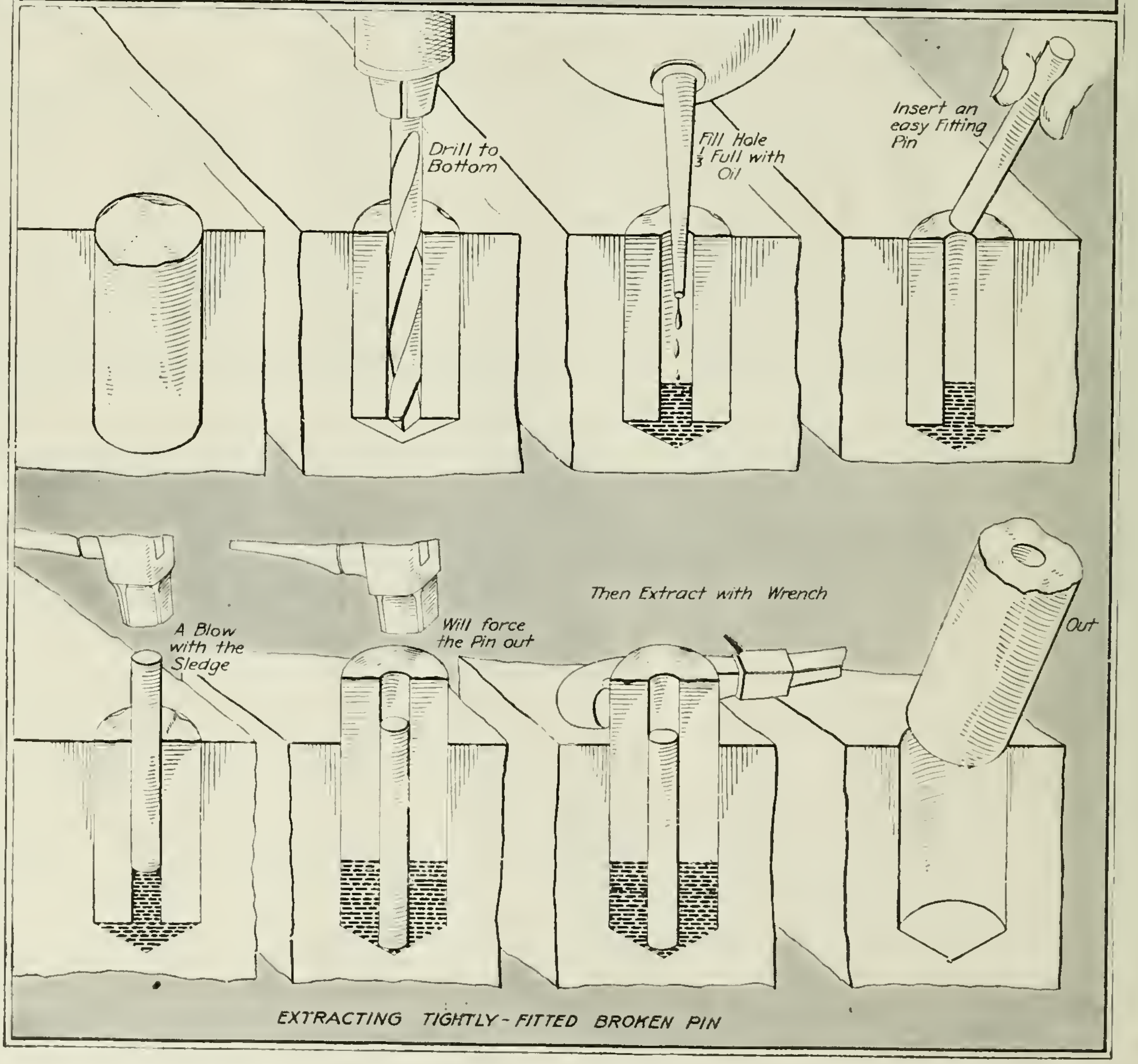
The remedy was simple and was made as shown in Fig. 2. An expansion loop of four ells was placed in the 6-in. return; the brick foundation under the receiving tank was replaced with iron-pipe standards flanged to the floor and tank. The two returns were connected separately into the tank, the one from the annex near the top, the other, as before, at the bottom. A 4-in. vent was run from the tank to the atmosphere, relieving the back pressure that slowed up the returns and the water-hammer was eliminated.

From an Engineer's Notebook

By M. P. Bertrande



EXTRACTING BROKEN STUDS WITH A LEFT-HAND DRILL



EXTRACTING TIGHTLY-FITTED BROKEN PIN

Editorials

The Vanishing Factor

THE average steam boiler under pressure possesses about as much potential power for destructiveness as a healthy deep-sea mine in the heyday of its existence, and frequently it lets loose all its energy on apparently smaller provocation than would disturb a mine of normal temperament and placid disposition. To offset this tendency toward unexpected and undesirable scatteration, we have adopted the plan of building our boilers with what we call a factor of safety—otherwise known as a factor of ignorance.

Under the circumstances, this procedure is the best that can be devised. We are not absolutely sure that every inch of the steel we use in the construction of the shell has the same characteristics as the test piece. We are not at all certain that the pressure for which the vessel is designed will not be exceeded considerably. Our knowledge of the stresses induced in the shell material by the methods of construction and the heat of the furnace is not so exact as we could wish. So we wrap up all our uncertainties into one package, label it "factor of safety," make everything five or six times as strong as the maximum shown by our calculations and trust that we have made the ante sufficiently high to forestall annoying consequences.

Too often our childlike confidence is shamefully betrayed. But when the coroner has completed his investigation and we have managed to collect the widely distributed pieces of boiler and examine them, we are usually a little better informed as to what causes boiler explosions.

Of course, we know at the outset that the sole cause of boiler explosions is the disappearance of the factor of safety, leaving no margin between the load on the shell and the power of resistance. The great trouble is that we are not yet clever enough to catch it in the vanishing act in all cases. Careful periodic inspection frequently detects it gumshoeing into oblivion, but it still has a tantilizing way of taking French leave.

However, we are considerably wiser than we used to be, for we know to some extent why and where the disappearance occurs. Plenty of explosions have their beginning in cracks along riveted seams. We have discovered, through careful and methodical tests, that when a strip of metal having a transverse hole in it is subjected to tension in the direction of its length, the tensile stress at the edges of the hole may be two or three times as great as the average tensile stress in the full cross-section of the strip.

The drilled plates of a riveted joint are similar to the test bar just mentioned, and we are led to suspect that the cracks which develop into disastrous failures have their beginning in minute fractures along the edges of the rivet holes, due to excessive stresses at these points. If we admit that these extraordinary stresses are perhaps twice as great as that considered in our average calculations, we say farewell to half of our adopted factor of safety on the instant.

In a boiler there is a breathing action due to the change of pressure with the periodic drafts of the engines or changing conditions of service, resulting in what are called repeated stresses. The shell is thus subjected to a series of changes of load, varying between fairly wide limits, and we know from the results of tests on iron and steel that a specimen subjected to a considerable number of alternately varying stresses, even though all of them are within the elastic limit, will eventually fail at a stress having a value of only half or two-thirds the normal strength. Therefore, under the long-continued increase and decrease of pressure of a boiler, a point may be reached where the resistance of the material is reduced to half of what might ordinarily be expected of it, and immediately another considerable fraction of our factor of safety evaporates into thin air.

We have made the discovery that caustic soda has an embrittling effect on mild steel such as is used in boiler construction, this action resulting apparently from the occlusion of hydrogen in the metal. Caustic soda forms a very common agent for the treatment of feed water, and if it is present in the boiler we may expect it to have some effect on the steel under favorable conditions. This embrittling renders the metal less able to withstand the loads put upon it. And so our factor of safety takes a further decline.

Considering these points—and they are far from being a complete catalog of the influences affecting the strength of a steam boiler—we begin to appreciate the reason for the reduction of the factor of safety. The unfortunate part of the whole matter is that we have had to obtain so much of our knowledge of the causes of explosions from costly experience; but, after all, that is exactly how the world has accumulated most of the facts it now possesses.

Camouflaged by Coal Conservation

EVERY good American will applaud the untiring efforts of the United States Fuel Administration to conserve the coal supply, even though the means suggested for the attainment of this end may put him to inconvenience and expense. He realizes that by subordinating his own likes and dislikes he is patriotically doing his share to further the common cause.

On the contrary, he is entitled to voice his disapproval and make an emphatic protest when he sees a ruling of the Fuel Administration made an instrument for building up one group of interests at the expense of another, in violation of all the laws of fair play and with little or no regard for the spirit of the ruling.

Charles E. Stuart, chief of the Power and Light Division of the Fuel Administration, has announced a series of plans for the saving of coal, foremost among which is placed the elimination of uneconomical isolated plants. Elaborating on this particular topic, Mr. Stuart says:

> The individualistic way in which fuel is now consumed in cities is not efficient. A ton of coal burned in a large central station will produce at least four times as much electric power as if burned in the average small plant, and if centralized burning could be introduced to a greater extent, the amount of fuel required could be reduced without reducing in any way the ultimate production of light and power.

No one denies that the central station is able to produce a kilowatt-hour with a smaller expenditure of coal than the small plant; but that is far from being the whole of the story. Electrical power is only one of the products of the heat energy in coal. There is a trinity of such products—heat, light and power—and all three are essential to human comfort and industrial existence.

If the people of this country were like a race of moon-dwellers, capable of enduring the rigors of winter without discomfort, then there might be a general shutting down of isolated plants. But so long as heating is required, just so long will the isolated plant for combined heating and electric generation have undisputed sway in a field in which the central station, with all its vaunted efficiency, cannot successfully compete.

Continuing, Mr. Stuart says:

> It is sometimes the case that in buildings where there are electric plants and where exhaust steam is utilized in the heating of the building and in furnishing hot-water requirements, central-station service can be adopted without a loss of money and at a saving in fuel.

This statement is diametrically opposed to all the results of experience in isolated plants using exhaust steam for heating. It is so completely at variance with the facts that it denotes either astounding ignorance of the subject or a deliberate attempt to distort the truth. In either case it stamps its author as an inaccurate spokesman for a Governmental department whose avowed purpose is to deal intelligently with the coal-conservation problem.

The Fuel Administration has repeatedly stated its intention to impose a minimum of hardship in enforcing fuel conservation. The wholesale shutting down of isolated plants and the compulsory substitution of central-station service would not only be a gross repudiation of that policy, but it would be a national disaster.

The oft-repeated assertion as to the splendid efficiency of the central station resulted in a passive acceptance of the statement. The popular mind became largely obsessed with the belief, just as it took for granted the much-heralded efficiency of the German. But, just as Teutonic efficiency has been shown to be a ridiculously overrated quality—in some cases even a negative quantity—so the preëminence of the central station has been found to exist largely as a state of mind rather than as an engineering fact.

The truth of the matter is that central-station service increases the coal consumption and the expense in any plant that has use for exhaust steam. From the viewpoint of coal conservation, the universal adoption of central-station service would be a huge and costly joke, and the country is in no mood for that sort of diversion at the present time.

The Fuel Administration, probably unwittingly, is in danger of being used by the overzealous henchmen of the central station as a bludgeon to beat the isolated plant into a condition of permanent coma. The isolated plant is painfully aware of its economic weaknesses. It is equally aware of its strong points, and it is well fortified with facts to meet the open onslaught of the central station. But it is at a decided disadvantage in a conflict in which its adversary skulkingly takes refuge behind the bulwark of the Fuel Administration and snipes away like a boche sharpshooter ensconced behind a crucifix.

Those Devil-Hounds

THE hearts of all unhyphenated Americans have been thrilled on reading the accounts of the splendid showing made by our troops in France under the conditions of open warfare brought about by the recent German offensives. It is a style of fighting to which they are adapted by both training and temperament. It makes the conflict a contest of individual skill and courage, in which the American soldier asks no odds of any adversary.

The dash, the intrepidity, the disregard of danger and punishment displayed by the marines in their engagements on the western front heartened and cheered the battle-weary troops of our Allies and electrified the spirits of our people at home. The effect went even farther than that. It taught the boche a wholesome respect for the new fighting element, which the German high command had hitherto affected to regard with sneering contempt; it proved, even to the wilfully blind and thickheaded Teutons, that the forces arriving by the hundreds of thousands from the western world constitute a factor that must be taken into account in the final reckoning; and it earned for those fearless fighters the German appellation of "devil-hounds."

