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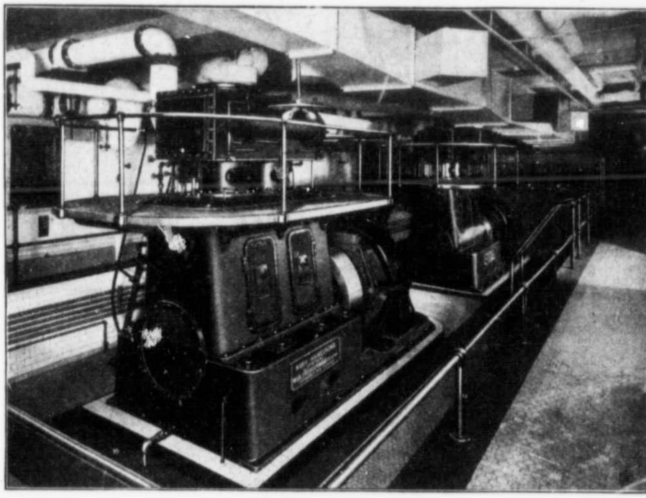

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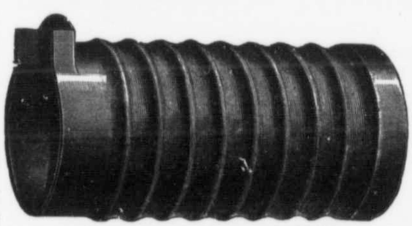

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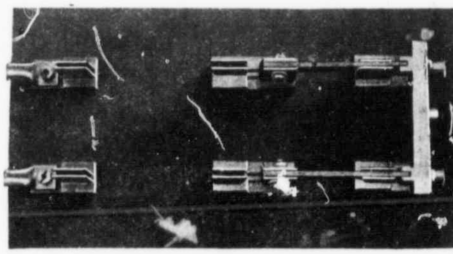

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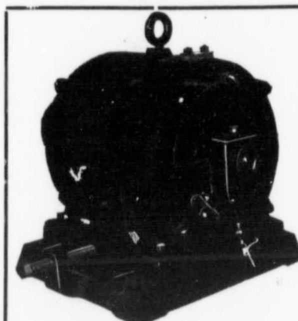

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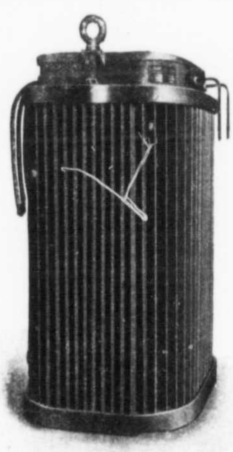

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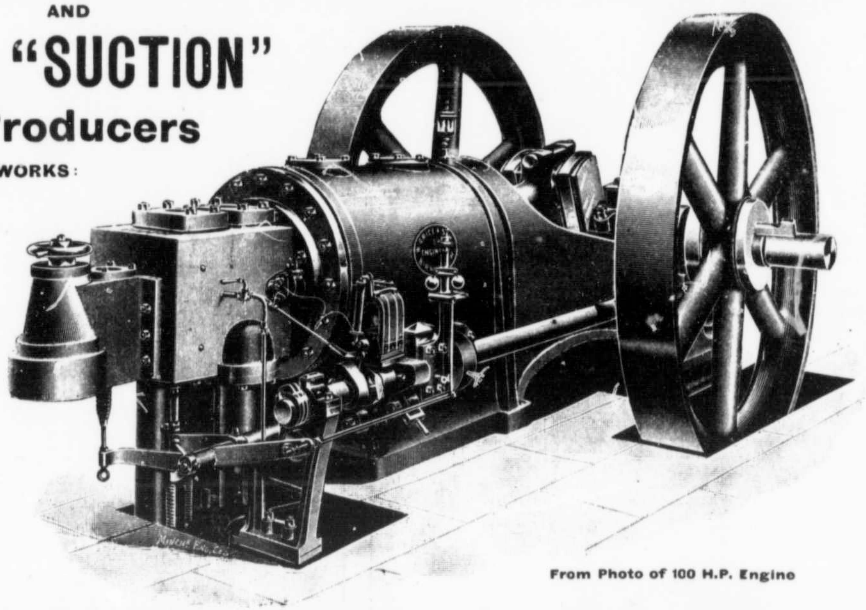

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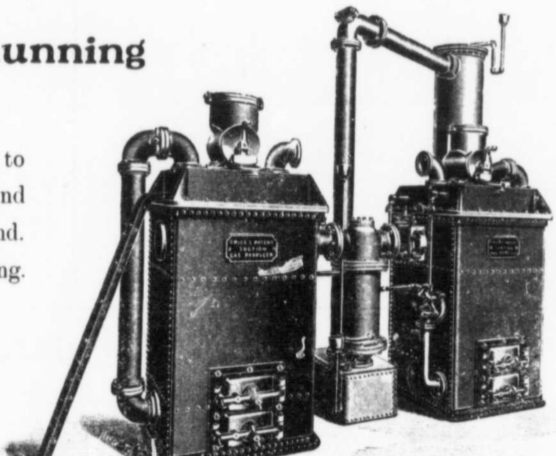

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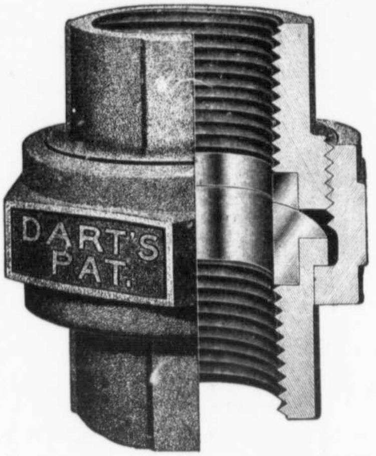

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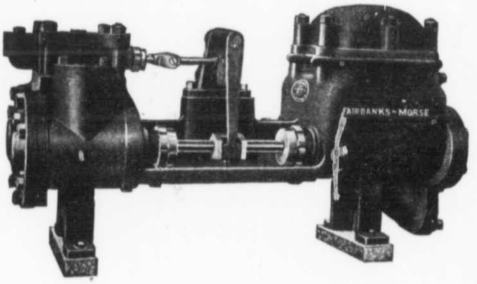

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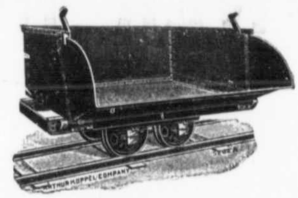

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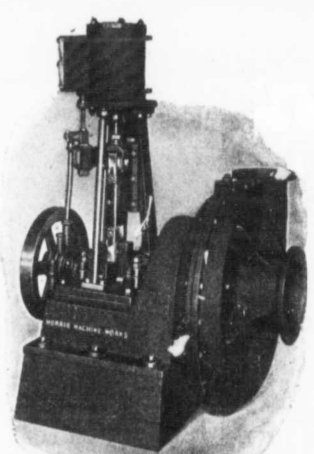

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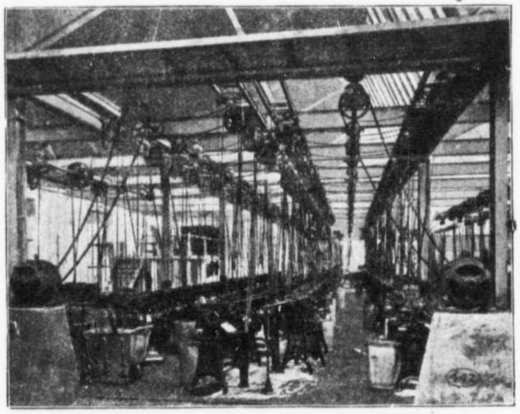

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Types of Mechanical Stokers and Grates

Description of Various Styles of Mechanical Stokers and Grates. First Section of Article. Second Section will Take Up Grates, and will Appear in Next Power Edition.

The following article is intended to place before the readers of THE CANADIAN MANUFACTURER simple and accurate descriptions of the features of different mechanical sto!—s and grates which are now in operation in power plants in Canada or which may be within a very few years. More complete descriptions are given of the styles which have been placed on the market recently, as they will not be so familiar to readers of the paper.

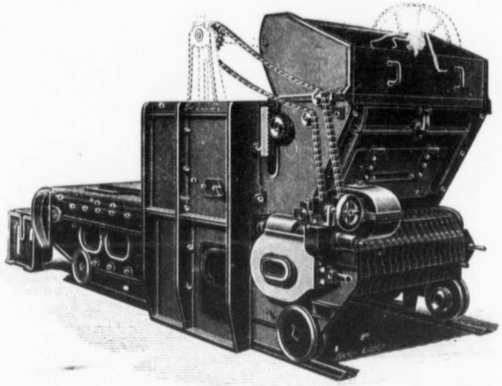


Fig. 1—B. & W. Mechanical Chain Grate Stoker, Forged Steel Construction Throughout.

This is the first section of the article, and is devoted exclusively to mechanical stokers. The second section, to appear in next month's Power Edition, will be devoted to different styles of grates—a line—not a definite one—being drawn between grates and mechanical stokers.

Babcock & Wilcox Mechanical Chain Grate Stoker.

The chain grate stoker has been long recognized by leading engineers as particularly adapted for burning bituminous coal without smoke and obtaining the best combustion results from the cheaper grades of this fuel and minimizing the cost of raising steam by reducing the labor of handling.

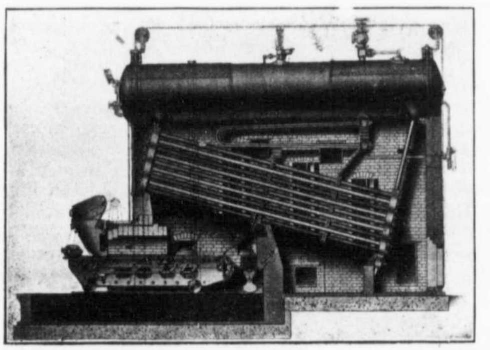


Fig. 2—B. & W. Mechanical Chain Grate Stoker, Installed in Connection with a B. & W. Water Tube Boiler.

The patent chain grate stoker made by Babcock and Wilcox, Limited, Montreal, provides for the even and continuous firing of coal in small quantities so that the distillation of the gases proceeds at a uniform rate, the volatile gas being liberated at the front of the furnace and, by passing over the incandescent fuel at the rear end, complete combustion is obtained with the minimum excess of air.

The stoker shown in Figs. 1 and 2, is the result of years of experience and scientific investigation. Particular attention is being given to Canadian and American fuels so that the grates are arranged with suitable air spacing and the necessary changes for dealing with clinkering coals.

Although the general arrangement is practically the same as that since adopted by other manufacturers

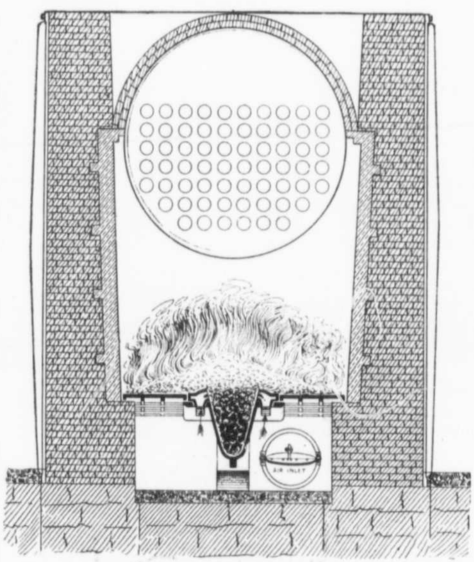


Fig. 3—Cross-Section Through Furnace Showing Retort, Dead Plates, Air Inlet, Etc., of the Jones Underfeed Stoker.

of chain grate stokers, it has many splendid features to recommend it—among the most important being, the design of the links and air seals which effectually prevent cold air from leaking past the grate, the facility with which the thickness of the fire and the speed of the grate can be regulated, the small amount of power required to operate it, and, in conjunction with this, the smooth running of the driving arrangement thus reducing riddling of fine coal through the grate to a minimum.

The proper adjustment for depth of fire and grate speed should be such that the fuel is burnt out by the time it reaches the ash plates over which the ashes and the clinker pass on to the doors, and are periodically dumped in the ash pit by simply moving a lever on the outside of the boiler setting.

The firebrick arches, in this design of the chain grate stoker, are so constructed that they ensure proper and smokeless combustion of the most fiercely burning coals, such as "Dominion," etc., and at the same time very few repairs are required.