The epithet thus applied becomes a title of merit when interpreted as shown by the artist in the colored supplement to this issue. The marines are hounding and harrying the German beast, and its snarls of rage and hate indicate all too plainly that it has felt the fangs of its tormentor.

It is this beast—the incarnation of all things unspeakable and devilish, glutted with conquest and lusting for further outrages—that stands as a hideous menace to the freedom and happiness of the peoples of the world. For the safety of the generations yet unborn it must be cowed, driven back, overwhelmed and slain. Our marines have splendidly begun the mighty task. Our swiftly arming millions will gloriously finish it.

In history there is one example of physical force, of military might, becoming so strong that nothing but force could overcome it. The Roman Empire reached that stage. It was not conquered; it died of rot; it wrecked itself in the decay of the Middle Ages. The works of civilization of the past were stamped under the oppressor's foot and the world relapsed into barbarism and darkness that lasted during the centuries of the Dark Ages. The world now faces a similar situation; and to prevent it, the military might of Germany must be crushed; otherwise it will die by slow rot, ever so much slower than the Roman Empire because of the science and technique of the oppressor.—*P. B. Noyes, Director Conservation Division, United States Fuel Administration, at annual dinner of the National Electric Light Association, Atlantic City.*

Correspondence

Using a Pitot Tube

Referring to the articles on pitot tubes on page 195, Feb. 5, and page 520, Apr. 9, there are graphic methods often useful for reducing the data to the average velocity head. One method that shows directly the locations in the cross-section of the pipe where it is desirable to take readings near together, for the sake of accuracy, and that gives each observation its proper influence on the result, may be explained as follows:

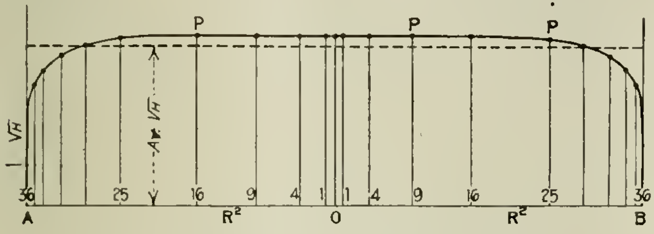


CHART SHOWING AREAS PROPORTIONAL TO FLOW IN PIPES

Since the volume passing a given section is the product of the area of the section and the velocity, these factors being πR^2 and $\sqrt{2gH}$, a plot laid out with values of R^2 and $\sqrt{H}$ as coördinates gives an area that is proportional to the flow. In the illustration, representing a flow of air, *O* represents the center of the pipe and readings *H* are taken by the pitot tube at known distances *R* away from the center across the diameter. Then each reading gives a point *P* located by laying out the distance R^2 from *O* along the base-line, and erecting $\sqrt{H}$ as an ordinate. The distance $OA = OB$ is the square of the radius of the pipe. The closed figure formed by the line joining points *P* and the base-line has an area proportional to the flow, and the average $\sqrt{H}$ is found by dividing this area, as found by planimeter, by the length *AB*.

The method is somewhat longer than the one in which the average pressure is found from concentric rings of equal area, but additional points are more readily represented. C. H. CHASE.

Stoneham, Mass.

Charged Steam Pipe

H. S. Whitney's letter, "An Electrical Phenomenon," published in *Power*, Feb. 12, and Dr. K. Becker's comments on this letter, in the issue of Apr. 23, bring to mind a somewhat similar experience with static electricity caused by a steam leak.

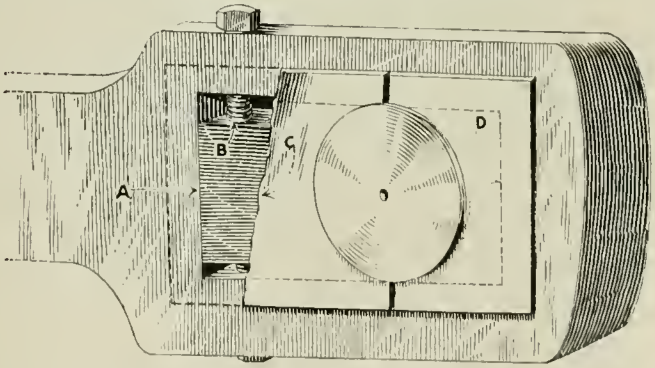
In a plant in which I was working it became necessary to install a supporting strap on one of the steam pipes. A steam fitter went up on a ladder to do the job, but on touching the pipe with a tool, he received a shock that almost knocked him down. As a temporary measure of relief a copper wire was connected between the charged-pipe section and a water main, so that the electric pressure could not accumulate as a charge. Later, a careful inspection was made for a contact between some live wire and a pipe or iron part of the building, but no such contact could be found.

The cause of the charged condition was not discovered until a week or ten days later, when a steam leak in the affected section was stopped; after repairing the leak, the charged condition no longer existed. The blowing of steam through the leak generated the electricity, which, ordinarily, could not have accumulated as a charge, because in most cases it would have followed the pipe line to ground. In this case, however, the pipe line had been installed a long time, and the joints on both sides of the affected section acted as insulation by virtue of rust and the intervening rubber gaskets between the flanges. E. C. PARHAM.

Brooklyn, N. Y.

Engine Broke Wedge Bolts

The crosshead ends of the connecting-rods of some of our engines are designed as shown in the illustration, and when all the adjustment was taken up on one of the engines, I raised the wedge, and as there was a thin shim at *A*, I thoughtlessly inserted another in the same place. The engine ran only a few hours before one of the wedge bolts broke off at *B* close to the adjusting wedge. I put in a new bolt, but the engine broke two more bolts at the same place in less than a week. I then decided it was time to use my head a little and reasoned that the shims being inserted at *A* threw the threaded hole in the wedge out of line with the hole through the strap, causing undue strain on the bolts, which broke them. I took the shims out and put them in at *C*, and the engine has never broken another bolt.



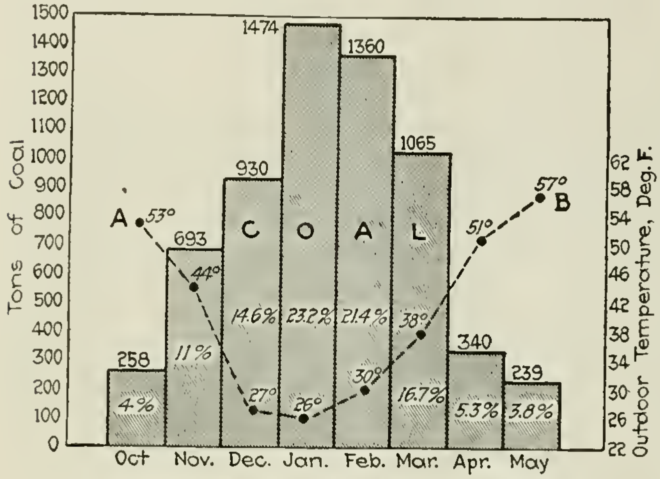
LINERS PUT IN THE WRONG PLACE

Whether the shim should be put at *C* or at *D* depends on the travel clearance of the piston. A shim at *C* will lengthen the rod and reduce the clearance at the head end of the cylinder, while the reverse will be true if the shim is put in at *D*. W. G. CAMP.

Ash Fork, Ariz.

Coal for Live-Steam Heating Plant

The amount of coal required for heating and the percentage of the total for the season used each month are valuable data in these days of coal shortage and lack of transportation facilities. In this connection the article by M. W. Ehrlich, on "Average and Maximum Heating Demand," in the Mar. 5 issue of POWER is interesting. In many large buildings the power and heating are combined, and with a scarcity of meters of the proper character it is difficult to separate the coal for the different services. Data from a live-steam heating plant, where coal is burned for heating only, may be of interest. Averages covering the three years, 1915, 1916 and 1917, for the retail department store of Marshall Field & Co. are presented herewith. The data apply to the main building, which is 380 ft. long, 380 ft. wide and 270 ft. high, giving in round numbers an interior volume to be heated of 39,000,000 cu.ft. Illinois washed nut coal averaging 12,000 B.t.u. per lb. is burned.



COAL USED PER MONTH IN TONS AND PERCENTAGE

Extending from October into May the heating season averaged 200 days of 14 hours, or a total of 2800 hours. The average coal consumption was 6359 tons per season. Above the first-floor line the building contains 215,000 sq.ft. of direct radiation, and the cubical content is 32,500,000 cu.ft. This space is 83 per cent. of the total and requires 90 per cent. of the coal, or 11,446,200 lb. Thus the coal consumption per season for that part of the building above ground reduces to 53.2 lb. per sq.ft. of direct radiation. Per 1000 cu.ft. of building space the coal consumption for the season reduces to 352 lb., and this in the writer's opinion is the better ratio to use in comparing the heating requirements of various buildings.

The chart shows the tons of coal used each month, including October and May, and in each case the percentage of the total for the season is given. These figures include the coal required to heat the basements and are given to show the relative quantities of coal required in the different months of the season. The basement has 15,000 sq.ft. of indirect surface, which is usually conceded to be equivalent to about 45,000 sq.ft. of direct radiation. The dotted curve gives the average of outdoor temperature readings taken at 8 a. m. and 4 p. m. every day of the heating season.

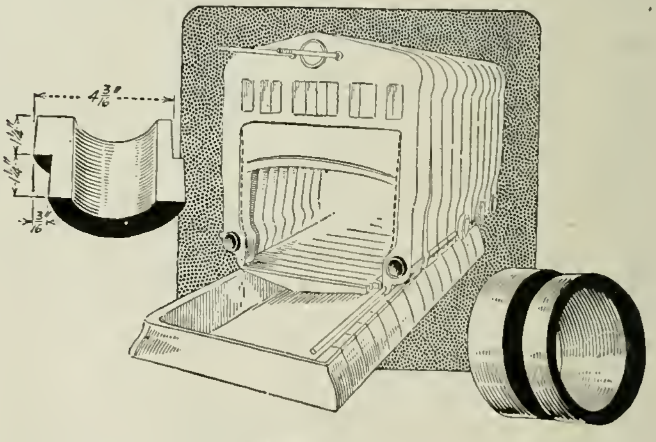
Chicago, Ill. C. W. NAYLOR.

Fitting New Sections to a Warped Boiler

In the layout of the heating system of a church in Tarrytown, N. Y., one boiler of nine sections was installed to heat both the parish house, which must be continually heated, and the church, which is heated only on Sundays. The furnace is in the basement of the parish house, and to heat the house and not the church all that is necessary is to have a low fire, not hot enough to force steam over to the church but enough for the house. No valves were provided to shut off the steam from the church. This works fairly well, but there is one trouble; when the church is not heated, there is no way to drain the returns and they remain full of water and are in danger of freezing. In fact one of them did freeze and burst during a cold spell last winter. The sexton built a hot fire under the boiler, got a steam pressure of .15 lb. about 6 p.m. Saturday and then left the church without discovering the burst pipe. He returned at 10:30 that evening and found that all the water had been driven out from the boiler. With the very hot fire and no water in the boiler, the front section was warped out of line one-half inch; resulting in damage amounting to $400. When the new sections arrived, the front section fitted nicely, but the last old section was warped out of line one-half inch; in fact, at least four and probably five sections were warped or spread at the bottom, as shown in the illustration; and being cast iron, it was impossible to force them into place.

Experts were called in, and each one maintained that it would be impossible to fix them so they could be used and that new sections would be necessary at a further cost of $500 to $600. It seemed to me that there must be some way to use these sections, which were still good, having stood a cold-water test of 10 lb. Careful measurements were than made to determine how much the nipple holes were out of alignment and it was found that the difference was $\frac{3}{16}$ in. on one side and $\frac{5}{16}$ on the other. Two eccentric, or offset, nipples were made accordingly, with slightly more taper than the regular nipples, and with these the new section of the boiler slipped into place with the same ease as in regular construction. A tight joint was made, and the boiler is giving satisfaction. The saving was nearly $600. As far as I can find out, this is the first time such a repair has been tried out. D. C. ASHMEAD.

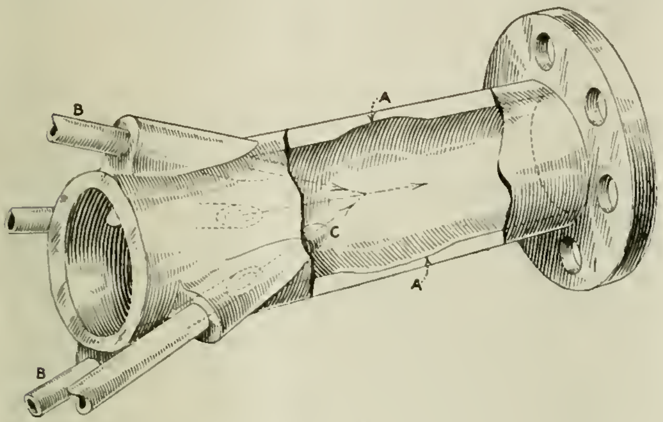
Tarrytown, N. Y.



OFFSET NIPPLES COMPENSATE FOR MISALIGNMENT

Suggested Steam-Jet Ash-Conveyor Improvements

The operation of steam-jet ash conveyors is simple and so is their construction in the main, but my experience with them indicates that there are one or two parts that might be improved. One is in relation to the method of placing the steam nozzles in the nozzle section. In the system I am using, there are two jets placed diametrically opposite and at an angle of about 15 to 20 deg. with the axis of the pipe. The streams issuing from these nozzles come together at a point depending upon the size of the pipe and upon the angle of the nozzles.



PROPOSED ARRANGEMENT OF STEAM JETS

The indications are that the jets coming together as they do, tend to combine and form a jet similar to that of the gas flame. This shape of jet, together with the ashes, causes a scouring action at the top and bottom of the pipe, as shown in the sketch at *AA*. This pipe is 8 in. diameter, 1 in. thick and 8 ft. long and is of chilled cast iron, which makes frequent renewals expensive. The best way, I believe, is to correct the trouble at the nozzles by placing them so that the resultant discharge is a cone-shaped stream. I believe that this could be done by adding two other nozzles placed as shown at *BB*, or 90 deg. from the present nozzles, which would tend to prevent this action. Care must be taken to have the center line of the nozzles lie in the same plane with the axis of the pipe, or a spiral or centrifugal scouring will be caused. With the coming of warm weather I expect to change the nozzles I am operating, as suggested herein.

The second improvement relates to sharp 90-deg. bends, which, from the point of economy in steam consumption and upkeep, should be replaced with long-radius bends fitted with cast-iron baffle plates. The long bends should be made sectional, as some of them are, so as to be easily replaced.

We have recently installed a skip hoist and tank ash-handling system, and as soon as possible I will forward data giving a comparison of the operation of both systems. Although the jet type of conveyor uses a greater amount of steam during the time it is engaged in removing ashes, the steam is used but a short time at each ash removal, and the system has the advantage of being capable of taking care of a great overload, which cannot be said of the skip hoist unless it is of very liberal size. **H. G. Burrill.**

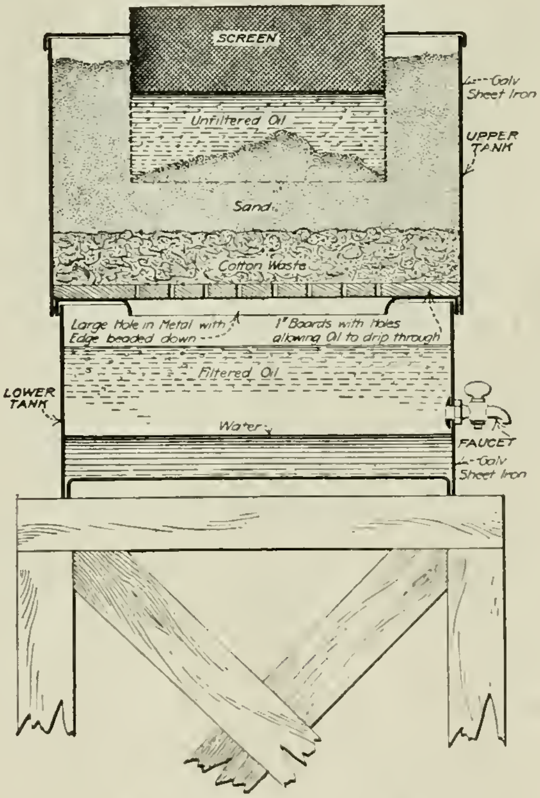
Herkimer, N. Y.

Sand Filter for Used Oil

Perhaps other power-plant engineers have experienced difficulty in filtering lubricating oils which have become heavily laden with grit and other foreign substance. The illustration shows a primary filter, which I constructed, to take care of black and badly carbonized lubricating oil drawn from the well of a semi-Diesel fuel-oil engine, which has proved entirely satisfactory for the purpose. I found that, quite contrary to the prevailing opinion, oil can be filtered through sand without danger of injury to the most delicate bearings in which it may be used later. After the oil is drawn from this filter it is, as an extra precaution, put through a standard make of oil filter.

The upper tank can be removed from the lower tank or reservoir for cleaning. The water in the lower tank is not necessary, but since a space for settling is left below the faucet, the use of water obviates the necessity for the excessive amount of oil which would otherwise be required to bring it to the faucet level. The construction of the upper tank is such that it will fit nicely on the lower tank and prevent the oil from creeping to the outer edges by the bottom having a large hole cut in the center and its edges beaded down, as shown.

The plan of screen arrangement allows for the adjustment of the amount of sand through which the oil must pass before reaching the waste, and by bringing the sand up around the sides of the screen, the oil is prevented from seeping down between the side of the tank and the sand unfiltered.



SAND USED IN FIRST STAGE OF FILTER

I will appreciate comments in the columns of *Power* and suggestions for improvements and also to know whether any engineer has previously used such a filter.

Harvard, Neb. **Julius E. Person.**

Supporting Effect of Boiler Heads

I was much interested in the article by Neil M. Macdonald in *Power* of May 21, wherein it is shown that the strength of the unsupported head should not be added to the strength of the stays to find the allowable pressure in a boiler. However, I question Mr. Macdonald's line of reasoning.

Let us confine our argument to the very good illustration of the two walls joined by a rope. The author states that "when the pressure reaches 528 lb., which is the ultimate strength of the rope, the rope breaks." This is not so, for the weaker wall is able to withstand 296 lb., so that there is a pull on the rope of only 232 lb., and the rope will not break. The author admits that "the pressure rises slowly until 296 lb. is reached . . . but there is no perceptible change in conditions, as both walls still stand and the rope is still intact." In other words, the rope is not subjected to any stress as long as the pressure on the wall is less than 296 lb., so that when the pressure on the wall is greater than 296 lb., the pull on the rope is equal to the amount that the pressure exceeds 296 lb. The pull on the rope will equal 528 lb. only when the pressure on the wall has reached 824 lb. Hence, the strength of the unsupported head should be added to the strength of the stays to obtain the allowable pressure in a boiler.

Bridgeport, Conn. D. Fliegelman.

A hasty first perusal of the article in the May 21 issue of *Power*, page 733, caused the writer to wonder if the author of that article was serious in his views or merely wanted to start something. If Mr. Macdonald's argument is a valid one, then in every line of machine design much material has been added uselessly in order to give supposedly greater strength to some weak member.

It seems strange that he did not go a step farther and assume that sixteen braces supported the head. He should have assumed that the total load to be carried by these sixteen stays was 80,000 lb. so that each stay would singly support 5000 lb. Then, using his "wall" argument, when the load rose to 5500 lb. one stay would break, since this was beyond its capacity; then the second, third, etc., would successively break under this load.

The conclusion to be drawn would follow the conclusion he stated—the strength of the boiler or stone wall was the strength of its strongest part, namely, one stay or brace. Absurd, you will promptly decide. No more than Mr. Macdonald's conclusion. Why does he not state the actual conditions existing in his wall? If he loads it with 528 lb., it can be assumed either that the rope bears all the pressure or that it is divided between the wall and the rope. Now, the wall has a resistance of 296 lb., then surely 296 lb. can be added before the combined resistance is overcome.

Philadelphia, Penn. E. S. Morrison.

The article in the May 21 issue of *Power*, page 733, seems correct to me in its final conclusion, namely, that a boiler head should be stayed without taking into account the strength of the unstayed head. But is the author not mistaken in his explanation of the reason why? It looks to me that with his weaker and stronger wall with a rope between, the strength of the weaker wall can safely be added to the strength of the rope to find the pressure at which the rope will break and the wall topple over, for both are rigid and both give their ultimate strength in the same position and at the same time. But with the boiler head it is not the same, for while the head might be ultimately strong enough to withstand considerable pressure, the pressure it will stand and remain in position is very much less; therefore, the stays must take the whole pressure, for the position the head will take under little pressure is beyond the position where stays will be broken off.

To illustrate, take a spiral spring with an eye-bolt in each end, hook up one end and hang a weight on the other end. Suppose that the spring will sustain a weight of 1000 lb. Now take the weight off, put a solid bolt from eye-bolt to eye-bolt through the center of the spring, make it just the right length so that the spring will be in its normal unstrained position, and make the bolt of sufficient strength to support 2000 lb. It is possible that some might think that the combined bolt and spring would suspend 3000 lb., and they would but for the fact that the bolt will be broken before the spring begins to take any material part of the load.

A wall and a tight rope, two bolts or any other combination of materials that will take strain at the same time, up to their ultimate strength, will have the resistance of one plus the other. With the spring and bolt, or the stayed boiler head, the strain it will stand is the strength of the first to fetch up, plus whatever strain is on the other element in the position where the first member takes up, and no more. With the boiler so little pressure will cause the flat head to move away from the pressure, that in figuring the strength of stays to keep the head in place the effect of the head should not be reckoned and is not in practice, usually. L. Johnson.

Exeter, N. H.

Wood for Pipe Covering Dangerous

On page 742 in the issue of May 21 there is a description of a system of pipe covering, which is not new, and is not desirable, as it is dangerous. Back in the early 80's I was in charge of a plant in the Middle West, in which the steam piping was covered in a similar manner and I think it had been patented. Having to make some changes in the piping to the cylinder lubricator, which was connected into the steam pipe just above the throttle valve, I had to remove some of the pipe covering and found almost all of the wood converted to charcoal, so soft that it could be easily crushed to powder with the fingers, and a spark would have started a blaze. The old covering was therefore ripped off, and a covering more nearly fireproof substituted.

In "ye olden times" it was the custom also to lag engine cylinders with fancy wood, but wherever this lagging was in contact with the bare metal it would invariably char, and steam pressures were low then compared with present practice, one hundred pounds being considered high. Alonzo G. Collins.

Philadelphia, Penn.

Inquiries of General Interest

Over-All Efficiency of Pumping Plant—What would be the over-all efficiency, or ratio of water horsepower to electric input, of an electrically driven pumping plant, where the efficiency of the motor is 85 per cent., efficiency of pump 70 per cent. and efficiency of pipe lines 75 per cent.? J. H. N.

The over-all, or combined, efficiency would be the product of the separate efficiencies: namely, 0.85 × 0.70 × 0.75 = 0.44625, or practically 45 per cent.

Height of Barometric Condenser—Would there be any gain in vacuum by raising a barometric condenser from 34 ft. to 38 or 40 ft. above the water in the hotwell? L. B. R.

The purpose of having an elevated discharge pipe is to obtain a column of water that will produce sufficient pressure for the water to discharge itself against the pressure of the atmosphere acting on the water of the hotwell. Under ordinary conditions, 34 ft. is sufficient for the purpose, and additional height would be of no advantage.

I.Hp. for Increase of R.P.M. and M.E.P.—An engine running at 75 r.p.m. with 40 lb. m.e.p. develops 100 i.hp. If the speed is increased to 80 r.p.m., what number of horsepower would be developed with 45 lb. m.e.p.? J. J. H.