Jones Underfeed Automatic Mechanical Stoker.

The principle of the Jones underfeed stoker, made by the Jones Underfeed Stoker Co., Montreal, is graphically

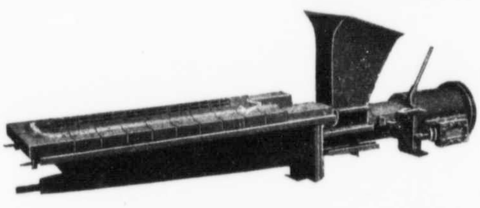


Fig. 4—Jones Underfeed Stoker Ready for Installing.

shown in Fig. 3, which is a cross-section of the boiler showing the shaped retort, dead plates and air inlet. Fig. 4 shows the stoker complete, ready for installation; and Fig. 5 is a complete installation, showing the method of control.

The object with the Jones stoker is to get a steady and uniform supply of fuel and a proper regulation of the air supply.

Operation of Stoker.

The operation of the stoker may be described as follows: Coal in the hopper descends through the opening in the throat of the machine immediately in front of the ram, and upon the forward motion of the steam actuated ram is introduced into the retort imparting an upward and backward movement to the whole body of fuel. Successive charges have the effect of elevating the fuel upward into the fire zone; and so the conformation of the fuel bed may be said to consist of three strata, viz., the green coal just introduced, the coal lying immediately above in process of coking, and the incandescent fuel bed at the top where combustion is completed. It is at the middle stage that the making of smoke is prevented. Here the air from the tuyeres permeates the fuel, uniting with the gases being released because of the great heat of the

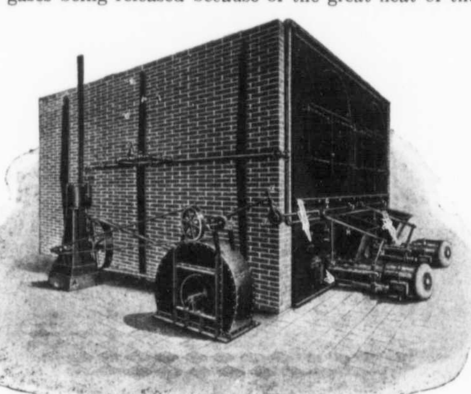


Fig. 5—Typical Installation of Jones Underfeed Stokers and Regulating Apparatus.

fires just above, and thus released the gases are burned in seeking an outlet through the uppermost body of incandescent coal. The whole effect is to elevate coke coal only into the fire zone.

The control of the elements affecting combustion is absolutely automatic in this method of stoking, and constitutes one of the distinctive features. As the steam pressure itself automatically proportions the fuel and the air to each other and the varying loads, the operation has the decided advantage of being both simple in application and positive in action.

Typical Illustration of Stoker.

In the typical installation shown in Fig. 5, the engine driving the blower is equipped with a regulating valve, which, as the steam pressure rises above a certain point, throttles the supply of steam, thereby slowing down the engine and the speed of the blower, and consequently diminishing the output of air; and vice versa, should the steam pressure fall. The engine also drives a crank shaft which runs along the front of the boilers, and operates the valve on the stoker cylinder, which regulates the amount of fuel fed into the furnace by means of the same regulating valve which controls the speed of the engine. The immediate effect is to diminish the amount of air and to decrease the quantity of fuel admitted to the furnaces

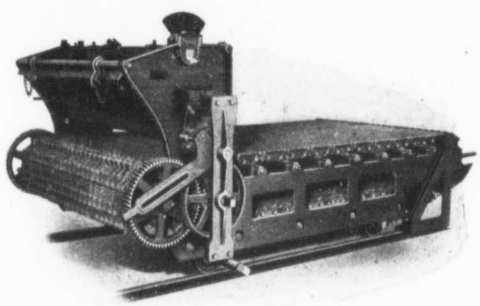


Fig. 6—The Green Travelling Link Grate.

if the steam pressure rises; and on the contrary, to increase the amount of air and to increase the amount of fuel if the steam pressure falls. The operation secures a correct proportioning of fuel and air, producing a clean and perfect combustion and eliminating smoke; limits steam production and burning of fuel to actual requirements; and being so completely automatic, responds immediately to fluctuations in load without attention or effort on the part of the operator.

The Green Travelling Link Grate.

The Green travelling link grate stoker, made by the Green Engineering Co., Chicago, consists of a rigid cast iron frame supported on truck wheels for the purpose of removing it from the furnace, and carrying thereon an endless chain which forms the grate surface, as in Fig. 6. The chain is caused to move forward by means of a train of steel gears actuated from an eccentric shaft supported on the boiler front. The attendant, if coal, and ash handling machinery is provided, has only to see that the stoker is so adjusted that the fires will be maintained in a uniform condition. The boiler damper being adjusted to the load requirements, the stoker can be easily made to harmonize therewith.

Construction of Grate.

The driving mechanism of the stoker is contained in a rigid bearing so that the wear on it and the power required to operate it are reduced to a minimum. The chain itself is formed of substantial links so designed that certain ones, designed especially to take the strain, carry the entire tension, the other clips being so designed that they are not subjected to the tension of the chain. A uniform air space around each link is provided. The longer links afford an increased overhang, so as to shear any clinker, which during the travel of the grate, may be brought up to the bridge wall, while at the same time it completely clears the ash from all the air spaces of the chain at every turn around the rear sprockets. The links of the chain are connected together by bars of oval section, which pass through round holes in the links or clips.

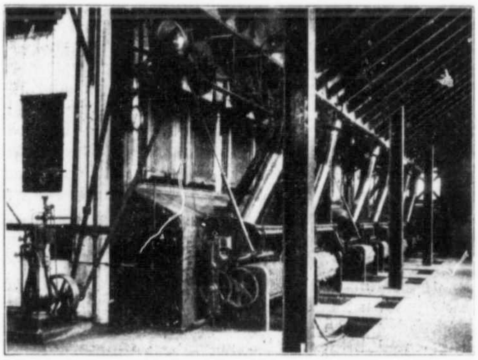


Fig. 7—An Installation of Green Travelling Link Grates.

The holes in the clips have a slot extending to the bottom edge, permitting any link or clip to be removed and replaced by another one without breaking the chain, removing the bars or interfering with the service.

The chain is supported at frequent intervals by rolls extending under the entire width.

The side frames and side girders are designed to be removed from the direct heat of the fire so that they are never cracked or burned due to this cause.

Operation of Stoker.

The coal is scraped off to a uniform thickness the entire width of the chain by means of an adjustable ventilated gate which can be set at any height from 2 ins. to 8 ins., and which, due to its design, permits the ready replacement of such of its parts as are most liable to failure.

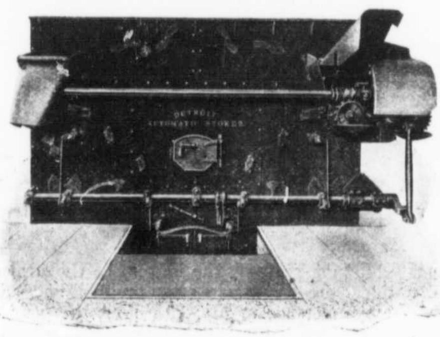


Fig. 8—Front View, Detroit Automatic Stoker with Worm Conveyor Feed.

As the fresh coal enters the furnace it is subjected to the radiated heat from the igniting arch, which causes it to instantly ignite. The uniform distance of this arch above the grate surface causes uniform intensity of ignition the full width of the furnace, which in turn causes uniform termination of the combustion and renders it possible to operate the stoker without bare spots on the grate surface. The arch itself is suspended from steel beams and the tile are made interlocking so that one or more can be removed and replaced without disturbing the rest of the arch.

The harder this stoker is operated the cooler it runs, and there is no rate of combustion so intense that it will injure the stoker. At each revolution the chain is cooled down to normal temperatures, and even at high ratings the hand can be comfortably placed on the chain just as it enters the fire.

The Green chain grate is made in two types, the standard grate suitable for the bituminous coals of the central and western part of this country, and the coking coal stoker, suitable for the semi-bituminous coals of West Virginia and Eastern Pennsylvania. Fig. 7 shows an installation of standard grates.

The Detroit Automatic Stoker.

From figures 8, 9 and 10 a good idea of the mechanical construction of the Detroit automatic stoker, made by the Detroit Stoker & Foundry Co., Detroit, can be obtained. This stoker has side feed, incline grates and an automatic clinker crusher. It is built with two distinct methods of feeding the fuel, one the worm conveyor, which is the more commonly used, and the other the reciprocating method, which is only recommended when the dutch oven or extension front is used,

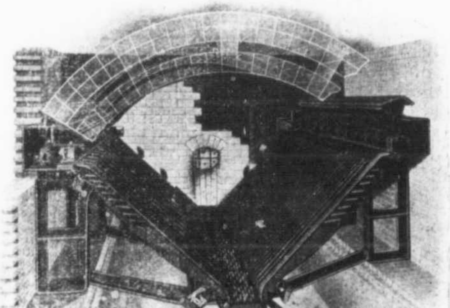


Fig. 9—Rear View, Detroit Automatic Stoker with Worm Conveyor Feed.

The coal is fed into the hoppers in front, either by hand or by gravity, as in Fig. 10. It is then fed into the stoker by means of the worm conveyors, and distributed evenly at the top of the inclined grates on the cooking plate.

Air is admitted through openings in the upper portion of the front of the boiler, as shown in Fig. 8, between the double arches, shown in Fig. 9. Thus the air can be controlled, and is heated before it strikes the fuel.

In Fig. 9 the right side air chamber and arch support is raised to show the end thrust ball bearing conveyor.

In the same figure the vibrating or operating grates are up on the right side and down in normal position on the left side.

The grates are of two kinds, stationary and operating, each alternate grate being operated continuously by the driving shaft in front. The vibrating grates leave a slicing vibration forward and backward, preventing clinkers from forming on the grates, and at the same time moving the bed of fire down towards the centre of the furnace.

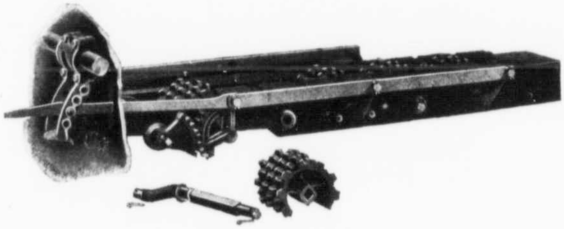


Fig. 10a—Detroit Stoker Clinker Crusher.

The vibrating grates are operated by upper and lower rocker bars connected to the lower driving shaft by links, which can be unhooked during the operation; thereby discontinuing the grate movement entirely when a non-coking coal is used. With this arrangement, either, both or neither end of the vibrating grates may be operated as described.

THE CLINKER CRUSHER.

In the centre of the stoker is a clinker crusher composed of a row of heavy cast iron disks which rotate alternately towards and from each other, crushing the clinkers and depositing them in the ash pit. This clinker crusher is shown in Fig. 9, but more clearly in Fig. 10. This does away with the necessity of cleaning the furnace by hand. In this way coal is fed into the stoker and ashes and clinkers removed without opening furnace door.

In Figures 11 and 12 are suggestions for labor saving methods for the handling of coal and ashes, which can be used in conjunction with this grate.

New Model Roney Mechanical Stoker.

This grate, shown in Fig. 13, the Westinghouse new model Roney mechanical stoker, is made by the Westinghouse Machine Co., and sold in Canada by the Canadian Westinghouse Co., Hamilton. A general description of the operation is:

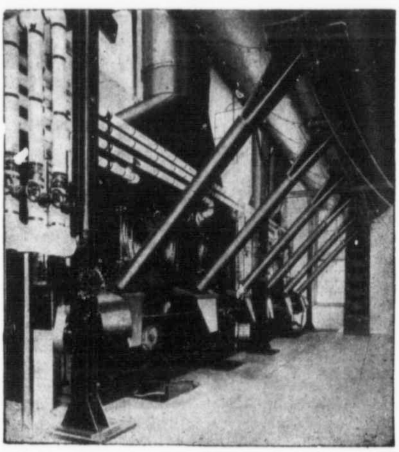


Fig. 10b—Installation of Detroit Automatic Stokers, Showing Method of Feeding the Coal.

OPERATION OF STOKER.