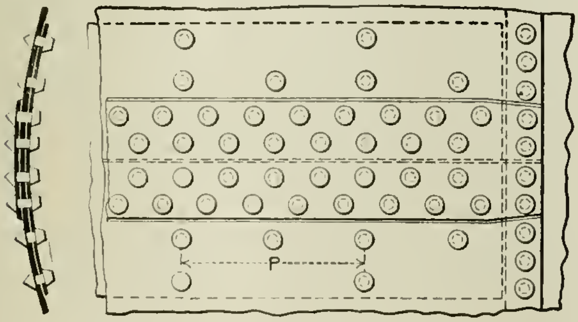
The power developed would be directly in proportion to the speed and the mean effective pressure. Therefore with 80 r.p.m. and 45 lb. m.e.p. the engine would develop

$$100 \times \frac{80}{75} \times \frac{45}{40} = 120 \text{ i.hp.}$$

Break in Boiler-Feed Line from Stoppage of Pump—My foreman states that stopping of the feed pump was the cause for frequent breaking of a tee in the feed line. How could that occur? M. S. C.

Stoppage of the pump might be an indirect cause of the breakage from expansion of the feed line, as a result of the feed line becoming heated from leakage of a boiler check valve; but breakage of the line from overheating should not happen if the feed line is laid out with proper allowances for expansion and contraction.

Efficiency of Quadruple-Riveted Boiler Joint—What is the efficiency of a quadruple-riveted butt and double-strap boiler joint like the sketch, made of steel plates of 55,000 T.S. and 95,000 lb. crushing strength, and having main plates ½ in. thick; butt straps $\frac{7}{16}$ in. thick; P, the pitch of rivets in the outer row, 14 in.; diameter of rivets after driving, $\frac{15}{16}$ in.; shearing strength of rivets in single shear, 44,000 lb., and in double shear 88,000 lb. per square inch? I. T.



The diameter of the rivet holes and rivets after driving would be $\frac{15}{16}$ = 0.9375 in., and each rivet would have a cross-sectional area of 0.9375 × 0.9375 × 0.7854 = 0.6903 sq.in. For each unit length of joint = P, there would be three rivets in single shear and eight rivets in double shear and for such unit of length there would be,

(A) Strength of solid plate,

14 × 0.5 × 55,000 = 385,000 *lb.*

The strength of the joint per unit P of length would depend on one of the following considerations:

(B) Strength of plate between rivet holes in the outer row,

(14 — 0.9375) 0.5 × 55,000 = 359,219 *lb.*

(C) Shearing strength of eight rivets in double shear, plus the shearing strength of three rivets in single shear,

(8 × 88,000 × 0.6903) + (3 × 44,000 × 0.6903) = 577,091 *lb.*

(D) Strength of plate between rivet holes in the second row, plus the shearing strength of one rivet in single shear in the outer row,

[[14 — (2 × 0.9375)] 0.5 × 55,000] + (1 × 44,000 × 0.6903) = 363,811 *lb.*

(E) Strength of plate between rivet holes in the third row, plus the shearing strength in single shear of two rivets in the second row and of one rivet in the outer row,

[[14 — (4 × 0.9375)] 0.5 × 55,000] + (3 × 44,000 × 0.6903) = 372,995 *lb.*

(F) Strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of one rivet in the outer row,

[[14 — (2 × 0.9375)] 0.5 × 55,000] + (0.9375 × 0.4375 × 95,000) = 372,402 *lb.*

(G) Strength of plate between rivet holes in the third row, plus the crushing strength of butt strap in front of two rivets in the second row and one rivet in the outer row,

[[14 — (4 × 0.9375)] 0.5 × 55,000] + (3 × 0.9375 × 0.4375 × 95,000) = 398,770 *lb.*

(H) Crushing strength of plate in front of eight rivets, plus the crushing strength of butt strap in front of three rivets,

(8 × 0.9375 × 0.5 × 95,000) + (3 × 0.9375 × 0.4375 × 95,000) = 473,145 *lb.*

(I) Crushing strength of plate in front of eight rivets, plus the shearing strength, in single shear, of two rivets in the second row and one rivet in the outer row,

(8 × 0.9375 × 0.5 × 95,000) + (3 × 44,000 × 0.6903) = 447,370 *lb.*

There would be least strength of the joint from consideration (B) and the efficiency of the joint would be

$$\frac{(B)}{(A)} = \frac{359{,}219}{385{,}000} = 93.3 \textit{ per cent.}$$

Power Absorbed by Idler Pulley—How much power is lost from the use of a 28-in. diameter idler pulley on a 2½-in. shaft making 220 r.p.m., used to hold a quarter-turn of a 17-in. double leather belt? A. T. M.

The power lost by use of the idler consists mainly of the bearing friction that results from pressure resulting from the direction and tension of the belt and the weight of the belt, pulley and shaft. The maximum belt tension probably would not exceed 90 lb. per inch of belt width, or about 17 × 90 = 1530 lb., and having a belt angle of 90 deg. the resulting pressure from belt tension would be 1530 × 1.4 = 2142 lb. The horsepower absorbed by friction of shafting, with continuously oiled bearings, is approximately equal to

Total pressure in bearings in pounds × diameter of bearings in inches × r.p.m. ÷ 2,900,000.

Allowing the total pressure on the bearings from belt tension and weight of belt, pulley and shaft to be 2500 lb., the power lost by friction would be 2500 lb. × 2.5 in. diameter × 220 r.p.m. ÷ 2,900,000 = 0.47 or about one-half horsepower.

[Correspondents sending in inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Meeting of National Electric Light Association at Atlantic City

THE thirty-fourth annual meeting of the National Electric Light Association was held in the Hotel Traymore, Atlantic City, N. J., June 13 and 14. In the words of W. W. Freeman, past president of the association, it was "The most serious and the most inspiring convention the association ever held." The attendance was comparatively small, only a little over 300 being registered, owing to many being away on and too busy to leave war work.

The following were the chief features of the address of President John W. Lieb, general manager and vice president, New York Edison Co.:

ADDRESS OF MR. LIEB

Mr. Lieb pleaded for continuation of teamplay in the electrical industries, in which he included street railways, telephone, telegraph, light, power and the manufacturing enterprises. Mr. Lieb said there were about 920,000 men engaged in the industry which represents capital of about $10,750,000,000 and an output valued at $2,675,000,000 a year. The electric light and power industry employs about 125,000 men, the capital invested is $3,000,000,000, and the annual business done amounts to $575,000,000.

The industry, according to Mr. Lieb, is second only to the great national railway system. He regards "linking up" of systems first to further fuel economy as the most important problem now confronting the industry. The public utilities were urged to take the initiative in this and similar matters; otherwise, he said, Government control would follow.

The mounting costs of conducting business have left nothing for dividends and sometimes have not covered fixed charges, and in any case have left barely enough to cover operating expenses.

The coal shortage, Mr. Lieb claimed, was due to labor shortage at the mines, transportation breakdown, troubles at the tidewater terminals and to lack of coal cars. Experience in normal times has shown it unsafe to begin the winter with less than 30 to 45 days' coal supply; now one cannot hope to accumulate the 60- to 90-day supply that the uncertainties of the present make necessary. Fuel costs from 75 to 80 per cent. of the cost of current delivered to the switchboard and from 20 to 25 per cent. of the cost delivered to the customer. Further fuel economy is impracticable at this time, although advantage may be taken of the diversity factor between systems, operating with a common reserve, and of the assistance which one system may give another through interconnection.

It does not need demonstration to prove that the coal consumption in the isolated plant is generally from 2½ to 4 and 5 times the amount required to produce the same quantity of electrical energy in central stations. Parallel operation of street systems (central station) and isolated plant is hardly practicable, in Mr. Lieb's opinion.

He recommended keeping the clock advanced one hour the year round. Relative to the growing shortage of labor, he pleaded for exemption from military service of those specially trained unless, of course, they were going to use their special training in the service. The further employment of women is now a live problem, and one soon to demand attention is the training and employment of the wounded and blind returned soldiers.

The member companies have purchased to date $29,555,250 in Liberty Bonds and $1,467,945.69 in War Stamps.

MR. INSULL'S ADDRESS

The next address of importance to the industry broadly was made at the dinner, Thursday evening, by Samuel Insull, president, Commonwealth Edison Co., Chicago. Mr. Insull sounded the trumpet of hope and confidence in the industry. He said that relief from the burdens of high cost of conducting the industry could be had if the reasons for rate increases were properly put before the people in the various localities where rate increases were necessary. He based his belief upon the fact that in 1917 out of 467 applications for rate increases 400 decisions in favor of such increases were given by the public-utility commissions hearing the cases. With labor increasing its wage, cost of fuel increasing as part of Governmental action, and with supply and demand exerting their usual force, it does not seem possible that the industry can contemplate the selling price remaining stationary. Those conducting the industry must have confidence in their industry if investment bankers were to be expected to invest their money in it. The industry must conduct itself so as to get and to maintain the confidence of the constituted authorities and so pass this confidence on to investment bankers.

Relative to fuel orders Mr. Insull said that every order of Mr. Garfield reduced the central-station load factor and reduced returns. As to the "lightless night" order, cutting out all electrical display advertising, it effected the industry's earning capacity out of all proportion to the coal saved. But because of its awakening effect upon the people, Mr. Insull said he would have done as Garfield did.

The speaker urged that central stations drop extravagances of a capital character and of operating nature. This is not the time to consider balance sheets.

To make up for the shortage of coal cars all unnecessary forms of improvements must be postponed and the open-top car equipment used to transport the materials for such improvements used for hauling coal. There is not the time or the capacity to make all the new equipment needed; it must be taken from other channels not absolutely necessary.

ADDRESS OF MR. NOYES

P. B. Noyes, Director Conservation Division of the United States Fuel Administration pointed out the enormous physical proportion of the work the administration was doing. The cotton crop of a whole year could be moved in one day of coal movement, and thirty days of coal movement are equivalent to the movement of the coming second largest wheat crop. Eighty millions more tons of coal will be needed by the industries alone this year over last. America must mine 220 million tons in excess of that ever before mined in one year. "We need 100,000,000 tons more coal this year than last; if we mine half of it we will do well," said Mr. Noyes. The draft had taken away 35,000 coal miners.

Mr. Noyes says that classifying industries as essential and non-essential cannot be done; he divides them as war and nonwar. He pointed out that it was impracticable to cut off completely fuel to nonwar industries even when some war industries must go without it, because industrial dislocation, riots, strikes and great evils would follow if coal was unthinkingly withheld from many centers where there were few except nonwar industries. These industries, said Mr. Noyes, use less than 100 million tons of coal a year. One ton of coal meant keeping at least fifty people at work. That is one view he wishes persons to take of the coal situation.

We, the administration, must tell the public utilities as we told the steel people, namely: make the utility business 100 per cent., then you will get 100 per cent. coal, said Mr Noyes. The utilities must refuse service to those whose use of it is not more or less intimately associated with the winning of the war, and they must see to it that those using the service use it economically. The administration expects the utilities to do much of their own policing in respect to this field of conservation.

DOCTOR WHEELER'S ADDRESS

Dr. S. S. Wheeler made an illuminating address on training the blind to do work in the electrical industry. They are now successfully winding coils of stators and armatures at the same piecework rate paid sighted persons. Arthur Williams also spoke at the dinner; his subject was food conservation.

The Prime Movers Committee was represented only by N. A. Carle, all other members being absent. Mr. Carle is the new appointee to the committee, having taken the place of the late John P. Sparrow, of the New York Edison Co.

George A. Orrok gave a paper on "Location of Power Plants at the Coal Mines," and Philip Torchio, electrical engineer, New York Edison Co., had a paper on "The Utilization of Water Power as a Measure of Coal Conservation." The chief point of Mr. Torchio's remarks was that the East must depend upon steam for the great heat unit requirement of this section, as adequate water power is unavailable.

Charles E. Stuart, chief of power and light division, United States Fuel Administration, read a paper on "War Conservation of Power and Light," from which the following is taken:

General plans have been laid out for the conservation of light and power by the Bureau of Conservation of the United States Fuel Administration, of which P. B. Noyes is director, and these plans will be carried out by the Power and Light Division. They will be developed under the following subdivisions: (1) Elimination of Uneconomical Isolated Plants. (2) The Application of the Skip-Stop to Railways and the Regulation of Car Heating and Lighting. (3) Economy in Utilization of Power and Light in Factories. (4) Utilization of Excess Water Power and Interconnection of Power Systems. (5) Limiting the Production of Power to the Most Efficient Points Available. (6) Economy in the Refrigerating and Ice-Manufacturing Industry.

A brief statement with respect to each of these subdivisions is developed below.