The coal is fed into a hoppr extending across the boiler front, usually by gravity from an overhead bin. From this hopper the fuel is automatically supplied to the furnace by a reciprocating pusher operated from the rock shaft by an eccentric. The fuel descends through the throat of the arch on to the upper grate bars where it is subjected to an intense heat radiated from the incandescent fire-brick arch spanning the upper portion of the furnace. This entirely cokes the fuel and drives off all the volatile gases, leaving the coke, or fixed carbon, which is then gradually worked down the inclined surface by the rocking motion of the grate bars, imparted to them from the eccentric on the rock shaft.

The oscillation of the grate bars not only work the fuel slowly down the furnace, but also keeps it constantly agitated, this preventing to a large extent the formation of clinker and bringing the fuel into intimate contact with the incoming air. After the solid combustibles have been totally consumed, the remaining ash is discharged on to the dumping grate at the bottom of the furnace. The operations necessary to clean the fire, will be readily understood by reference to Fig. 13. First the guard is raised, thus preventing the fuel bed from sliding. Next the dumping grate is dropped thus permitting the free descent of ash both front and rear of the axis.

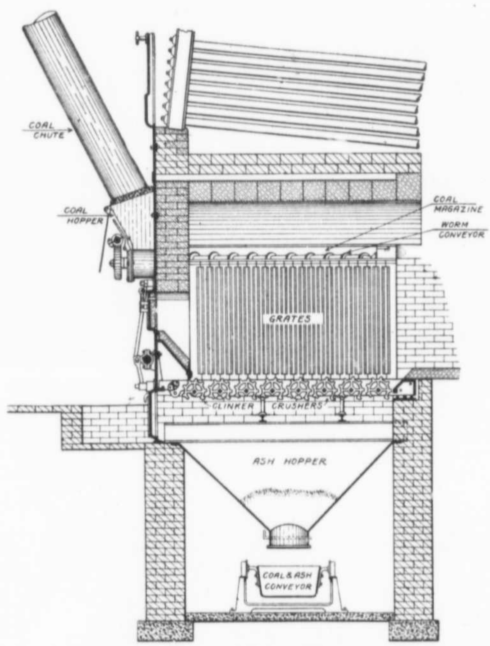


Fig. 11—Suggestion for Labor Saving in Handling Coal and Ashes.

Special Features of Roney Stoker.

One of the most important features of this new model Roney stoker is the sectional grate bar, or fire top, shown in Fig. 14. For the upper four grates, a nonsifting type

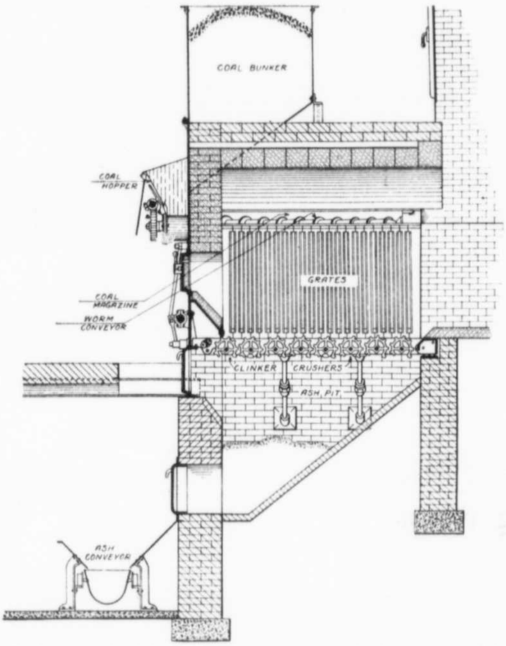


Fig. 12—Suggestion for Labor Saving in Handling Coal and Ashes.

top is used, provided with abutting horizontal ledges to prevent the fine fuel sifting through. The construction of the grate is made quite plain by the illustration and it is evident that the plates are easily removed.

The new type of guard prevents the fire from sliding into the ash pit when the dumping grate is operated; and the new dumping grate is hinged about one-third forward, dumping both front and rear.

The rocker motion is transmitted to the grate bars

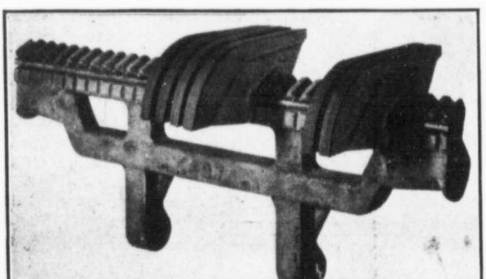


Fig. 14—Sectional Grate Bar, New Model Roney Stoker.

by means of a connecting rod from the eccentric "agitator."

The air supply is admitted through two wind gates, located on either side of the stoker as shown in Fig. 13. It first passes to the rear of the fire brick arch, extending across the front of the furnace, and is then directed by baffles to the crown of the arch, at which point it enters the front air spaces. From the latter, it enters the furnace through the spaces between the stoker front and the first ring of arch brick. Passing the air over the furnace in this manner, not only pre-heats the air, but assists materially in cooling the arch.

The fire brick arch is of such extent and so designed that it completely cokes the green fuel and directs the gases downward over the hottest parts of the fire, therefore, permitting the volatile gases to be completely consumed before coming in contact with any of the boiler heating surfaces.

New Lodges Being Formed

That engineers throughout Ontario realize the benefits to be derived from membership in the Canadian Association of Stationary Engineers is evident from the movements now on foot in several localities towards the organization of local lodges. These districts include Sarnia, Strathroy, and Dresden. Engineers in these different centres are talking the matter over, and meetings will be called, at which the organization of local lodges

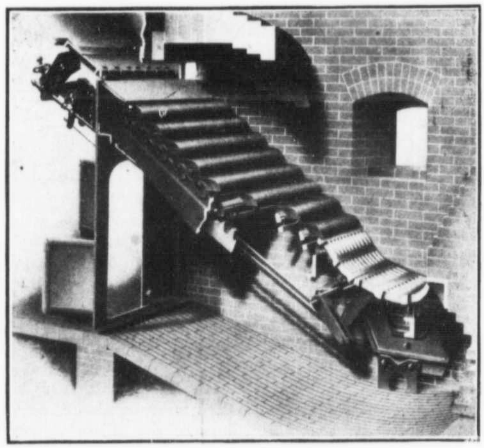


Fig. 13—New Model Roney Mechanical Stoker.

will be started. The Executive Secretary will probably be present at these meetings to lend his assistance and advice. It is fully expected that four or more new lodges will be formed before the end of this year.

The aims of the Association are such as to deserve the hearty support of all engineers and all others interested directly or indirectly in the advancement of stationary engineering. There is no doubt that as long as the Association lives up to the preamble to their constitution, it will do good work and will make steady advancement. The Association is building on a solid foundation; if the building material continues as good as heretofore, there is a big future ahead of the Association.

In this issue is continued a series of articles on the transformer designed to be of value to the man in the shop and also to the station operator. Some of the best practical information on transformers obtainable will be contained in this series of articles. The article in this issue treats with transformer insulation.

The Efficiency of Gas and Oil Engines*

A New Method of Stating the Power of Gas and Oil Engines, Claimed by the Writer to be more Convenient and Practical, and Also to form a Better Basis for the Comparison of the Thermo-dynamic Performance of Engines of Different Types. Power of Engine Expressed in Total Work Done by the Working Substance, called Thermo-dynamic Horse Power

BY LIONEL S. MARKS.

For a whole century the indicated h.p. of the steam engine has been accepted as the most satisfactory measure of the work done in the cylinder of that engine. When the gas engine came into use it was but natural that the same measure of its power should be used. So long as the whole cycle took place in one cylinder there was but little doubt as to what was meant by the indicated h.p. of the engine; but when auxiliary air and gas pumps were used, the indicated h.p. acquired special definition. A committee of this society reported in 1902 a code of rules which contained this special definition, and which has given a consistent meaning to the indicated h.p. of steam engines and of gas and oil engines of all types.

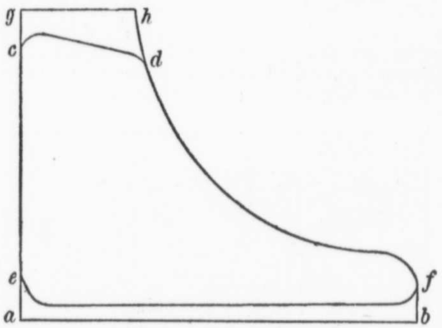


FIG. 1—Indicator Card of Steam Engine

The definition referred to is not, however, universally accepted. The pages of the Zeitschrift des Vereins deutscher Ingenieure for 1905 contain a long and most animated discussion by many of the ablest German engineers on the meaning of indicated h.p. and mechanical efficiency in two-cycle engines, and they show very marked differences of opinion as to the correct method of calculating those quantities. Within the past few months the definition of the indicated h.p. of a four-cycle engine has been the subject of debate by the British Institution of Mechanical Engineers, and a strong tendency manifested itself to take as the measure of the indicated work of a four-cycle engine only that area which is included in the positive loop of the indicator card.

DIFFERENT METHOD OF SLATING POWER OF ENGINE.

In all cases it has been assumed that the indicated h.p. is the best measure of the work done in the engine, but the differences of opinion as to the methods of its measurement are really indications of the fact that the indicated h.p. of an engine, and the quantities deduced from it, do not give that information which engineers have been trying to extract from them. The fundamental trouble with the indicated h.p. as the unit of power is that it does not represent the actual work done by the working substance, but the difference between that quantity and certain resistance. Consequently it does not permit a comparison to be made between the actual amounts of work done by the working substances in the cylinders of engines of different types.

So far as the steam engine is concerned, the indicated h.p. is certainly the most convenient and probably the most practical method of stating the amount of work that is done in the engine; but for gas and oil engines, it is possible to use another method of stating the power of the engine; a method which is not only more convenient and practical but which also gives more information as to the real actions taking place, and forms a better basis for the comparison of thermodynamic performance of engines of different types.

DEFINITION OF INDICATED HORSE POWER.

The indicated h.p. of a steam engine is really the algebraic sum of two quantities; these are (*a*) the total work done by the steam inside the cylinder and (*b*) the negative work done in overcoming the frictional and inertia resistances of the steam during the exhaust period. Thus, in Fig. 1, if *a b* represents the pressure in the space into which the steam is exhausted, the total work done by the steam in the cylinder is *a c d f b*, and of this am unt *f e a b* is used up in overcoming the resistances to the escape of the steam, leaving the area *e c d f* as the indicated work, or the total work done on the piston.

The work done in the cylinder is not however the total work done by the steam, since the steam has to do work in order to overcome the resistances to its admission. In Fig. 1, if *g h* represents the boiler pressure, the area *g h d c* is the work that the steam has to do in order to flow from the boiler to the cylinder. The total work done by the steam is consequently the area *g h b a;* and the area *c d f e* (i. e., the indicated work) is the difference between the total work done by the steam and the work necessary to get the steam into and out of the cylinder. The total work done by the steam in a steam engine is not shown directly on the indicator card, but has to be

FIG. 2—Indicator Card of Four-cycle Gas Engine

* Paper presented before the American Society of Mechanical Engineers in June 1908, at Detroit.

obtained by drawing in the boiler pressure line and prolonging the indicator card to meet it.

The indicated h.p. of gas and oil engines is defined by the Code of 1902 of the Committee on Standardizing Engine Tests, as the power developed in the engine cylinder (the algebraic sum of positive and negative works) minus the power indicated in the separate compression or feed cylinders, if there are any.

In a four-cycle engine, according to this definition, the indicated work is equal to the difference between the areas *c d e f* and *f a g b*, Fig. 2. If the area *e f b* be added

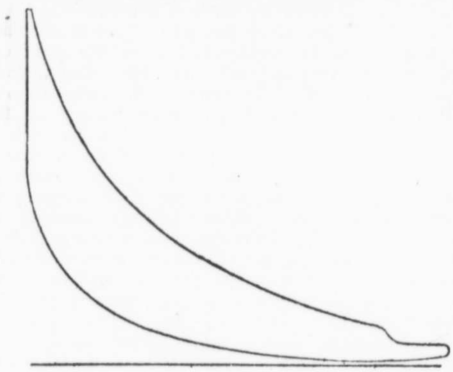


Fig. 3—Indicator Card of Two-cycle Gas Engine

to each of these, the indicated work is seen to be the difference between the areas *c d e b* and *e a g b*. The area *c d e b* is the total work done by gas; the area *a g b* is the work done in overcoming the resistances to the admission of gas, and the area *e a b* is the work done in overcoming the resistances to the exhaust of the gas; or in other words the area *e a g b* represents the work that has to be done to get the charge into and out of the cylinder. The indicated work of a four-cycle engine is consequently seen to be the difference between (1) the total work done by the gas, and (2) the work necessary to get the gas into and out of the cylinder.