The plans will be carried out through the coöperation of the following: *First*, a force of engineers organized and stationed with the Fuel Administration at Washington; *second*, the Engineering Department of the United States Geological Survey; *third*, the Power Division of the Council of National Defense; *fourth*, a state fuel engineer attached to the office of the State Fuel Administrator, to supervise the activities in his state; *fifth*, the public service commissions and state regulatory bodies; *sixth*, the chambers of commerce and similar representative business bodies; *seventh*, volunteer engineers located throughout the country.

The following gives the scope of the subdivisions:

1. Elimination of Uneconomical Isolated Plants

The individualistic way in which fuel is now consumed in cities is not efficient. A ton of coal burned in a large central station will produce at least four times as much electric power as if burned in the average small plant, and if centralized burning could be introduced to a greater extent, the amount of fuel required could be largely reduced without reducing in any way the ultimate production of light and power.

It is frequently the case that in buildings where electric plants are located and where exhaust steam is utilized in the heating of the building and in furnishing hot-water requirements, such buildings can adopt central-station service without a loss of money and at a saving in fuel.

As a rule it may be stated that where no extensive heating system is operated in conjunction with the generating plant, such a plant can purchase power at a great fuel saving and with a possible reduction in power cost. In other cases it would be more economical, from the viewpoint of fuel saving, to utilize central-station service in conjunction with isolated electric plants.

It is the duty of the Fuel Administration to devise means for securing a curtailment in the use of fuel in ways that will impose a minimum of hardship. It is believed that there are many plants, not only in New York but throughout the entire country, which could, at least temporarily, shut down their own electrical machinery and purchase power from others at a financial advantage to both parties and with a considerable saving in fuel.

The Fuel Administration believes that if even a comparatively small proportion of the plants throughout the country which could save fuel in this way at a profit to themselves would do so, it would prove a tremendous help in meeting the fuel situation with which the country is confronted, and in winning the war.

While it may appear that the interests of the central station are being benefited to a large degree, such is not of necessity the case. In some cases, central stations may be shut down. In any event any connection between a central station and a building or a manufacturing plant that is affected, will, of necessity, be for the period of the war only or through the period where the coal situation is critical. The machinery of the isolated plant can be readily preserved through this period of necessity. Under these circumstances the heavy expense attendant upon the making of the connection by the central station may completely or even more than offset any profit which could be expected of such a load through a short period.

2. Economy in Utilization of Power and Light in Factories

The United States Fuel Administration is requesting, as a means of accomplishing power and light conservation in manufacturing and industrial establishments, the appointment, by the management, of a Shop Committee, composed of those best suited for the purpose and in size or number suitable to the size of the plant, one member of this committee to act as its chairman; the committee to be active with and have charge of all details in the operation of the plant that would in any way contribute to economy in fuel or that in which fuel is used to produce, and report weekly to the management or head of the plant.

It is also suggested that this committee be changed from time to time, so that the spirit and interest in this work may be maintained.

It is not the purpose arbitrarily to outline in detail the method for doing this work, rather to suggest in a general way, leaving the details and adoption of the plan in the hands of the manufacturers interested, as we realize that conditions in different plants and character of manufacture, as well as organization, will have a bearing on the size, character and details of the committee, which must be suited to the particular case under consideration.

As a typical illustration of possible waste and opportunity for conservation, we suggest the following items: (1) Lights being unnecessarily burned; (2) lamps of too high candlepower; (3) the elimination of carbon lamps in favor of Mazda lamps where practicable; (4) the elimination of arc lamps and substitution of nitrogen-filled lamps, which are from two to three times as efficient; (5) the restricted use of sunlight due to dirty windows; (6) operation of motors when machinery is idle; (7) excessive sparking, heating or erratic speed of motors; (8) improper alignment of shafting; (9) grouping of machines so as to operate motors or engines as nearly loaded as possible; (10) staggering of operations so as to maintain as flat a load curve as possible; (11) slipping belts; (12) dry bearings; (13) overheated or underheated parts of plant; (14) excessive drafts due to lack of proper protection about openings of doors, windows, elevator and staircase areas; (15) the reduction of elevator service or the application of a skip-stop to elevator service; (16) the testing out of power circuits for relationship of capacity to load carried; (17) the paralleling of power circuits.

We also suggest that the work of this committee be conducted in such a manner as to provide records of savings, which could be incorporated in reports and information desired from time to time as to the progress of this work.

3. Utilization of Excess Water Power and Interconnection of Power Systems

A method of fuel conservation that promises a certain amount of immediate relief and at the same time opens up a field with almost limitless possibilities for future development is the interconnection of the present power systems of the country, and the consequent utilization of considerable excess water power which is at present available.

In many parts of the country duplicate transmission systems exist, serving practically the same territory. An interconnection between these systems for the mutual exchange of energy would, in many cases, result in marked economies. In other cases, the lines of a power company which derives all, or nearly all, its energy from water power may extend very close to the lines of another company which uses coal to a large extent for the generating of power. Since no company is so fortunate as to be operating with a 100 per cent. load factor, there are necessarily times during light load when the water-power company is forced to allow unproductive water to flow over its dam. At such a time a great saving in fuel would be effected were the two companies tied together and the load on the steam station transferred in part or entirely to the water-power plant. Numerous hydro-electric companies have for a long time been carrying out this idea within their own systems, where the bulk of their power is derived from water, and at the same time they maintain a steam reserve to carry their load during low-water periods.

In some cases these system interconnections would involve a considerable expenditure of both time and money, in which event they would not be subject to immediate aggressive action by the administration but would be held in abeyance as possibilities for future consideration and developments.

4. Limiting the Production of Power to the Most Efficient Plants Available

We have been able to locate nearly 500 instances throughout the country where there exists, in one form or another, a duplication of power production and supply. In other words, there are communities where two or more central stations are furnishing electrical energy with systems paralleling one another.

In certain instances the results of such a condition are not serious and in many cases probably unavoidable. Our investigations so far, however, have proved that a large percentage of these situations offer an opportunity for large fuel conservation.

5. Economy in the Refrigerating and Ice-Manufacturing Industry

In coöperation with the Joint Commission on Refrigeration, which was organized to assist the Government during the war, the Power and Light Division is planning to get in touch with the entire ice industry to introduce a number of proved economies in the operation of ice-and-refrigerating plants.

A number of suggestions have already been made by the commission and by individuals connected with the industry. One plan that possesses merit and has possibilities of considerable fuel saving is that of allotting a definite amount of coal to individual plants, depending upon the size and type of plant, such allowances being based upon a reduction of 10 to 15 per cent. of the average present fuel consumption. This will make it necessary to adopt many simple measures of economy that are now being overlooked.

Another possibility is that of producing white or opaque ice at a fuel saving of 5 to 20 per cent. This is accomplished by eliminating the power that is generally used for agitation in raw-water plants and for producing distillate in distilled-water plants, both of which are merely means of producing a transparent product. This measure is possible of adoption in many territories.

A further line of effort which will be productive of considerable economy and one that was successfully applied last winter is that of operating during the winter season only the most efficient plant, or plants, as the particular case requires, in communities where, during the summer season, all plants are required. This can be done and the individual business of each manufacturer will not be interfered with, as the arrangement provides that the operating plant or plants will sell at wholesale rates to those manufacturers whose plants are temporarily closed down.

This arrangement also produces a saving in ammonia, and for this reason was applied last winter at the request of the Food Administration.

W. W. Nichols, of Allis-Chalmers Co., gave the following in his paper on "The Development of Water Power as a War Measure":

The year 1917 was one of inferior demand in water-power machinery, yet 1,058,000 hp. of hydro-electric machinery was built and installed. This alone represents a saving of 8,500,000 tons of coal, besides a saving in production labor and transportation. Ten per cent. of the estimated coal shortage of this year therefore would be met if the industry could do as well this year. Without building new plants there are two ways of hydro-electric development: (1) By increasing the capacity of plants already built. In this connection it has been estimated that 300,000 hp. can be developed in the next twelve months by central stations. (2) Replacement of machinery installed prior to 1911. This would take care of an increased horsepower of 450,000. By these means 6,000,000 tons of coal would be saved in the twelve months in addition to labor and transportation. Power is now more than ever fundamental to cur existence. The power shortage is a national calamity, calling for a broad national treatment.

The convention visited the shipyards at Hog Island Saturday.

W. F. Wells, vice president and general manager of the Edison Electric Illuminating Co., Brooklyn, N. Y., was elected president of the association.

New York State Convention, N. A. S. E.

The New York State Association of the N. A. S. E. held its twenty-third annual convention at Coney Island, June 13-15. The Shelburne Hotel on the boulevard at Ocean Parkway was the headquarters. There were fully seventy-five delegates present. The business sessions of the convention were held in the balcony on the second floor of the hotel. The front portion of the main dining room was artistically decorated and conveniently arranged for the mechanical display. From the exhibitors' standpoint the arrangements for their convenience and comfort outclassed anything in the history of the state association. There were 52 companies represented. The meetings of the delegates were unusually interesting this year, and much important business was dispatched in the three days.

The opening ceremonies of the convention took place on Thurday evening. John B. McGowan, chairman of the local committee, delivered a brief though earnest address on the needed efficiency of the members of the N. A. S. E. in the present crisis. He then introduced Judge Henry Goldfogle,

SOME OF THOSE IN ATTENDANCE AT THE NEW YORK STATE N. A. S. E. MEETING who welcomed the delegates to the city, congratulated them on the preamble of the organization, and told them of the responsibility which now rests upon the engineer. George Van Vechten responded for the delegates, and Fred Felderman spoke of the necessity of closer attention to the educational work of the members of the N. A. S. E. The meeting was then adjourned until Friday morning at 8 o'clock.

On Friday morning the ladies were taken on an automobile sightseeing trip, and in the afternoon enjoyed a vaudeville show at Henderson's theater.

One of the features of the convention was the banquet on Friday evening, attended by the delegates, supplymen and ladies; covers were laid for two hundred. During the dinner Monroe Silver, Billy Murray, Bob Jones and Jack Armour entertained.

At the final meeting on Saturday evening the delegates elected the following state officers: P. H. Cassidy, Brooklyn, president; Robert Tobin, Troy, vice president; William Roberts, Yonkers, secretary; William Downs, New York, treasurer; W. B. Wear, Middletown, conductor; F. J. Desmond, Rochester, doorkeeper; A. T. Bennett, Brooklyn, chaplain; Samuel Thackerberry, New York, state deputy.

Next place of meeting Troy, N. Y., in June, 1919.

The retiring state president, George C. Van Vechten, was the recipient of a mahogany clock, and Mrs. Van Vechten received a dressing-table set of cut glass.

The memorial services were conducted by the Rev. Arthur H. Cummings.

Annual Convention of American Boiler Manufacturers' Association

The American Boiler Manufacturers' Association held its thirtieth annual convention at the Bellevue-Stratford Hotel, Philadelphia, on June 17 and 18. At the opening session on Monday morning, the president of the association, M. H. Broderick, addressed the convention. He was followed by Dr. E. J. Cattell, city statistician of Philadelphia, who welcomed the association to the city. D. M. Medcalf, chief inspector of steam boilers, of Toronto, was called upon to speak and told of the part that Canada was playing in the furtherance of war work. William H. Barr, president of the National Founders' Association, next addressed the delegates, after which Dr. D. S. Jacobus, of the Babcock & Wilcox Co., gave a talk on furnace and combustion chamber volumes, illustrated by blackboard sketches. *Power* hopes to present the main points of Dr. Jacobus' talk in a later issue.

At Monday afternoon's session, E. R. Fish presented the financial report of the committee on uniform boiler laws. The work accomplished by this committee during the past year was outlined by Charles E. Gorton, who said that since the 1917 convention seven states had adopted the A. S. M. E. Code. In Kentucky active support had been obtained and a campaign was being organized to submit a bill to the state legislature. In Louisiana legislation had been introduced, calling on the governor to appoint a committee to investigate the desirability of adopting the A. S. M. E. Code and to report its findings to him. The Merchants' and Manufacturers' Association of Baltimore had been interested in the matter and a bill will be introduced at the next session of the Maryland legislature. The governor of Missouri has recognized the importance of adopting a uniform boiler law and favorable action is expected on the bill that is to be introduced in that state. In South Carolina the work moves slowly, but in due time the state may take up the matter. In Virginia it is expected that the bill will be reported out of committee at the next meeting of the legislature. Montana appreciates the need of such a law, and is in a favorable position to act on it, as the Industrial Accident Board is able to put the law into effect. Iowa is in the same state of mind and the legislature is expected to act favorably. Progress is being made in Massachusetts, but in Rhode Island the bill was not reported out of committee. In Vermont and New Hampshire the prospects are good. In Georgia the Manufacturers' Association is pledged to further the interests of a bill to adopt the A. S. M. E. Code.