In a two-cycle engine with separate air and gas pumps, or with preliminary compression of the charge in the crank case the indicated h.p., according to the definition, is the difference between (1) the main cylinder h.p., Fig. 3, and (2) the indicated h.p of the air and gas pumps, Fig. 4 and 5, or of the crank case, Fig. 6. In this engine the exhaust occurs only near the end of the stroke, so that the amount of work done by the main cylinder piston in overcoming the resistance to the escape of the gases is so small as to be practically negligible. The work represented by Fig. 3 is the total work done by the gas; while the work represented by Fig. 4, 5 and 6 is the work done in overcoming the resistance to the admission of the charge and consequently, in part, the work done in overcoming the resistance to the exhaust, since the incoming charge helps to force out the exhaust gases. The indicated h.p. of a two-cycle engine is seen to have practically the same meaning as the indicated h.p. of a four-cycle engine.

Considerations in Diesel Motor.

In a Diesel motor, the conditions are the same as in an ordinary four-cycle engine, with the addition that work is done in compressing the air used to spray the fuel. The indicated h.p. of the air compressor must, according to the definition, be subtracted from the indicated h.p. of the main cylinder in order to obtain the indicated h.p. of the engine. The difference between the areas *c d e b* and *e a g b*, Fig. 7, is the indicated work of the main cylinder, and, as with the four-cycle engine, Fig. 2, it is the difference between the work done by the gas in the cylinder and the negative work done in overcoming the admission and exhaust resistances. The compressor card however, Fig. 8, is different from the compressor cards for the two-cycle engine, Fig 4 and 5, for it represents not only the work required to overcome the frictional resistances of admission of the fuel spray to the cylinder, but also the work of compressing the air used for spraying up to the pressure existing in the cylinder during the admission of the charge. It is obvious that if a large percentage of the air used per cycle in a Diesel motor were compressed in the air compressor instead of in the main cylinder, there would be a serious error in regarding the work done in the compressor as part of the frictional resistance to the admission of the fuel. In actual engines, the indicated work of the compressor pump is generally at least 6 per cent of the indicated work of the main cylinder. It is easily possible by drawing the cylinder admission pressure line *c d* on Fig. 8 to separate the work done there into its two components; the work done in compressing the charge (area *b*) and the work done in overcoming discharge resistances (area *a*). The frictional resistance to the admission of air to the compressor is too small to be shown on the diagram. The total work done by the charge is then the algebraic sum of the positive area *c d e b*, Fig. 7, and the negative area *b*, Fig. 8, the work done in overcoming frictional resistances is the sum of the areas *e a g b*, Fig. 7, and *a*, Fig. 8. The indicated h.p. of a Diesel motor has the same meaning as the indicated h.p. of a four-cycle or a two-cycle engine; it is the difference between (1) the total work done by gas, and (2) the frictional resistances to the admission and exhaust of the gases.

Thermodynamic Efficiency and Net Efficiency.

In the analysis of the performance of a heat engine, there are two principal quantities that the engineer wants to know, namely (*a*) the thermodynamic efficiency of the engine, or the percentage of the total heat going to the engine that is actually converted into work, and (*b*) the net efficiency of the engine, or the percentage of the total heat going to the engine that is available for doing useful work. The difference between these two efficiencies is the percentage of the total heat going to the

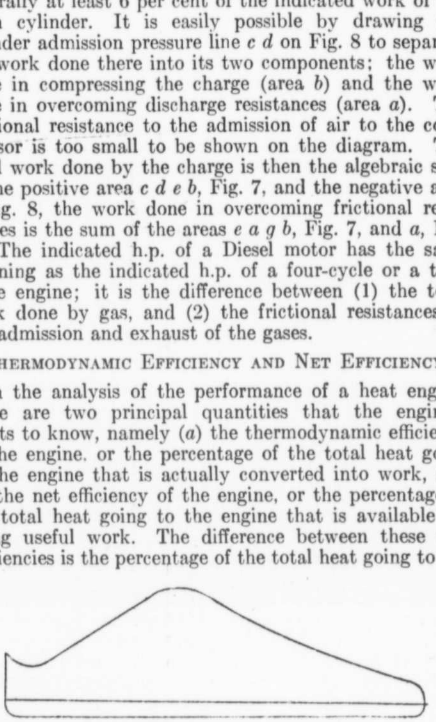


Fig. 4—Indicator Card of Air Pump

engine that has been used up in overcoming the various resistances which the engine itself offers to the carrying out of the cycle of operations.

It has been the practice in the past to calculate the thermodynamic efficiency by finding the ratio of the indicated work to the total heat supplied. But this does not really measure the percentage of the total heat that has been converted into work; it measures the percentage of the total heat that is available for doing work after certain engine resistances, viz.: those offered to the admission and exhaust of the working substances, have been overcome. The thermodynamic efficiency of an engine should have but one meaning and that is the efficiency of the engine in converting heat into work, irrespective of whether that work is used up, in part, in overcoming engine resistances or remains entirely available for useful applications. That is the plain meaning of the term and the only meaning which will permit a direct comparison of the efficiencies of the processes actually occurring in the cylinders of different engines. If the indicated work is used in calculating the thermodynamic efficiencies, such a comparison does not necessarily throw any light on the actual processes at all, since the frictional resistances resulting from a poor design of compression pumps, valves, ports, etc., may more than offset the gain from the use of a more efficient cycle.

It is, moreover, important that the thermodynamic efficiency should have the suggested meaning in order to permit a fair comparison with the ideal cycle. The state that the thermodynamic efficiency of a gas engine is 60 per cent. of the thermodynamic efficiency of the ideal gas engine working under the same external conditions, is

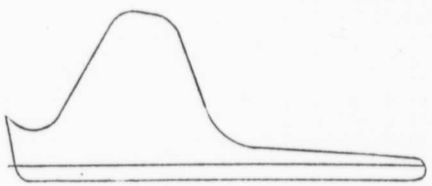


FIG. 5—Indicator Card of Gas Pump

entirely misleading, if the gas friction resistances to admission and exhaust have been subtracted from the total work done by the gas. In some engines, the gas friction resistances may amount to 15 or 20 per cent. of the total work, and if that were the case, an actual ratio of efficiencies of 70 per cent. would appear to be but 60 per cent., that is, the apparent possibility of improvement of the purely thermodynamic processes would be reduced from 40 per cent. to 30 per cent. If the gas friction is taken into account in calculating thermodynamic efficiencies, there does not seem any sufficient reason why the machine friction should not similarly be taken into account. The process of getting a charge into and out of the cylinder is purely mechanical—it is not part of the thermodynamic cycle.

Total Work of Dynamic Horse Power.

The writer believes that for gas and oil engines, the power of the engine can be most usefully expressed as the total work done by the working substance—this might be called the total h.p., or, since it measures the amount of heat converted into work, the thermo dynamic h.p. The total work for a four-cycle engine is the area *c d e b*, Fig. 2; for a two-cycle engine, the area of Fig. 3; and for a Diesel engine, the area *c d e b*, Fig. 7, minus the work represented by the area *b*, Fig. 8, of the air compressor card. As measured in this manner, the total work is not entirely independent of the design of exhaust valves and passages since the occurrence of release before the end of the stroke (which is necessitated by the resistance of the exhaust) reduces the total work area. It is only in the case of the comparatively early exhaust of the two-cycle engine that the actual work might be considered as being affected in an appreciable manner by the release before the end of the stroke. It is, however, proper to regard the work of this cycle as being finished when the exhaust opens—the toe of the diagram being the equivalent of the negative area of the four-cycle diagram. Since the area of the toe of the diagram is always extremely small, its inclusion in the total work area introduces no appreciable error.

The total work done by the working substance is used up in three ways.

a. In overcoming the resistances to the admission and exhaust of the charge; this may be called gas friction work.

b. In overcoming engine friction; this may be called machine friction work, and

c In doing useful work.

The indicated h.p. is then the total h.p. minus the gas friction h.p. and it retains the meaning it has always had.

What Gas Engine Tests Show.

An ordinary gas engine test permits the determination of the total h.p., the gas friction h.p., the machine friction h.p. and the useful or brake h.p. The value of finding these separate h.p.'s will be apparent if, for example, a comparison is to be made between two-cycle and four-cycle gas engines. It is urged against the two-cycle engine that it obtains its very great advantage of nearly doubled power per cubic foot of piston displacement, at a cost of considerable loss in efficiency. This loss in efficiency is said to be (1) thermodynamic, resulting from (*a*) the loss of some of the charge to the exhaust during admission, or (*b*) the retaining of too much of the burnt gases in the cylinders; (2) gas friction loss resulting from the separate compression of the gas and air and the consequent extra valve and pipe resistance, and (3) machine friction losses resulting from the actual mechanical arrangements. The statement of the separate h.p.'s will throw light at once upon all these points, and will show also wherein any particular engine fails to come up to the standard of its class.

From the commercial point of view, there is no advantage in retaining the indicated h.p., since it is the brake h.p. that the engine user wants. From the scientific point of view, the indicated h.p. can be of use only for the comparative study of engines and if it is not the best measure of power for that purpose, it should not be permitted to retain its present position.

If the total h.p., gas friction h.p., machine friction h.p.

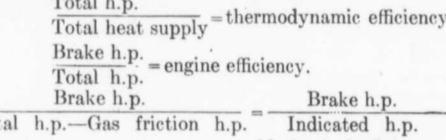


FIG. 6—Crank Case Indicator Card

and brake h.p. are used as the standard measures of the engine power and losses, the various engine efficiencies could be defined in the following manner:

$$\frac{\text{Total h.p.}}{\text{Total heat supply}} = \text{thermodynamic efficiency.}$$

$$\frac{\text{Brake h.p.}}{\text{Total h.p.}} = \text{engine efficiency.}$$

$$\frac{\text{Brake h.p.}}{\text{Total h.p.—Gas friction h.p.}} = \frac{\text{Brake h.p.}}{\text{Indicated h.p.}} = \text{Mechanical efficiency}$$

$$\frac{\text{Brake h.p.}}{\text{Total heat supply}} = \text{net efficiency.}$$

Thermodynamic efficiency × engine efficiency = net efficiency.

These definitions retain for indicated h.p. and mechanical efficiency their usual meanings.

The thermodynamic efficiency is the actual efficiency of the process of converting heat into work; the engine efficiency is the true measure of all the frictional losses of the actual mechanism, not only the friction of bearings and pistons, but also of the gas entering and leaving the cylinder; and the net efficiency is the quantity that interests the person who pays the bills for fuel. The mechanical efficiency has its use in showing the extent of machine friction losses, but unless the engine efficiency is also stated, it tends to obscure the real magnitude of the more or less avoidable friction losses in an engine.

Other Advantages of Suggested System.

There would be certain incidental advantages from the use of total h.p. as the unit of measurement apart from the more important scientific advantages of a unit which means a single definite thing—and not the sum of two quantities of very different kinds. In ordinary practice there is more complexity and greater possibility of inaccuracy in the measurement of the indicated h.p. of gas and oil engines than is the case with steam engines. The greater complexity arises from the fact that it is necessary in the two-cycle engine to take indicator cards not only from the main cylinder but also from the auxiliary gas and air pumps or from the crank case, and for a Diesel engine, it is necessary to take cards from the air compressor as well as the main cylinder. The greater inaccuracy results from the fact that in going round the negative area of the four-cycle, or Diesel-cycle cards, the probable planimeter error has the same absolute magnitude as in going round the positive area, and these two errors may both be of the same sign. If, to avoid this, a weak spring diagram is taken of the work of the exhaust and suction strokes, we have the complexity of another indicator. Of course when scientific results are needed, in which case the gas friction h.p. must be obtained, it will be necessary to take cards from all the auxiliary cylinders, and the greater complexity cannot be avoided; but for ordinary commercial purposes, if any measurement of power is required beside the brake h.p., the total h.p. would serve quite as well as the indicated h.p., and it could be obtained more easily and with

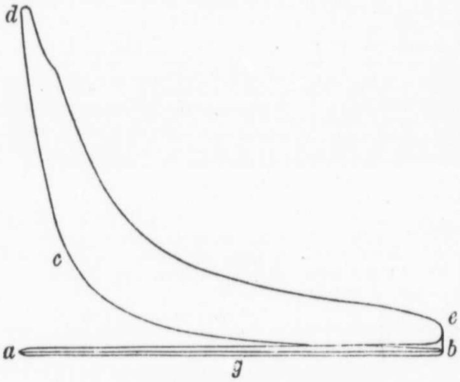


Fig. 7—Indicator Card of Diesel Engine

more accuracy. Commercially, the indicated h.p. is of no particular use when the brake h.p. is known, and scientifically it is less useful than the total h.p.