C. O. Meyer, deputy inspector of the State of Ohio, presented a communication from his department, pointing out that the A. S. M. E. Code fails to cover vertical-flue boilers and track locomotive boilers, and that as a consequence it had been necessary to ignore the A. S. M. E. Code and use the rules of the Interstate Commerce Commission. He intimated that Ohio might return to its own rules, in force before the adoption of the A. S. M. E. Code, and suggested that the chairman of the American Uniform Boiler Law Society be a man who is neither a member of the A. S. M. E. Code Committee nor a boiler manufacturer.

A letter from the United States Board of Supervising Inspectors pointed out that their own inspection rules had been in use for sixty years, had met all conditions, were efficient and safe, and for those reasons the board declined to adopt the A. S. M. E. Code instead.

The vice president of the association, C. V. Kellogg, gave an exceedingly earnest and stirring address. He pointed out the folly of individualism and the necessity of organization and coöperation among boiler manufacturers to meet the industrial conditions that would follow the war, particularly the labor crisis that was sure to arise. C. J. Champion, who followed him, also took coöperation as the theme of his remarks, and described how it could be obtained and the results it would produce.

Col. F. N. Gunby, U. S. A., gave a very interesting account of the methods employed in building the various cantonments and the difficulties to be overcome. His talk was illustrated by lantern slides and moving pictures showing construction work in progress and in various stages of completion.

On Tuesday morning, G. S. Barnum presented the report of the committee on uniform costs. He outlined a simple cost-keeping system, laying particular stress on the method of distributing overhead charges. Charles A. Howard, who spoke next, disagreed with Mr. Kellogg on some points. He insisted that a cost system had other uses besides showing how much profit to charge. At the close of his speech, the president announced that Charles M. Schwab, director general of the Emergency Fleet Corporation, had just arrived and would address the convention. As Mr. Schwab entered the convention hall, he was given an enthusiastic welcome by the delegates. In responding to this ovation, he impressed upon the boiler manufacturers the important part they must take in the success of the shipbuilding program, inasmuch as the lack of accessories is the greatest cause of delay. From 80 to 90 per cent. of the hulls now afloat are waiting for engines, boilers or other accessories. Mr. Schwab said that beginning with July 1 he expected to publish a list of the relative performances of all the shipyards in the United States, showing those which had done the best as well as those which had fallen short of expectations, so that the American people should know exactly where to place praise or censure. Further, he said he intended to ask Congress to authorize service medals, to be awarded for industrial work to those concerns that have done and are doing their best to aid in winning the war. By this means he hopes to give public recognition of the services of those who deserve it because of their efforts and achievements in the industrial promotion of war tasks.

At Tuesday afternoon's session, Hon. Edwin F. Sweet, Assistant Secretary of Commerce, addressed the delegates on the subject, "Some Compensations of the War." He showed that as a nation we will benefit from the war by becoming more economical; that we shall increase production both in industry and in agriculture; that we shall learn the forgotten trade of shipbuilding and develop a vast merchant marine to serve a great foreign trade; that we shall learn how to guard against the ravages of preventable diseases; that our inventive genius will be spurred to greater achievements; and that both individual and national character will receive a wonderful uplift.

W. C. Connelly, chairman of the committee on war service, reported as to the work accomplished by that committee. It had sent out questionnaires to boiler manufacturers throughout the country and had received responses from

95 per cent. From the information thus obtained, the equipment and manufacturing facilities of practically every boilermaking establishment had been listed. This information was sent to all the various Government departments to which it could be of service.

The nominating committee presented the list of nominees for officers of the association, as follows: President, W. C. Connelly; vice president, C. V. Kellogg; secretary-treasurer, H. N. Covell; executive committee, M. H. Broderick, G. S. Barnum, W. J. Moore, E. C. Fisher and Dr. D. S. Jacobus. They were unanimously elected. The place of the next convention was left to the decision of the executive committee.

N. A. S. E. Iowa State Convention

On June 12-14 at Cedar Rapids the Iowa State Association of the National Association of Stationary Engineers held its fifteenth annual convention. It was an unqualified success notwithstanding the busy times and war conditions. Over one hundred engineers were registered and with the Ladies' Auxiliary and the exhibitors the attendance was exceptionally good. The exhibits were up to standard and the program made up by the convention committee was carried through with enthusiasm. Headquarters was at the City Auditorium, where the sessions were held and the exhibits displayed.

With F. W. Laas, state president, in the chair, the convention opened Wednesday afternoon. Mayor J. F. Rall gave the address of welcome. He was pleased to notice that the organization stood for education. It was a rare exception in these days to find an institution that was not organized for raising salary. The mayor spoke of the Cedar Rapids adjustment plan which called for arbitration in any dispute between capital and labor. It was his hope that the visiting engineers would find many things of interest in the city.

F. W. Raven, national secretary, responded. He informed the mayor that he was facing a small cog of a great organization that had done much in the last thirty-five years to conserve national resources. Briefly he outlined the educational methods employed. The day had come when the older engineers must show the results of the training the organization had given them and the younger members must take full advantage of the opportunities offered. The Government needed the best services of all.

For the first time in the history of the organization a national president had visited the state and was in attendance at the convention. The honor was appreciated and those present listened with interest to a brief address by John A. Wickert. In his opinion the engineer had the opportunity to be the man of the future. He was recognized more than ever before, as a man belonging to a profession. Those engineers who did not wake up to their responsibilities would find that other men would supplant them. Mention was made of the power-plant cost-data system that had been added to the educational program and of the help it would be in filling out intelligently the Government questionnaire. The president bespoke a big attendance at the national convention, where the educational features were to be the big thing and the entertainment secondary. Good delegates were requested—men who could bring back intelligent reports.

A patriotic address by James E. Bromwell, of Marion, was the event of the evening session. It was of exceptional quality and was commented upon highly by all present. "How many of you are true soldiers?" was the opening remark of National President Wickert. "Last year millions of tons of coal were wasted. Are you doing your share to conserve it?" The whole country is demanding service and none were better prepared than the engineer to give it. It was obligatory upon the engineer to attend meetings and better prepare himself for the work demanded. Subscriptions to the Red Cross and the buying of Liberty Bonds was not enough. Each engineer must recognize his responsibility and learn to do his work to the best possible advantage.

National Secretary Raven reminded the engineers that all of them were drafted. Each had his work, and his efforts had just as much to do with the results of the war as those of the men at the front. Dancing followed, with music by the Laas orchestra.

At the Thursday morning session J. H. Coates lectured on condensers. He outlined the theoretical possibilities of the condenser and told why maximum results could not be obtained in practice. The two general types, surface and jet, were discussed, the latter type including the low-level or ejector condenser and the high-level jet condenser of the barometric type. The construction, advantages and disadvantages and the auxiliaries required were given attention in each case, and some mention was made of the recent advances in cooling-tower construction.

J. M. Drabelle, of the Iowa Railway and Light Co., had an ascilograph at the hall. It was in running order and each engineer had an opportunity to see the wave line of the particular circuit to which it was attached. At the meeting its action was briefly explained and the speaker told how instantaneous information given by the instrument, and not available from the ordinary switchboard instruments, helped to locate troubles at the plant or in the line.

R. H. Holbrook, president of the local association, talked on fuel. In the United States about 1,900,000 tons of coal per day had been mined, while 2,300,000 tons would be required to carry on all industries satisfactorily. There would be a daily shortage of 400,000 tons of coal, or 120,000,000 tons per year of 300 days. He enjoined engineers to use their heads and to follow Government advice given in

MEMBERS AND THEIR GUESTS ATTENDING THE FIFTEENTH ANNUAL CONVENTION OF THE IOWA regard to coal economy. Transportation difficulties and the zone system were reviewed and the Iowa situation discussed. In Iowa boys' help was counted upon to solve the labor problem at the mines. If handled right Iowa fuel would give excellent results. With the moisture and ash out it was better than Illinois coal and as good as the fuel formerly obtained from Kentucky. It was a question of learning how to use it, and in this connection the campaign of a year ago would be continued.

Thursday afternoon and evening were given over to the exhibitors. In the evening the feature was a smoker.

The last session of the convention on Friday morning was given over to committee reports and routine business. The license law committee was instructed to coöperate with other engineering bodies with a view to the enactment of license legislation. A motion calling for discontinuance of the state convention until the war is over, was lost. State Deputy Holbrook reported relatively large increases in several associations of the state and urged to greater effort the locals that had not shown a gain. National Secretary Raven reviewed the work of the national association up to date. Up to the present the finances were ahead of those of last year. He emphasized the necessity for careful selection of officers and delegates and in general pointed out the duties of all.

As the next convention city Marshalltown had no opposition. The following officers were elected: Robert Mullin, president; P. H. Heise, vice president; Abner Davis, secretary; J. A. Coulson, treasurer; R. Moore, conductor; S. C. Dike, doorkeeper; R. H. Holbrook, state deputy.

Firms having display space at the convention were: American Engineering Co., American Steam Conveyor Corporation, Anchor Packing Co., Baker Valve Co., Cedar Rapids Pump Co., Crandall Packing Co., Crane Co., Dearborn Chemical Co., The Fairbanks Co., Fisher Governor Co., Garlock Packing Co., Gustave Lidseen, Hawk-Eye Compound Co., Hays Instrument Co., Hills McCanna Co., International Correspondence Schools, Jenkins Bros., H. W. Johns-Manville Co., Lunkenheimer Co., Murray Iron Works Co., Reordway Co., Sinclair Refining Co., Standard Oil Co., Viscosity Oil Co., Wehlage Electrical Co., Western Boiler Compound Co.

War Industries Board Moves to Obtain Capital for Power Plants

The War Industries Board has sent to Congress the draft of a proposed bill to appropriate $200,000,000 to increase the power supply in overloaded industrial centers of the East. Cities along the Atlantic Seaboard in which munitions and materials for war are being manufactured would be the especial beneficiaries under the measure, which has been committed to the care for the present of Representative Kitchin, chairman of the House Ways and Means Committee, on the House side, and of Senator Martin of Virginia, chairman of the Appropriations Committee, on the Senate side. The measure, it is understood, was drafted by Frederic Darlington, chief of the Power Plant section of the War Industries Board, at the request of Bernard M. Baruch, chairman of the board, and it is said to have the backing of President Wilson.

The measure is frankly emergency legislation, made necessary by the apparent need of the industrial section of the East for more power with which to turn out munitions of war. It is stated in Washington that the power supply of the East is obviously overloaded, and that while different sections of the country are also raising the question of not having sufficient power with which to turn out the munitions and material needed by the Government, it is the intention of the War Industries Board to see that the East is supplied first, and then endeavor, perhaps by additional legislation and appropriations, to supply other sections of the country. Until recently, it is stated in Washington, power companies with insufficient equipment, and without sufficient funds to purchase equipment, had expected to be assisted in obtaining capital and equipment through the War Finance Corporation, but now that that body has ruled in a manner which makes it unlikely that power companies can be so supplied, the need for empowering legislation of a specific and emergency character becomes apparent as one of the necessities for winning the war. It is said in Washington also that some of the power companies have come to see that if money is borrowed now for additional equipment which might not be needed at the end of the war, they would be doing themselves more harm than good in so borrowing money and increasing plant facilities.

Plans for passing the legislation desired have not been worked out in Congress, and until the proposed emergency legislation is introduced the War Industries Board is not likely to be able to make plans for the distribution of the capital when obtained. It is said in Washington that much more than the $200,000,000 now proposed to be appropriated will be needed, inasmuch as in the Pittsburgh district alone, which supplies power for a radius of 100 miles, it is estimated that $40,000,000 or $50,000,000 for additional plant facilities might be needed. The War Industries Board is now making a census of the various power needs of the different localities in the country engaged in war work. It is expected by the Washington correspondent of *Power* that the proposed emergency legislation will be difficult of passage in Congress, although it is admitted on all sides in Government industrial circles engaged in obtaining war material that some such legislation is needed at once.