System Cannot be Applied to Steam.

The proposed new measure of power cannot be conveniently applied to the steam engine, nor does it seem desirable to so apply it, since the practice in that case is firmly fixed. In the steam engine, part of the compression work is carried out in the air and feed pumps, but the indicated work in these auxiliaries is not taken into account in calculating the indicated h.p.: i.e., a different practice exists from that which this society recommends as proper for the determination of the indicated h.p. for gas and oil engines. The history of the steam engine is probably more in the past than in the future, so that a change in the practice is not particularly desirable, even if practicable; but the history of the gas and oil engines is almost entirely in the future, and a proper choice of the units of power may help to make their history more clear.

In conclusion, the writer wishes to submit to the

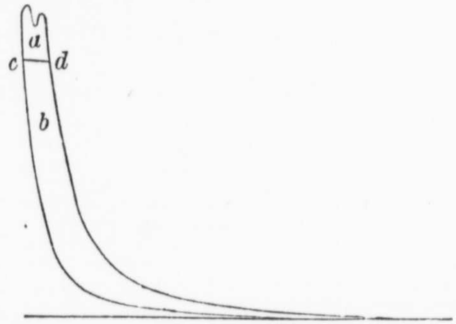


Fig. 8—Indicator Card of Air Compressor Diesel Engine

society the desirability of an early revision of the code of rules for carrying out and reporting gas and oil engine tests. The remarkable extension in the use of the gas engine, the growth of the large variety of types which that has stimulated, the considerable body of research throwing light on that motor which has been published since the appearance of the code, have made it apparent that the code is deficient in certain respects, and have rendered it desirable that many changes should be made.

When such revision is made, the writer hopes that there may be incorporated in it the suggestions as to h.p. and efficiencies which he has presented above.

Do the Thing Right

The first thing in the common sense creed is obedience. Do your work with a whole heart. Revolt is sometimes necessary, but the man who mixes revolt and obedience is doomed to disappoint himself and everybody with whom he has dealings. To flavor work with protest is to fail absolutely. When you revolt, why revolt—climb, get out, hike, defy—tell everybody and everything to go to Hell! That disposes of the case. You thus separate yourself entirely from those you have served—no one misunderstands you—you have declared yourself. But to pretend to obey, and yet carry in your heart the spirit of revolt is to do half-hearted slipshod work.—Elbert Hubbard.

An Irishman was returning to his native land. As the steamer came in sight of the coast of the Emerald Isle, his joy became so intense that the son of Erin shouted, "Hurrah for Ireland!"

This so disgusted an Englishman standing near that he sneeringly remarked, "Hurrah for Ireland—Hurrah for Hell!"

"That's right," retorted the Irishman, "every man for his own country."—Silent Partner.

Regulations re Engineers' Certificates

Amendments Made to the Regulations Governing Examinations and the Granting of Certificates. The Personnel of the Board of Examiners.

By Order-in-Council, dated 27th day of November, 1908, a number of changes were made to the Regulations Governing Examinations and the Granting of Certificates under the Act respecting Stationary Engineers.

Sections 6, 7, 8, 14, 17, were amended to read as follows:—

6. In all cases where the applicant for examination has had less than two years' experience as an engineer, fireman, oiler or assistant under the supervision of a competent engineer, and also in the case of any other applicant whom the Board deem should be so examined, the examiner shall examine a candidate orally on the questions contained in the examination paper, and have him demonstrate his knowledge of the operation of a steam plant in an engine and boiler room; and in cases where a candidate is examined in this manner, the examiner shall fill in on the examination paper, so far as possible, the replies received to the questions asked, and shall state his opinion of the candidate's

Mr. William C. McGhie.

ability and whether or not he possesses a practical knowledge of the subject dealt with.

7. Candidates must appear personally before the Board, or an authorized member thereof, or some person appointed by the Board and approved by the Minister, for examination, and in no case shall examinations be conducted by mail, nor shall examination questions be sent to a candidate by mail, nor shall he be furnished or made acquainted at any time previous to the examination with the questions upon which he is to be examined.

8. Answers to examination papers shall be passed upon at a meeting of the Board, at which all members are present, before certificates are granted.

14. Before presenting himself for examination, a candidate shall supply evidence satisfactory to the Board:

(a) as to his practical experience as an engineer, fireman, oiler or assistant under the supervision of a competent engineer;

(b) that he is of the full age of twenty-one years.

17. The fee for examination (including certificates) shall be three dollars; and in the event of a candidate failing to pass, the fee shall not be refunded nor credited to him if he again presents himself for examination.

The fee for the initial certificate granted under Section 6 shall be two dollars.

The fee for renewing a certificate, and for the issuing of a duplicate certificate, shall be one dollar.

The fee for renewal of a certificate, where the holder has failed to register before the first day of February, shall be five dollars.

WM. C. MCGHIE, CHAIRMAN OF THE BOARD.

Reference was made in the last issue of THE POWER EDITION to the qualities and experience of Mr. Wm. C. McGhie, the chairman of the Board of Examiners. We are pleased to note that Mr. McGhie's appointment has been received most heartily by all classes interested.

A photo of the new chairman is herewith given.

THE NEW MEMBERS OF THE BOARD.

It was generally expected that the Board of Examiners would consist of three practical engineers, to be chosen from different sections of Ontario and that all three would become permanent officers, giving their entire time to the work. It has been decided, however, to have but one permanent officer, the chairman, and that the services of the other two members of the Board should only be called upon as occasion demanded.

This being decided, it became necessary that leading engineers in Toronto should be appointed, as no engineer could frequently leave his permanent work at distant cities to partake in the deliberations of the board.

Messrs. Chas. Moseley, chief engineer at the Toronto Electric Light Co.'s plant and William Corrigan, engineer in charge of the power plant of the School of Practical Science, Toronto University, two eminently capable men, have been appointed to work with Mr. McGhie in the important duties under the act. Both of these gentlemen have had wide experience and know the requirements for a stationary engineer and can, with Mr. McGhie, be depended upon to bring the level of engineering up to a higher level.

Mr. W. B. Varley, secretary of the Minister of Agriculture, will act as secretary to the Board.

Regarding Engineer's Certificates

Editor THE CANADIAN MANUFACTURER, POWER EDITION:

Noting in your Power Edition, dated November 6, under the heading of Regulations Re Engineers' Certificates, a comparison as to prices charged for the same, claiming Ontario to be the cheapest. I wish to state that this is not the case. You quote Saskatchewan as charging $5.00, which is not correct. We pay $3.00 for each grade, making a total of $9.00, when we have written for the first-class grade. Then we have the privilege of taking charge of steam engines and boilers of any capacity in this province; besides the certificates are granted for life, and are not cancelled except for good cause.

Now as to comparison of cost. A Saskatchewan in twenty years pays $9.00, and holds a first-class engineer's certificate. Now the Ontario engineer pays $3.00 for certificate first year, $2.00 per year for the next nineteen years, making a total of $41.00 paid.

Alberta's laws are the same as in Saskatchewan, except that there is a slight difference in the horse power allowed by the three grades of certificates, and the certificates of the two provinces are interchangeable. I note that there is no provision for transference in the Ontario Act.

In the past our Provincial Board has granted third class certificates for Ontario Association certificates. Many of these men when presenting themselves for examination here, holding an Ontario first class, have failed to secure enough marks to obtain third class here.

That the graded law is a good one, and also Government inspection of boilers can be proven by statistics. According to the records kept at the Government office for this purpose, there has not been a boiler explosion of a serious nature reported since the Act was put in force.

GOLDEN WEST.

MOOSE JAW, Nov. 21, 1908.

[We are glad to have our correspondent correct the statement concerning the fees for engineers' licenses for Saskatchewan and Alberta.—EDITOR.]

PROSAIC AGE.

The modern Romeo climbed up the fire escape and stood beneath the balcony.

"Darling," he gurgled fervently, "I love you."

"But how do I know you speak the truth, Romeo?" responded the modern Juliet. "Men are so fickle these days."

"Fair one, I swear by yonder moon!"

Juliet laughed and showed her bridge-work.

"Why, you goose," she giggled, "that's not the moon. That's a headlight on an airship."

Pining for the days of Bill Shakespeare, the modern Romeo dropped down the fire escape just as the night watchman awoke from his nap.

NEW ONE.

Kind lady—"What was your last occupation, my poor man?"

Gritty George—"I was valet in a sawmill, mum."

Kind Lady—"Valet in a sawmill! Gracious, what were your duties?"

Gritty George—"I had to dress undressed lumber, mum."

Producer Gas and Gas Producer Plants

Third of a Series of Articles Appearing in the Power Edition, Taking up This Subject in an Educative Way. Informati n Has Been Gleaned from Various Noteworthy Authorities, Names of Authorities Being Given. Absolute Confidence Can be Placed in all Statements and Claims, as They Come from Some of the Highest Authorities on This Subject. This Series of Articles will be Followed by Another Series on Large Power Gas Engines. Each Article will be Complete in Itself. This Article Deals with the Suction Gas Plant and Its Parts.

By J. C. Armer

The Suction Producer Plant.

The historical sketch shows us that the suction plant is a development of the pressure plant, and in spite of the short time since the first successful suction plant was built and operated, it has become exceptionally popular. Indeed it must be said that the suction plant is responsible for the remarkable progress that producer gas has made in America, and for the prestige it has gained. In Canada certainly it is the suction plant which is arousing so much interest among manufacturers, probably one reason being that the size of units required are more to be desired for various reasons in the suction producer than in the pressure plant.

Operation of Typical Plant.

Since this paper is meant to give special attention to suction plants, it is in keeping that a detailed description of the operation of a typical suction plant should be given. The general principles involved in the manufacture of producer gas have already been explained in the previous articles of this series, and need not again be introduced.

When the engine is running the suction during the admission strokes of the engine draw a regulated mixture of air and steam up through the bed of incandescent fuel in the generator, A. Fig. 1, where the gas is formed. The gas collects in the annular ring, shown at 1, and passes on through the vaporizer B. Here the hot gas gives up part of its heat to the water, and steam is formed to be mixed with the air. From the vaporizer the gas is drawn into the scrubber or washer C, through the water seal shown at 2. The scrubber is filled with coke or some other substance which will answer the same purpose, over which water is continually sprinkled, as shown in the upper portion of the scrubber. As the gas makes its way up through the coke it is washed, to remove dust and particles of tar if possible, and is thoroughly cooled. After having passed through the water seal and through the scrubber the gas is quite damp; and it is to dry the gas and to further purify it from all objectionable matter that it is drawn through D, the sawdust purifier. From thence the gas in some plants passes through what is called a pressure equalizer, of which more will be said later, before being taken into the engine through the mixing chamber.

The generator is provided with coal by means of the charging box, shown in 3, which is a device to feed fuel into the generator without the admission of air.

The plant is started up by blowing up the fire in the generator with a hand blower shown at 4, the valve to the engine being closed and that to the ventilator shown at 5 being opened.

As soon as the fire is in a sufficiently high state of incandescence and the gas is of good quality, of which more will be said later, the hand blower is shut off, the ventilator valve closed and the engine started. Steam will have been produced by the passage of the poor gases through the vaporizer and up the ventilator, so that when the engine is started it will draw the required mixture of air and steam up through the generator giving the correct gas composition to start operating upon.

The Generator.*

The generator has the following three essential features, a mantle or covering made of cast iron or sheet iron, containing refractory lining which forms a retort, a grate and an ash-pit. The cast-iron mantle is only used for small generators, as its cost is prohibitive in the case of large sized generators. The riveted sheet-iron casing is also used in the latter case to reduce the weight.

The shapes of the generators are usually cylindrical, but are often rectangular and sometimes even conical.

The different parts of the generator, if made of sheet iron, are held together by means of angle irons forming yokes, a sheet of asbestos being interposed. If the parts are made of cast iron they are connected in the same manner as pipe joints, and the joints are packed with compressed asbestos. These methods of connection allow free expansion of parts and thus secure joints, the importance of which can be realized when the ill effects of air leakage into the generator are considered; that is the interfering with the quality of the gas, and the danger of the production of an explosive mixture.