STATE ASSOCIATION OF THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS AT CEDAR RAPIDS

Improving Plant Efficiency at Both Ends of the Steam Cycle

On June 17, at a joint meeting of the Western Society of Engineers and the Chicago sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, two important papers having a bearing on fuel conservation were presented. The attendance was large and the material presented was received with unusual interest. The first paper on "Advantages of High Pressure and Superheat as Affecting Steam Plant Efficiency," by Eskil Berg, of the General Electric Co., dealt with the improvements in economy to be obtained at the upper end of the steam cycle, while D. W. R. Morgan, of the Westinghouse Electric and Manufacturing Co., in his paper on "Condensers" showed how better results could still be obtained at the lower limits of the cycle. Both papers with the discussion will appear in later issues of *Power*. Briefly, Mr. Berg showed that a more efficient turbine was obtained by a combination of high pressure and superheat, the latter being necessary to obviate as much as possible the troubles arising from condensation in the turbine. In Europe steam temperatures of 700 deg. and higher are common. In this country boilers have been built for 350 lb. pressure and for a certain installation in England, B. & W. boilers were designed for a working pressure of 500 lb. With a superheat ranging from 200 to 300 deg., the final steam temperature would reach 800 deg. This would necessitate smaller tubes in the boilers, redesigning of the auxiliary equipment and elimination of joints by welding the piping system solid.

The salient features of the two general types of condenser, surface and jet, were brought out by Mr. Morgan. The three principal losses are drop in vacuum through the condenser, difference in temperature between the steam and condensate and incomplete air removal. The speaker pointed out where improvement is possible and compared the various auxiliaries in common use, such as circulating pumps and air pumps of the reciprocating, hydraulic and steam-ejector types. Owing to the shortage of copper the Government is seriously considering the elimination of the surface condenser for the period of the war. The effect on the coal pile must of course be considered, but the great saving in material by the use of jet or barometric condensers demands attention. With proper steps toward eliminating the action of the water, steel tubes might be used to advantage in surface condensers. In heat transfer the time element would be an important factor and would call for low circulating-water velocities.

There Should Be No Letup During the Summer Months*

With the advent of the hot weather a falling off in the sales of Thrift and War Stamps may be expected unless the efforts of the patriotic workers are not suffered to diminish. There need be no falling off in the sales, however, if we all keep our heads and continue to view the situation sanely and clearly. Let each one of us ask himself or herself whether the need for our coöperation is as great among the Allies as it was and then, when we have answered our own question in the affirmative (and who could answer it otherwise?), let us make up our minds at once that while the need exists the money shall be supplied. There were a million reasons advanced during the last Liberty Loan campaign why everyone should subscribe and induce others to do likewise, and there was not a reason advanced at that time that does not apply with just as much force to the War Savings Stamps now.

Someone may say, "But I've bought stamps until I'm almost broke," and they may really feel that they have a valid reason for not buying more, but people who talk like that have failed to grasp the significance of the situation. Such people do not stop to consider their sacrifices as compared to the sacrifices that are being made daily, hourly by the young men of America who are on the firing line in Europe.

There really should be no need to plead with anyone to buy stamps and thus have a part, though a small one, in this the greatest movement in the history of man. Every individual should consider this not alone a duty, but a great privilege. Now, viewing the matter from another angle, divesting the question of all sentiment, patriotism and obligation, let us consider it as a matter of dollars and cents.

And let us remember right at the start that we are not giving, we are receiving. We lend on the best security in the world and in five years the loan is returned with interest. But that is not all. Let us also remember that after peace has been restored and conditions return to normal the purchasing value of the dollar will be greater by far than it is now, so that every dollar saved now will doubtless do the work of two or more in a few years.

There is nothing new in the foregoing, but for the sake of emphasizing the importance of the War Savings Stamp campaign let us continue to keep this important matter before the people.

National War Savings Day

Every loyal American is being called upon to sign a War Savings Stamp pledge card that is in effect a renewal of the promise of loyalty that arose, consciously or unconsciously, from the heart of every American when the news came from Washington a year ago that we had entered the conflict and ranged ourselves on the side of civilization against the forces of destruction. The pledge card also means that the signer takes up anew the fight against extravagance and waste, which are enemies as deadly to the cause of the Allies as any bullet that wings its way from the German lines.

Remember this: You take no chances when you go the limit on War Savings Stamps. They are the best and safest investment in the world. They pay you 4 per cent. interest, compounded quarterly. They can't go below par. You can get back every dollar you put into War Savings Stamps any time you need it. You can turn them in at the Post Office any time for their full value plus interest.

Uncle Sam is asking hundreds of thousands of men to give their lives to their country. He is asking you only to lend your money. What are you lending?

June 28 is National War Savings Day. That's the day we sign up, telling Uncle Sam just how much we can or will do to help win the war. You are expected to pledge the full amount that you can afford to use to buy War Savings Stamps during the remaining half of 1918.

In every state, county, city, town and village the War Savings committees have prepared for this big patriotic rally day. Unless you have already bought W. S. S. to the $1000 limit, get busy and figure out the utmost you can do.—*W. S. S. Committee.*

Establish United States Service Clearing House for Engineers

Placement of engineers as civilians in any and all Government departments as well as in private positions will be the function of the newly established service clearing house in Chicago of the United States Employment Service of the Department of Labor. For some time a division of education has been operating, and this week a division of engineering was initiated with the appointment of A. H. Krom as director, reporting to Dr. P. L. Prentis, district superintendent. Offices have been taken at 29 South La Salle St

After graduation as an electrical engineer from Purdue University in 1910, Mr. Krom was for three years with the Commonwealth Edison Co., one year chief engineer of the Haskins Glass Co., two years power engineer of the Central Illinois Public Service Co., two years with the Illinois Public Utility Commission, one year assistant engineer at Springfield and one year as engineer in charge of the Chicago office. For the last 18 months he has been secretary of the American Association of Engineers.

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*From New York "Evening Sun."

National Coal Association's Program To Increase Coal Output

The National Coal Association issued the following statement June 15:

The National Coal Association, composed of bituminous operators, whose annual output exceeds 350,000,000 tons, has undertaken a program of maximum effort to increase production and minimize the serious results of the threatened shortage in coal next winter which now appears to be almost inevitable.

The entire membership of the association, consisting of approximately two thousand coal-mine owners and operators, is undertaking by scientific management and in other ways to increase production to the greatest possible total. A coal-production committee, of which A. R. Hamilton, of Pittsburgh, is chairman, has been appointed by the Board of Directors with instructions to coöperate to the fullest extent with the Fuel Administration and to comb the industry for practical ideas and suggestions to increase the amount of coal mined during the coming summer and fall.

Every producing field in the country is represented on the committee. Meetings will be held in Washington, beginning at an early date and continuing practically without interruption. Problems confronting the industry will be studied carefully, and constructive steps looking toward greater efficiency will be put into effect wherever possible.

At its annual convention in Philadelphia last month, the association pledged to the Fuel Administration its wholehearted support and endeavor in producing a maximum output. The appointment of the coal-production committee and the great program confronting the committee are an earnest of the intention to fulfill that pledge.

Mine output has been restricted greatly in the past by the shortage of railroad cars at the mines. To this dominating factor in curtailing production have recently been added others, among them being difficulty in securing sufficient labor and mine supplies. The coal operators realize that the situation confronting the nation is a serious one, calling for the best thought of the industry; the problem of producing more than 12,000,000 tons of coal weekly—an output never reached before—is no little one; but nothing that can be done will be left undone to mine coal.

New Publications

FUEL ECONOMY IN THE OPERATION OF HAND FIRED POWER PLANTS

The scarcity of coal last winter and the recent warnings of the Fuel Administration regarding the possibility of a shortage next winter emphasize the need for greater economy in the use of fuel. The present high rate of production is still insufficient to supply all needs, and there seems to be no possibility of an increase in the output of the mines sufficient to satisfy every demand. There are two possible results of this fuel shortage; either certain industries must close down or more work must be done with the coal available. The Engineering Experiment Station of the University of Illinois has issued a 90-page booklet printed in four colors which shows that the average small power plant can save 15 per cent. of its fuel by the exercise of greater care in equipment and operation. This means a saving of 12 or 13 million tons per annum if applied throughout the country. The purpose of the publication is to present to owners, managers superintendents, engineers and firemen certain suggestions which will help them in effecting greater fuel economy and in determining the properties and characteristics of the coal purchased. Features of installation essential to the proper combustion of fuel are discussed, the practice to be observed in the operation of the plant is outlined, and the employment of simple devices for indicating conditions of operation is prescribed.

Only a limited supply of copies of this publication is available for free distribution. Requests for copies should be directed to the Engineering Experiment Station, Urbana, Ill., and should specify "Circular No. 7."

Miscellaneous News

An Economizer and Boiler Exploded in the central power plant of the New Orleans (La.) Railway and Light Co. on June 10, injuring eight men, two probably fatally, and plunged the city into almost total darkness for nearly an hour. The business section of the city was kept lighted through sub-stations. The damage is estimated at $50,000. A fuller report of the accident will appear in a coming issue.

Feather River Development—The development of hydro-electric properties along the Feather River is the principal feature of the program of the California State Railroad Commission to increase the electric power production of the state. The plan suggested by the Railroad Commission includes the joint development by the Great Western Power Co. and the Pacific Gas & Electric Co. of the tremendous power possibilities along the Feather River. The work as proposed would mean the expenditure of at least $30,000,000. Government financing for the development is proposed.

Millions Saved by Daylight.—France, it is understood, estimates her saving in lighting and fuel alone by the daylight saving plan at not less than $10,000,000 a year. England is reported to have saved gas and electricity to the extent of about $12,000,000, and actually saved 300,000 tons of coal in the summer of 1916. Edinburgh saved $50,000 in fuel alone. Manchester, England, decreased lighting cost 15 per cent. over the previous year, and Nottingham 25 per cent. In Vienna the saving in lighting bills was $142,000. The estimated possible saving for the United States for the five months under this plan is placed at from $25,000,000 to $50,000,000 in lighting bills, and in fuel several million more.

Continued Failure of Coal Transportation—The failure of car supply at the coal mines still continues as is evidenced by conditions at the properties of the W. S. Barstow & Co. The normal supply should be at the rate of 266 cars per month and at no time during the past seven months has it been 50 per cent. The actual record is as follows:

	Cars
November	129
December	80
January	52
February	70
March	101
April	115
May	124

Unless there is a pronounced improvement in car supply in the next four months there is no doubt that the coal experience of last fall will be repeated during the coming winter, even though the winter may be a mild one.

Business Items

The Westinghouse Electric and Manufacturing Co., Pittsburgh, Penn., has purchased the property, business and good will of the Krantz Manufacturing Co., Inc., Brooklyn, N. Y., manufacturers of safety and semisafety electrical and other devices. The supply department of the Westinghouse Electric and Manufacturing Co. will act as exclusive sales agent for the products of the Krantz Manufacturing Co., whose business will be continued under its present name. H. G. Hoke, of the former company, will represent the supply department at the Krantz factory.

NEW CONSTRUCTION

PROPOSED WORK

R. I., Woonsocket—W. F. Fontaine, Arch., 285 Main St., is in the market for motors, etc., in connection with the erection of a 3 story spinning mill on Cass Ave.

N. Y., Hudson—B. Wenzel is considering plans for the erection of an electric lighting plant. Water from Lake Charlotte will be used to generate the power.

N. Y., Kings Park—The State Hospital Commission received bids June 12, for the installation of a heating system, etc., for the Employees' Home at the Kings Park State Hospital, from the W. B. Armstrong Heating Connections Co., 3 Fulton St., Albany, $20,966; Murtaugh & Reddington, 26 Pleasant St., Rochester, $22,500.

N. Y., New York—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to install boilers and superheaters at the Navy Yard, here. Estimated cost, $100,000.

N. Y., Olean—The Board of Armory Commission, 158 State St., Albany, received low bids for the installation of a heating system in its proposed 2 story, 52 x 110 ft. armory, from Hickey Bros., 256 North Union St., $4574; W. H. Simpson, 184 North Union St., $4853; Murtaugh & Reddington, 26 Pleasant St., Rochester, $7500. Noted June 4.

N. Y., Peekskill—The Village is in the market for new pumping apparatus. H. W. Taylor, 26 Cortland St., New York City, Consult. Engr.