Between the external mantel or shell, shown at 6 in Fig. 1, and the refractory lining, 8, is a layer of sand, asbestos or some other bad conductor of heat, so as to prevent as far as possible loss of heat due to external radiation. Sand, however, used for this purpose, does not give the best of results.

The refractory lining consists of fire bricks made from the best quality of refractory clay. This lining is built up with fire-bricks, instead of as a solid retort, so as to facilitate repairs. The fire-bricks are cemented together with refractory cement, which is also used to form a continuous cement surface on the inside of the retort. It is comparatively difficult to obtain fire-bricks suitable for lining generators; their quality depends very con-

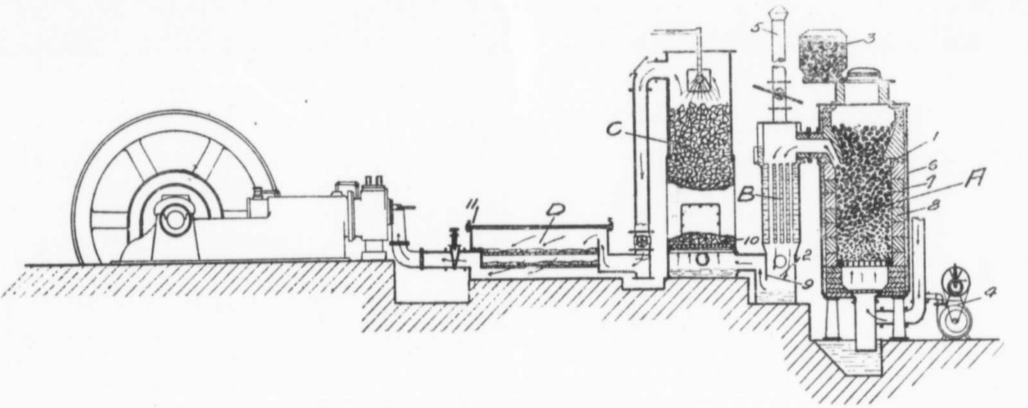


Fig. 1—Typical Suction Gas Plant and Engine.

* The two authorities for information on the detail parts of the suction plant are: "Suction Gas," by O. W. Haeussgen and "Gas Engines and Producer Gas Plants" by R. E. Mathot.

siderably upon the properties of the materials used in their manufacture, and thus upon the part of the country in which they are made. The fire-bricks for lining generators must be made according to the drawings, as it is necessary that each brick should fit its place nicely with a clearance of about one-sixteenth of an inch.

The interior of the generator consists of two parts, the fire space or retort proper, and the heating space. The heating space is above the annular space arranged for the collection of gas. In this space the coal is heated before falling into the space below. Sometimes, as in the case of the generator shown in Fig. 1, the coal rests against the lining of the chamber; whereas in other cases the feeding hopper extends down from the charging box in the top of the generator, into this heating space, and then the annular space for the collection of gas is usually coincident with the space around the feeding hopper. In this arrangement a considerable amount of the heat in the gas can be utilized to pre-heat the coal.

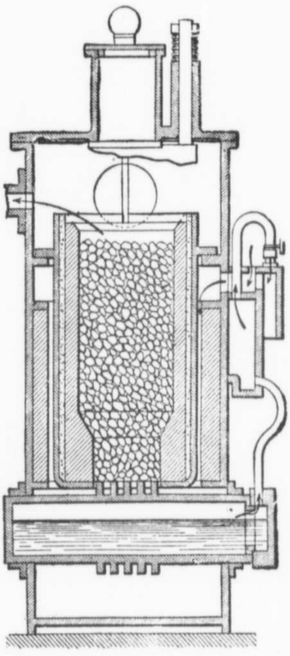


Fig. 2—Bernier Producer Showing Bernier Style of Grate.

In the top part of some generators, and in suitable places in the sides, small openings are provided which permit the introduction of iron bars for the removal of the slag which clings to the generator lining.

Grates and Ash Pits.

The grates and the support for the lining of the generator, are in contact with the hottest part of the fire, and therefore are liable to deteriorate rapidly. For this reason it is necessary that they be removable. There are many types of grates, but because of the rapid deterioration it would appear that the grate with the removable bars would be preferable, although for small producers the plain cast iron grate is quite suitable. For large grates, however, it is practically essential that the bars be separate, so that should one bar burn out it would be necessary to replace this one bar only.

These bars are composed of a special hard iron.

Some grates are stationary, while others are movable and may be turned about in a horizontal direction or tilted in order to remove ashes and refuse.

There are special styles of grates, patented in some instances, and two of these are well worthy of our attention.

One of these is the patented cone-shaped grate, used in the pressure plant made by Crossley Bros. The apex of the grate projects into the fire space, while its base rests on the bottom of the ash pit. The grate-bars are concentric around the cone shaped grate. The grate is designed so that it may be rotated by means of bevel gears, whereby the ashes are caused to slide down to the ash-pit.

The other special grate is a French one, that invented by M. Bernier, in 1898, and although this is one of the oldest forms of grate construction, it has so many admirable features that it is of considerable interest at the present time. This grate is shown in Fig. 2 and consists of a hollow cast iron cylinder, passing through the shell of the ash-pit and supported in two journals, which allow the grate to be revolved. The central part of this cast iron cylinder which is directly below the fire space is closely studded with short square projections or teeth that carry the fuel, and form a substitute for the grate bars. On the bottom of the ash-pit a comb-like contrivance is fixed, the prongs of which enter the clearances between the teeth. By turning the cylinder occasionally the teeth are successively brought in contact with the fire, whereby the wear is distributed equally over a large surface. Water is constantly passed through the hollow of the grate cylinder to keep down destructive temperatures; this water is afterwards used in the production of steam; so that the heat taken from the grate is not wasted. As may be seen in the illustration referred to, water vapor is produced in the grate and rises to a chamber above.

In some generators a space is left between the grate and the support of the lining, as shown in Fig. 3. This arrangement has the merit of allowing only finely divided and completely burnt ashes to pass to the ash-pit; then again a large grate surface can be obtained, thus facilitating the passage of the mixture of air and steam. This space between the retort support and the grate is provided with a door through which slag and cinders can be removed.

In the other generators the grate rests either on the support of the generator lining, as shown in Fig. 1, or upon a projection embedded in the lining. Some special generators have wide hollow grate bars, through which water circulates.

Certain producers have no grates, the fuel being held in the retort by the ashes, which form a cone resting on a sheet-iron base. In order that the fire may be stirred from below without entirely destroying the cone of ashes, the generator is supplied with a poker comprising a central fork, which is worked with a lever.

Ash-pits, as well as the grates, are exposed to the destructive effect of the high temperatures, and moisture, and should preferably be made of cast iron, sheet-steel being liable to corrosion quickly.

Some ash-pits are dry while others contain water, as shown in the typical plant in Fig. 1. Such ash-pits formed as water-cups are fed by the overflow from the vaporizer, and the ash-pits themselves are provided with an overflow consisting of a siphon tube forming a water seal. The water in the ash-pit serves a good purpose, in that the vapor rising from it tends to cool the grates; and under conditions such as these it is possible to pre-heat the air, and also to superheat the steam to a greater extent than if the ash-pit were dry, since then the damp steam in the mixture is relied upon to cool the grates.

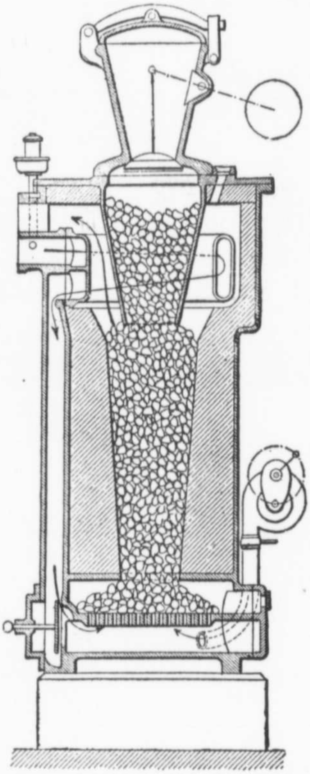


Fig. 3—Producer in which there is a space Between the Grate and the Support for the Lining.

If it is possible to preheat the air considerably and to highly superheat the steam more of the otherwise wasted heat from the gas can be utilized, and thus the thermal efficiency of the producer plant can be increased.

The doors of the ash-pit, and also the doors of the fire space in the generator, are usually made of cast iron or cast steel and are strongly constructed, since they as well as the grate and dry ash pit are exposed to the damaging temperatures. Particular care must be taken in the fitting of these doors in the generator so as to make them air tight.

In the suction producer there must not be leakage of air into the generator through these doors, since it would interfere with the proper operation of the generator; and in the pressure plant there must be no leakage of gas from the generator as it is very poisonous. To accomplish this end the engaging surfaces of the frame and the door are carefully finished, and the door is pressed firmly against the finished surface of the frame by means of a screw which operates through a yoke spanning the door and resting on the producer. The pintles of the hinges should be carefully adjusted so that the joint members of the door shall remain true. Some authorities claim that hinges with horizontal axes are preferable to those having vertical axes. The door of the furnace in the best practice is lined with refractory material to protect it against the radiated heat of the fire. To enable the grates to be cleaned with a tool, the doors are sometimes provided with holes, closed when not in use with air-tight plugs.

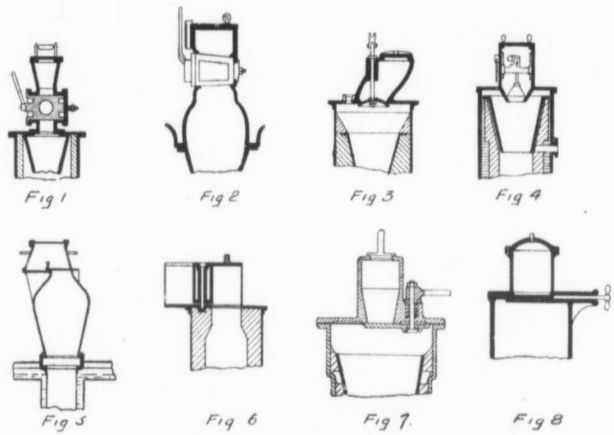


Fig. 4—Different Styles of Hoppers.

Charging Hoppers or Boxes.

There are almost as many styles of charging boxes, or apparatus for charging the generator with fuel, as there are makes of generators, but all of these incorporate one of two principles, a single closure or double closure.

In the double closure principle there is a preliminary chamber with two openings, one to the outside air and one to the generator, both of which have devices for closure. In this principle the charging operation consists of first charging the preliminary chamber with fuel and then emptying to the generator when the opening to the atmosphere has been closed. This prevents any inrush of air to the generator in the case of the suction plant, and any escape of gas from the pressure plant.

The single closure principle is very poor, and is not employed in any good type of generator; and for that reason our attention will be devoted to the other principle.

The point in which there is the radical difference between the many types of charging hoppers is the style of valve between the preliminary chamber and the generator; and charging hoppers may be divided into three main classes in this respect, namely those having cock valves, those having lift valves and those having slide valves. These three types of charging boxes are shown in Fig. 4. First and second are illustrative of the cock valve, third and fourth of the lift valve and fifth, sixth, seventh and eighth of the slide valve.

The cock consists of a large cast iron cone, provided with an opening and operated with a handle, which revolves in a sleeve formed in the charging box. The chief advantages of this type of valve are its simplicity, compactness, strength and the ease with which it can be taken apart for cleaning.

The lift valve consists of a conical or partially spherical shape, which is moved up and down by means of a lever; this is held in position either by means of a counter weight as shown in the third illustration, or by the weight of the valve and the fuel in the box as shown in the fourth illustration. This style of valve insures a tight joint irrespective of wear, and has the advantage of evenly distributing the fuel as it falls into the generator. But it is apparent that to insure easy and smooth operation in the case of a valve such as illustrated in the fourth illustration, there must be careful designing and considerable strength of parts.

Styles of the slide-valve as commonly spoken of are shown in the seventh and eighth illustrations, used in the Bernier plant, and the Tangye plant respectively; but the valves used in the Crossley charging box and the Pintsch, shown in the fifth, and sixth illustrations, respectively, must also be included in this type. This slide valve closure commonly consists of a smooth finished metallic plate movable below the charging box, either in a revolutionary way, or in a longitudinal way. The disadvantages of the slide valve, as illustrated in Figs. 7 and 8, can easily be imagined; since the plate is operated from the outside, it is evident that the slightest play, the wearing of the pivot or the weight of the charge, will form spaces between the plate and its seat, through which air may rush in or gas escape, according as the plant is suction or pressure. The design of these valves does not appeal to one as being a good or serviceable one. The advantage which may be claimed for them is their simplicity of design; but the actual construction, if well done, cannot but require considerable work, in the case of the Tangye at least.

Feed Hopper.

Most generators are provided with hoppers situated below the charging box, for feeding the coal uniformly to the generator, and also to act as a storage chamber for the fuel. These are known as feed hoppers. Usually they are tapered conically downward, but are sometimes cylindrical, and are made of cast iron. They are removable and easily replaced. The annular space between the feed hopper and the lining of the producer acts as a receiving chamber for the gas, which imparts some of its heat to the coal before proceeding through the external vaporizer.

In the case of generators having the vaporizer within themselves, the feed hopper often forms part of the water tank, and the main part of the hopper is above the top of the generator. But in the Crossley generator this is not so. Here the hopper forms part of the water tank, but that part of the tank projects down into the generator allowing the hot gases to come in contact with a large heat absorbing surface.

[The next article in this series will be a continuation of the suction plant, taking up the manner of air supply; the vaporizer; dust collectors; cooler, washer and scrubber; purifying apparatus; gas holder and regulating bell; pipes and connections —Editor.]

Open Meeting of No. 1. C.A.S.E.

On November 20 an open meeting of Lodge No. 1, Toronto, of the Canadian Association of Stationary Engineers was held in their rooms. An address was given by C. B. Turner, New York, on Formation and Prevention of Boiler Scale.

On December 18 a smoker will be held, at which a short address will be given.

Catalogues Worth Having

These Catalogues will be sent by the firms upon request. Mention The Canadian Manufacturer.

Lime Kiln Costs—"What are Your Lime Kiln Costs?" is the title of an attractive booklet issued by the Harbison-Walker Refractories Co., Pittsburg, Pa. The booklet contains an attractively illustrated article emphasizing the fact that quality is cheapest in the end, and telling of the methods of this company in the manufacture of fire brick specially suitable for the lining of lime kilns.

Diamine Colors on Cotton Yarn—Catalogue of the Cassella Color Co., 182-184 Front Street, New York, containing samples of Diamine colors on cotton yarn. The catalogue is 6½ inches by 10 inches by 2 inches thick. It is a most complete and valuable catalogue of reference for manufacturers using dyestuffs. In the front of the catalogue are detail instructions as to the use of the dyestuffs.

Underground Insulation of Steam Pipes

Taking Up Methods of Insulating Underground Steam and Hot Water Pipes. Abstract of Paper Presented Before Ohio Society of Mechanical, Electrical and Steam Engineers, Nov. 21, 1908.

Why do we insulate underground steam and hot water pipes? In order that we many carry our steam or hot water the required distance with the least possible loss of heat or power. The insulation of such pipes can only be obtained by confining that pipe within a covering, which contains dead, dry air split up into small particles by the use of some non-conducting, indestructible materials, felted or massed together. Underground insulation of such pipes is difficult for two reasons: First, on account of dampness getting into the covering (water being a good conductor of heat), which cannot be readily driven off. the pipes being confined by the earth; and secondly, that the coverings themselves are liable to be attacked by destroying influences found in the earth itself. These combined with the heat of the pipe inside and dampness on the outside of the covering, means certain death sooner or later to anything of an organic nature. Consequently, the future insulation of these pipes must of necessity be confined to methods and materials, which will positively safeguard the pipes against such influences as above mentioned, and so far as present knowledge permits this seems to be either the tunnel or some form of conduit composed entirely of inorganic substances. We will consider these two types.

No one will dispute the statement that a tunnel is a pretty substantial proposition, but in a good many ways it has advantages which are worth consideration. The pipes are always accessible and if a leak occurs there is not much trouble in locating it so that repairs can be made without much difficulty. New pipes can be added from time to time as occasion requires, the tunnel being erected in a permanent manner and of size sufficient to accommodate additions. On the other hand the first cost is very high, the excavation being relatively much larger than would ordinarily be required for the number of pipes contained. The pipes must be separately insulated and as it is never thought necessary to cover the flanges under such conditions, the loss of heat from the pipes is sufficient at all times to comfortably heat a space, as a rule, approximating about the same number of cubic feet as are contained in one-quarter of the buildings whi h are to be heated. The argument is sometimes advanced that once this space is heated the loss is very slight, and to some extent this is true, but not by any means entirely so.

The other system is that using "Vitrified Sectional Conduit." All the materials are absolutely inorganic, the shell being composed of a carefully selected and thoroughly ground and mixed combination of stoneware clay. After the material passes from the moulds it is properly treated before being placed in the kiln to avoid warping of the sections, this being extremely important. The conduit is scored in process of manufacture so that it can be readily split, which is done before shipping, each half being so marked that it can be identified on arrival in order that the original tops and bottoms may come together. Before splitting, each conduit length must sustain a transverse test between hardwood supports which cover one-third of the entire circumference of the conduit.

The fitting or insulating material is composed of asbestos fibre and sponge, which is so intermixed that a maximum number of confined air-cells are obtained.

The pipes are carried on roll frames embedded in concrete, special tees being provided for this purpose, and whenever it is found necessary to anchor or turn a corner, brick pits are built. Almost any number of pipes may be placed in a single conduit and it is purposed that no pipe shall have less than three inches of the insulating material around it. The pipes are perfectly insulated and the entire conduit, with its contents, is self-contained. The loss in pressure is practically only that caused by the friction between the steam or hot water and the interior surface of the pipes.

This conduit can be laid within six inches of the top of the ground, snow not melting directly over it, as long as the atmosphere is below freezing point, according to actual observation.

The question of installation is a vital one with this, as with all other mechanical devices, especially so as it is of the greatest importance that no leakage of water shall occur. The lower half sections and the roll frames must be in perfect alignment, and it is absolutely necessary that the pipes shall be tested with a cold water test of at least 50% in excess of the steam pressure to be carried before the top half-sections are placed or any insulating material put on; neither should caulking or rusting of joints be allowed. The job of steam fitting must be perfect and experience teaches that by following this course it will remain perfect.

Observation tees are provided in case it is necessary at any time to look for a leak, but after a long term of years, during which time many thousands of feet of the conduit have been placed under ground throughout the Eastern States, it was proven that no observation is necessary and the reason is simple. In the first place the necessity for careful and proper installation has been duly recognized and taken care of; there is no chance of anything attacking the pipe from the outside, and with this danger eliminated the chances for necessity of renewal are very slight. In case, however, it does become necessary, after a long term of years, the defective pipe is easily located and the trouble and expense of renewal quite small. On the other hand the results to be obtained are almost marvelous. We have one case in mind, at Andover, Mass., where a line 600 feet long was tested and the gauge at both ends showed exactly the same pressure, and other cases could be mentioned where approximately the same results have been obtained; in fact no case was ever reported where, with proper installation, the efficiency test showed less than 90%.

Formerly wooden covering was used, but this would crack and allow the surface water to enter the crevices, so that the heat losses were sometimes equal to 30-40% of those of bare pipes. A new and good job would show an average loss of 20% of the loss of an uncovered pipe, or in other words, a saving of 80% of heat otherwise dissipated. Various substances have been tried out, but most of them deteriorate so easily, so that financially nothing was found to equal, as an efficient insulating material, water and heat proof substances which could be moulded into convenient shapes, and be made to entrap a lot of air; for, still and stagnant air is the very best kind of an insulator.

After many laboratory tests have been made on a large variety of substances, asbestos was found to fill the requirement best. It can be worked up easily into any shape, dense or loose in construction, and is not easily damaged by vibration of pipes, etc.

An idea as the amount of energy lost due to condensation of steam in pipes may be derived from the statement that 6 feet of 6-inch pipe uncovered, will cause a loss of energy each hour, equivalent to that generated by one pound of coal under average conditions. A good covering reduces this loss at least 80%.

THE CAUTIOUS DRUMMER.

The statement is made that the commercial traveller is considered by insurance companies a first-class risk. The reasons given are:

1. He is generally on the road and the railway train has been proven to be the safest place a person can be in.

2. He is a cautious person and generally selects a middle seat in a car about the centre of the train—no last cars or first cars for him. If there is a Pullman he selects that not for its greater luxury, although he is not adverse to that, but because of the better construction and greater strength of the Pullman.

AN OPPORTUNITY.

"You have had words with your chief?" "Yes. But I'll be even with him. The next time he makes a joke, I won't laugh."—Meggendorfer Blætter.

CAPTAINS OF INDUSTRY

Opportunities for Business. News of Building or Enlargement of Factories, Mills, Power Plants, Etc.—News of Railway and Bridge Construction—News of Municipal Undertakings—Mining News.

BUILDING NEWS.

Ontario.

TORONTO.—A new registry office will be erected here.

COLLINGWOOD.—The Grand Trunk lumber docks here, have been badly damaged by fire.

PORT BURWELL.—The building and plant of the Weekly News here have been destroyed by fire, caused by an explosion. The loss is estimated at $4,000.

OTTAWA.—The Bank of Montreal Building, Ottawa, will be floored with Terrano, by the Eadie-Douglas Co., Montreal. Messrs. Byers & Anglin, 18 St. Alexis Street, Montreal, are the general contractors.

TORONTO.—Only a section of the new building for the Department of Education, University of Toronto, will be built during the coming year. This was decided by the Board of Governors on November 27.

Quebec.

MONTREAL.—A new ice house for the City Ice Co. is being built by Messrs. Laird, Paton & Sons, general contractors, 487½ St. James Street.

MONTREAL.—The British American Import Co. will erect a warehouse costing about $65,000. Mr. Eugene Payette, 15 St. James Street, is the architect. Tenders will be invited about the middle of December.

MONTREAL.—The Longue Pointe Protestant schoolhouse, on the Longue Pointe Road near Dominion Park, was recently destroyed by fire.

MONTREAL.—Mr. John Watterson, 27 Common Street, will erect a warehouse on Murray Street, costing about $16,200. Mr. Geo. T. Hyde is the architect and H. C. Hitch is general contractor.

MONTREAL.—Mr. Erie Mann, architect, 30 St. John Street, has prepared plans for a warehouse with 250 feet of frontage on Masson Street, Deloraine municipality, for E. N. Heney Co., St. Paul Street, Montreal. A bonus to this company has been voted by the municipality, and the matter of exemption from taxes for ten years is now before the Legislative Assembly.

STE. ANGELE.—The Roman Catholic congregation here will build a $30,000 stone church.

Saskatchewan.

SASKATOON.—The John Deere Plow Co. will erect a new warehouse here.

Alberta.

EDMONTON.—A new theatre building may be erected here by Mr. E. R. Sims, manager of the Calgary Amusement Co.

Manitoba.

BRANDON.—A new fire hall will be erected here.

MILL AND FACTORY EQUIPMENT.

Ontario.

ST. CATHARINES.—A pulp mill will be erected here by the Colonial Wood Products Co., of Niagara Falls.

MURILLO.—The sawmill and gristmill here owned by Mr. McArthur have been destroyed by fire.

TORONTO.—The Canada Metal Co. have practically completed the construction of their new works on Fraser Avenue, so it is now about ready for the installation of machinery and equipment.

WELLAND.—The Tin Plate Co., of Swansea, Wales, with a paid-up capital of $250,000, have signed an agreement to locate a plant at Welland. It will employ at the start 250 workmen, mostly skilled laborers. They will locate near the Billings & Spencer forge factory. The agreement calls for the starting of the erection of the buildings before April 1. One of the buildings will be 100 by 300 feet, of steel construction. The town is to give them a fixed assessment for ten years. One of the agreements is that Welland is to build 150 houses that will be needed by the workmen, as there are not enough houses in Welland at present.

Quebec.

ST. FARNSTIN.—The saw and planing mill here was destroyed by fire recently, the loss being about $10,000. It was the property of T. X. Bernard & Son, Montreal.

ST. LOUIS, MONTREAL.—Messrs. Lebel & Forgues, Clarke and Van Horne Avenues, umber merchants, will build a factory on St. Urbain Street, costing about $1,000.

MONTREAL.—Messrs. Betts, Brown & Co. have taken over the garage and automobile repair business of the Franco-American Automobile Co., Guy Street, Montreal. They are enlarging the machine shop so as to be able to handle small contracts in machine, engineering and ornamental iron work.

British Columbia.