N. J., Newark—The American Oil and Supply Co., Lafayette St., will soon receive bids for the installation of heating, lighting and plumbing systems in the proposed 1 and 2 story warehouse. P. B. Taylor, Essex Bldg., Engr.

N. J., Pompton Lakes—City will receive bids until July 2, for the erection of a brick and concrete power plant near the Pompton Lake Dam. Equipment including 2 turbine engines, electric switchboard, etc., will be installed. Estimated cost, $42,000. Noted June 4.

Penn., Hillsville—The Bessemer Limestone Co., Bessemer, plans to install an electric haulage system in its plant here. Estimated cost, $60,000.

Wash., D. C.—The Bureau of Accounts and Supplies, Navy Dept., Wash., D. C., will soon award the contract for machine and machine tools as follows:

(Item 1) two 15 hp. electric motors, 900 r.p.m.

(Item 2) one 15 hp. electric motor, 1200 r.p.m.; Class 397, Schedule No. 4704½.

Wash., D. C.—Bids will be opened June 25, by the Bureau of Supplies and Accounts, Navy Dept., for machines and machine tools:

(Item 1) 2 motor driven, double spindle, threading bolt machines; Class 423, Schedule No. 4733½, delivery Navy Yard, Norfolk.

(Item 1) 1 motor and drum type controller and pulley; Class 427, Schedule No. 4735½, delivery Navy Yard, Brooklyn.

June 28. (Item 1) 1 motor driven, cylinder grinding machines; Class 434, Schedule No. 4720½, delivery Navy Yard, Boston.

(Item 1) 10 turbo generating stes, 200 kva., 220 volt. a.c., 3 phase, 60 cycle; Class 432, Schedule No. 4738½, delivery Brooklyn, N. Y.

Va., Hampton—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install boilers and superheaters at Navy Yard, here. Estimated cost, $90,000.

W. Va., Mabie—The Randolph Smokeless Coal Co., is having plans prepared for the erection of a new plant near here. Electrical equipment will be installed. Total cost, $100,000. A. F. Bennett, Philippi, Pres.

Ga., Flovilla—City plans an election soon to vote on $25,000 or $30,000 bonds for the erection of an electric lighting plant and a water works system.

La., Cheneyville—City plans an election soon to vote on $16,000 bonds for the construction of an electric lighting plant and a water works system.

Tenn., Nashville—Morgan & Hamilton, 1400 8th Ave., N., plans to install motor driven machinery in its new addition now being constructed.

Ky., Seurgeant—The Whitley-Elkhorn Coal Co. plans to install electrical equipment in its plant here.

Ohio, Akron—Summit Co. received low bids for installing a heating system in the proposed 2 story dormitory addition to the Children's Home, from the Akron Plumbing and Heating Co., 73 West Exchange St., $3645; the Industrial Heating and Engineering Co., 413 Ohio Bldg., $3785; the H. P. Cahill Plumbing and Heating Co., 4 South Canal St., $3975.

Ill., Chicago—The Illinois Central R.R., 135 East 11th St., plans to install a low pressure steam heating system, direct radiation, in its proposed through depot on 53rd St. A. S. Baldwin, Ch. Engr.

Ill., Chicago—The Trustees of Sanitary District, 910 South Michigan Ave., received low bids (a) building a sewage pumping station, (b) furnishing 6 centrifugal pumps with auxiliary machinery, piping, etc., (c) one 72 in. centrifugal pump, complete, (d) 8 synchronous motors, exciters, etc., (e) switchboard, conduit and wiring, from T. J. Forschner Contg. Co., West Pullman. (a) $922,278, (b) $231,000, (c) $65,000, (e) $50,000; Nash Bros., 10 South La Salle St. (a) $1,547,000; Nash-Dowdle Co., 29 South La Salle St., (a) $1,396,653, (b) $230,000, (c) $16,000, (e) $47,500; Camden Iron Works, Linn and Coppers Creek, Camden, N. J. (b) $254,300, (c) $46,000; The Electric Machinery Co., 14th Ave. and Tyler St., Minneapolis, Minn. (d) $120,000; General Electric Co., 53 West Jackson Blvd. (d) $123,494; Westinghouse Electric and Manufacturing Co., Indiana Harbor, (d) $131,000; Beaver Electric Constr. Co., 30 North La Salle St., (e) $49,495.

Wis., West Milwaukee (Milwaukee)—The Globe Seamless Steel Co., Colby Abbott Bldg., is in the market for three 10 ton electric cranes in connection with its proposed 1 story factory. F. J. O'Brien, Gen. Mgr.

Kan., Baxter Springs—The Big Lead Mining Co. will build a concentration plant and install air compressor, engines, boilers, etc., in same. Estimated cost, $60,000. J. E. Hoshal, Supt.

Kan., Baxter Springs—The Cortez Mining Co., Jefferson City, Mo., will build a power plant, etc., near St. Louis, Okla. Equipment including a 125 hp. boiler, motors, pumps, etc., will be installed in same. Total cost, $68,000.

Kan., Newton—The City plans to build a sewage disposal plant and install two 300 gpm. motor driven centrifugal pumps, etc. in same. Black & Veatch, 502 Interstate Bldg., Kansas City, Mo., Engr.

Kan., Pittsburg—The Joplin and Pittsburg R. R., 1st National Bank Bldg., Kansas City, Mo., plans to build power houses and a 45 mi. transmission line from here to Columbus, Kan., and Miami, Okla., in connection with the construction of the new electric railway. Estimated cost, $400,000. E. E. Maxwell, Pittsburg, Ch. Engr.

N. D., New England—The Aaby Light and Power Co. plans to build an electric lighting plant and a flour mill.

Mont., Saco—D. T. Gilbert plans to extend and improve his electric lighting plant here.

Mo., Badger—The Badger Mining and Development Co. is in the market for belts, engines, boilers, etc., for installation in its proposed concentration mill near here. Total cost, $60,000. T. E. Forester, 103 Miners Bank Bldg., Joplin, Supt.

Mo., Joplin—The Connor Investment Co., Miners Bank Bldg., is in the market for boilers for the heating system in the proposed hotel annex on 4th and Joplin Sts.

Mo., Joplin—The Klein and Stern Investment Co., Frisco Bldg., will build a concentration plant. New equipment including engines, boilers, etc., will be installed in same. Estimated cost, $35,000. A. Klein, Supt.

Mo., Joplin—The Miami Yellville Mining Co., West 7th St., will remodel its concentration plant and re-equip same Mashinery to be installed includes engines, boilers, etc. Total cost, $25,000. J. Taylor, Main St., Supt.

Mo., Joplin—The Muskogee Lead and Zinc Co. is in the market for conveyors, air compressors, etc., to installation in the proposed concentration mill near here. Total cost, $58,000. E. C. Beatty, Springfield, Supt.

Mo., Joplin—The Playter Bros. Mining and Realty Co., 315 Wall St., will build a concentration plant at the Silver Fox Mine near Monarch, Kan. Boilers, engines, belts, etc., will be installed in same. Total cost, $60,000. G. H. Playter, Mgr.

Mo., Richmond—The Missouri Gas and Electric Service Co. plans to enlarge or improve its plant here. J. H. Boggs, Engr.

Okla., Pilcher—The Southwest Missouri R.R., Webb City, plans to build an 18 mi. transmission line from here to Miami, in connection with the construction of a new electric railway. Estimated cost, $150,000. A. H. Rogers, Webb City, Pres.

Okla., Poteay—The Citizens Consolidated Power and Electric Co., recently incorporated, has petitioned the city for a franchise to install and operate an electric lighting plant.

Okla., Quapaw—The Miami Co. will build a concentration plant near here. Equipment including boilers, air compressors, etc., will be installed in same. Total cost, $250,000. J. P. McNaughton, 8 A St., S. E., Miami, Supt.

Colo., Brighton—The Town is in the market for new pumping machinery in connection with its proposed water work extensions. Total cost, $50,000. P. O'Brien, 306 American Bank and Trust Co., Denver, Engr.

Colo., Sterling—The Presbyterian Congregation will soon award the contract for the installation of a steam heating system in its proposed church. Wilson & Wilson, Commonwealth Bldg., Denver, Arch.

Wash., La Crosse—The Washington Water Power Co., Spokane, may take over the electric lighting plant here, and extend an electric transmission line from here to Endicott. C. E. Uhden, Spokane, Ch. Engr.

Cul., Tiburan—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build a power house and a machine shop here. Estimated cost, $8000.

CONTRACTS AWARDED

Mass., Boston—The Board of Education has awarded the contract for the installation of a direct radiation system in the English and Latin High Schools on Warren Ave., to the J. L. Hern Engineering Co., 68 East St., $20,500. Noted May 28.

N. Y., Brooklyn—The Doehler Die Casting Co., 9th and Huntington St., has awarded the contract for the erection of a 7-story factory. A steam heating system and boilers for same, will be installed.

N. J., Kearney—(Arlington P. O.)—The Ford Motor Car Co., Highland Park, Detroit, Mich., has awarded the contract for the electrical work in connection with the proposed factory here, to the K. W. Electric Co., 49 Lawrence St.

Ky., Fulton—The Illinois Central R. R. 135 East 11th St., Chicago, has awarded the contract for the erection of various units including a 40 x 50 ft. boiler house here, to J. E. Nelson & Son, 118 North La Salle St., Chicago. Total cost, $225,000. The company is in the market for two 150 hp. boilers. Noted June 11.

Ohio, Columbus—G. Borden, Director of Public Service, has awarded the contract for the installation of a new heating system in the city hall, to the Huffman-Wolfe Co., Columbus. Estimated cost, $15,233. Noted May 14.

Ill., Amboy—The Illinois Central R. R., 135 East 11th St., Chicago, has awarded the contract for the erection of various units including a 40 x 150 ft. machine shop and boiler room, an 100 ft. electric turntable, etc., here, to W. J. Zitterell, Webster City, Ia. Total cost, $250,000. The company is in the market for two 150 hp. boilers. Noted June 11.

Ill., Carbondale—The Illinois Central R. R., 135 East 11th St., Chicago, has awarded the contract for the erection of various units including a 40 x 150 ft. boiler room and machine shop, an 85 ft. electric turntable, etc. here, to the Leyden & Ortseifen Co. 53 West Jackson St., Chicago. Total cost, $250,000 The company is in the market for two 150 hp. boilers. Noted June 11.

Ill., Mounds—The Illinois Central Ry., 135 East 11th St., has awarded the contract for the erection of a 40 x 50 ft. boiler house, an electric table, etc., in connection with the proposed improvement of terminal facilities here, to G. B. Swift & Co., 189 West Madison St., Chicago. Total cost, $250,000. The company is in the market for two 150 hp. boilers. Noted June 11.

Kan., Baxter Springs—The Board of Education has awarded the contract for the installation of fans and ventilation system in the Mark Twain and Eugene Field schools, to the M. C. Woodlong Heating and Ventilating Co., 512 Reliance Bldg. Kansas City, Mo. Estimated cost, $10,168. Plans include the installation of electric motors, fans, belts, wiring, electric switches and switchboards.

Mo., Kansas City—The Kansas City Railways, 303 Montgall St., has awarded the contract for the erection of a 43 x 82 ft. substation, to the L. Breitag and Son Constr. Co., 3701 West Prospect Pl. Estimated cost, $25,000. Noted May 14.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	....—....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.85	5.60
Barley	3.80	4.00
Rice	4.25	4.80
Boiler	....	....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.10	$4.70	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.40	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70	$3.25—3.40
Mine-run	2.35—2.50	3.00—3.15
Screenings	2.05—2.20	2.75—2.90

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.55-2.90	$2.55-2.70	$2.55-2.70
2-in. lump	2.55-2.90	2.55-2.70	2.55-2.70
Steam egg	....-....	....-....	2.20-2.40
Mine-run	....-....	2.35-2.50	2.00-2.20
No. 1 nut	2.55-2.90	2.55-2.70	....-....
2-in. screen	2.05-2.20	2.05-2.20	....-....
No. 5 washed	2.05-2.20	2.05-2.20	....-....

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$2.05	$2.35	$1.75
Pratt, Jagger	2.25	2.55	1.95
Corona	2.30	2.65	1.95
Black Creek, Cahaba	2.75	3.00	2.35

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.