FALSE CREEK.—The Royal City Mills, including the factory and planing mill, have recently been destroyed by fire. The loss is estimated to be $100,000.

Quebec.

The Canadian Northern Railway may build repair shops here which will cost $200,000

Alberta.

OKOTOKS.—The Electric Light Co. are putting up a new building and installing $10,000 worth of new machinery.

Saskatchewan.

REGINA.—F. A. Bean, Minnesota, will erect a $100,000 oatmeal and flour mill here.

MOOSE RIVER.—A mill of the Moose River Lumber Co. has been destroyed by fire.

ST. JOHN.—On November 27 two sawmills owned and operated by the Inglewood Pulp Co. at Musquash, were destroyed by fire. Loss is estimated at $22,000 and insurance of $13,000.

POWER PLANT OPPORTUNITIES.

Ontario.

WATERFORD.—The Swedish American Telephone Co. will erect a plant for which the town recently passed a by-law to raise a loan for $10,000 and $1,000 for a free site.

Nova Scotia.

INVERNESS.—J. E. Hughs, Inverness, has been figuring on putting in a plant for lighting the town.

British Columbia.

KELOWNA.—The Hinton Electric Co., Vancouver, are installing a $40,000 electric light plant in this town.

Manitoba.

MACLEOD.—A by-law will be submitted to the ratepayers on December 4 to issue debentures amounting to $35,000 for improving the power plant.

Quebec.

MONTREAL.—It is stated that the Montreal Light, Heat & Power Co. contemplate the construction of an additional steam plant whose maximum will equal 100,000 h.p.

Saskatchewan.

SASKATOON.—The ratepayers have approved a by-law to raise $30,000 for extensions to the electric light plant.

WATERWORKS, SEWERS, SIDEWALKS.

Ontario.

RENFREW.—The town council have passed a by-law to raise $5,000 by debentures for the extension of the sewerage system.

Saskatchewan.

YORKTON.—Twenty thousand dollars is to be raised for the improvement of the waterworks system.

BRIDGES AND STRUCTURAL STEEL.

British Columbia.

VANCOUVER.—A petition will be presented to Mayor Bethune, requesting that the construction of the Cambie Street bridge over False Creek be at once proceeded with.

TRADE NOTES.

Alberta.

CALGARY.—The American Abell Engine & Thresher Co., Toronto, have opened up a large warehouse here.

MONTREAL.—J. W. Williamson, 54 Notre Dame Street East, Montreal, Canadian agents for Hendry's patent laminated leather belting, have made arrangements to carry a stock so as to be able to fill orders for any size belts on short notice.

SOREL.—On November 27, 200 feet of the Government wharf, situated on the east side of the mouth of the Richelieu River, built five years ago, tumbled into the river. Those 200 feet are the continuation of the 500 feet that gave way some time ago.

MONTREAL.—The Goulds Mfg. Co., Seneca Falls, N.Y., have established a branch house in Canada to be known as the Goulds Pump Co. The offices will be in the Coristine Bldg., Montreal. In this way the company will be able to devote every attention to their Canadian business.

COMPANIES INCORPORATED.

Ontario.

WELLAND.—Dain Mfg. Co., Limited, have been incorporated with a capital of $200,000 to manufacture and sell farm implements and machinery. The provisional directors include Joseph Dain, P. F. Arbeng and B. J. McCormick.

OTTAWA.—Lowe Martin Co., Limited, have been incorporated with a capital of $20,000 to manufacture and deal in paper box board, paper boxes and pails, etc. The provisional directors include E. D. Lowe, T. H. Martin and R. G. Code, all of Ottawa.

WALLACEBURG.—The Consumers Gas Co., of Wallaceburg, Limited, have been incorporated with a capital of $40,000 to acquire a franchise to lay down pipes and pipe gas through Wallaceburg. The provisional directors include D. A. Gordon, H. A. Stonehouse and W. W. Hay.

TORONTO.—Brazilian Electric Steel & Smelting Co. have been incorporated with a capital of $10,000,000 to carry on a mining, milling and reduction business. The provisional directors include J. S. Lovell, W. Bain and Robert Cowans, all of Toronto.

BELLEVILLE.—Marsh & Henthorn, Limited, have been incorporated with a capital of $100,000 to carry on the business of machinists, founders, mechanical engineers and manufacturers of machinery. The provisional directors include L. W. Marsh, W. H. Henthorn and E. S. Marsh, all of Belleville.

ALLISTON.—Fisher Robson Mfg. Co., Limited, have been incorporated with a capital of $100,000 to manufacture and sell agricultural and farm implements. The provisional directors include Robert Scott, T. M. Brown and W. J. Hill.

THOROLD.—The Colonial Wood Products Co., Limited, have been incorporated with a capital of $100,000 to construct, build and operate pulp, paper and lumber mills. The provisional directors include H. B. Eshelman, August Vowerk and William Johnstone.

TORONTO.—The Farah Mining Co., Limited, have been incorporated with a capital of $2,000,000 to carry on a mining, milling and reduction business. The provisional directors include J. S. Lovell, W. Bain and E. W. McNeill, all of Toronto.

TORONTO.—General Contracting Co., Limited, have been incorporated with a capital of $100,000 to carry on the business of preparing and supplying plans. The provisional directors include G. H. Kilmer, W. H. Irving and J. A. McAndrew, all of Toronto.

TORONTO.—Red Jacket Silver Mines, Limited, have been incorporated with a capital of $1,250,000 to carry on a mining, milling and reduction business. The provisional directors inlude G. H. Sedgewick, F. V. Johns, and G. E. McCann, all of Toronto.

Manitoba.

WINNIPEG.—Thunder Bay Elevator Co., Limited, have been incorporated with a capital of $1,000,000 to carry on an elevator and warehouse business. The provisional directors include J. J. Fisher, S. M. Battram and C. S. Blanchard, all of Winnipeg.

Quebec.

MONTREAL.—Canadian Palace Car Co., Limited, have been incorporated with a capital of $1,500,000 to manufacture, buy, deal and sell in cars. The provisional directors include A. J. Estes, G. S. Hart and F. H. Markey, all of Montreal.

Personal Mention

Mr. Geo. C. Burnham, formerly associated with the Allis-Chalmers-Bullock, Limited, has left that concern and entered into partnership wth Kilmer & Pullen, under the style of Kilmer, Pullen & Burnham, McKinnon Bldg., Toronto, electrical engineers and contractors, representing the General Electric Co., of Sweden.

This firm has during the past few years made several important installations of power equipment for central stations and manufacturing plants.

They are at present engaged on an unique installation for M. F. Beach, at Iroquois, Ont.

Toronto Electric Light Co. goes to William Mackenzie

According to a cable message from Sir Henry M. Pellatt, from England, on November 26 arrangements have been made between himself, William MacKenzie and the English shareholders of Toronto Electric Light Co., whereby Mr. MacKenzie secures control of that company. Nothing definite is known concerning the arrangements, but it is supposed that the Toronto Electric Light Co. would pass under the control of the Toronto Power Co., the latter being the holding company, and that the holders of Toronto Electric would receive eight per cent. guaranteed debenture stock of the Toronto Power Co. Toronto Electric Light now earns between 12 and 13 per cent. and pays 8 per cent. It is current opinion that in view of the probability of competition from a civic plant an assured return of 8 per cent. would be a fair settlement for the shareholders. Those shareholders who might object to it, however, it was stated last night, might have the option of having their stock taken off their hands at a fixed price.

Railway Commission Issues Order to Abate Smoke Nusiance

The Railway Commission has made an anti-smoke order, which applies, however, only to Ontario cities, and there only to cities which have passed by-laws for the restriction of the smoke nuisance.

Orders have been issued to the railways instructing them to equip all locomotives run within cities in the Province of Ontario with a device which will prevent the issuing of dense and opaque smoke.

However, it is recognized that such smoke must issue at times. The order therefore allows an engine to belch smoke for a minute in any ten minutes in each hour.

In the case of cleaning a fire-box or building a fire, an engine is allowed to belch for six minutes in any hour. In ascending the Scarboro' grade at Toronto, and the Hamilton grade, engines are allowed to belch. There is a penalty of $25 for each violation.

TO PLEASE THE CUSTOMER.

To please a customer, is not the least of reasons for adopting new kinks in getting out goods. That was what the management of a textile company discovered when the concern began to send out garments baled into tight bundles instead of packed as in ordinary shipments.

It occured to one of the firms that goods could be packed more closely by making use of a baling frame. Correspondence with firms manufacturing hay bales, finally brought to light a simple piece of apparatus which with a few modifications is now used to compress the garments into compact bales.

This simple method not only expedites packing and handling of goods, but stops leaks caused by petty thieving from the freight cars enroute. A suit of overalls can not be abstracted easily from a package of goods baled under pressure. Freight charges are also reduced.—System.

KEEP ALIVE.

Tell us, are you advertising
In the same, old foolish way,
Blowing in your dollars
And persist, "It doesn't pay?"

Think the whole world knows your address?
"Cause it hasn't changed in years."
Wouldn't the pathos of such logic
Drive a billy-goat to tears?

"Just a card" is all you care for,
Hidden, lonesome and unread,
Like the sign upon a tombstone
Telling folks that you are dead.

Wake up, man, and take a tonic,
Bunch your hits and make a drive,
Run a page and change your copy—
Advertise and keep alive!

—**Exchange.**

Practical Treatise on the Transformer

Second of a Series of Articles on the Transformer Appearing in the Power Edition. This one Deals with Waterproofing Compounds, Drying Out Transformers, and Cooling of Transformers. Others will Deal With Transformer Oil, Transformer Cases, Terminals and Bushings, Transformer Connections and Transformer Testing. This is a Very Complete and Reliable Series of Articles.

By Norman P. Death,* Ass. M. A.I.E.E.

Use of Waterproofing Compounds After Completion of Winding

Let us now discuss the advisability of the use of waterproofing compounds after the transformer windings are completed. The use of these compounds has in view the purpose of keeping the windings free from moisture from the time they are completed at the factory until the time they are immersed in the oil in their cases, where they are to be used. The compound, whatever it may consist of, has to do this work perfectly or else it is of no service at all, or at least very little.

In many transformers waterproofing compounds are used which may or may not be soluble in the oil in which the transformer is immersed. These waterproofing compounds are necessarily good insulators. The materials used may have either an asphalt, coal tar or linseed oil base. When asphalt or coal tar base compounds are used they are always somewhat soluble in oil, especially when the oil is hot. Compounds having a linseed oil base, when thoroughly dry, are practically insoluble in mineral oil.

When large quantities of waterproofing material, with asphalt or coal tar as a base, are used in transformers, the compound resulting from the combination of the waterproofing material and the transformer oil may form a pasty mass, which will close up the ventilating spaces and consequently cause dangerous heating of the transformer due to the lack of ventilation. From an insulation standpoint there is no objection to the waterproofiing compound being dissolved out after the transformer is put in service provided the design is such that the ventilating spaces, which are essential to the cooling of the transformer, are not filled up.

Any compound, which is soluble in mineral oil should not be depended upon for cementing parts of the transformer or for closing spaces when this compound may be dissolved out by the oil later. The linseed oil compounds are waterproof in the sense that they will not allow water to pass through where there is an unbroken film, but they are not waterproof in the same way that asphalt and coal tar base compounds are waterproof, i.e., they are not water-repellant. When transformers are treated with linseed oil compounds more care must be taken to prevent the absorption of moisture than when the other class of compounds is used.

Drying Out Transformers.

Before filling our transformer case with oil, when the winding is placed there, it would be well to know whether the winding is in a fit condition to receive the oil, which is to act as part of its insulation, and as the medium which is to convey to the air or water the heat generated in the various coils and core of the transformer.

The use of insufficiently dried insulating material and the failure to dry out apparatus which has become damp, are probably responsible for a great majority of the failures which have occurred with high voltage apparatus. But trouble from this cause is not confined to high-tension apparatus alone, but appears in all classes of electrical machinery. The severe insulation tests applied to high-voltage apparatus have served, however, to emphasize the dangers of moisture, and the improvements required in the treatment of the insulation of high-voltage apparatus has resulted in a marked improvement in the quality of the insulation of all other apparatus.

With each increase in voltage, new difficulties develop. Materials and methods of manufacture which are entirely satisfactory for one voltage, may prove quite inadequate for a higher one. The inspection and care, which may be ample in the operation of apparatus at one voltage, may be wholly insufficient for a higher voltage. So called "dry wood," for example, which at 5,000 volts gives excellent results as an insulator, proves to be quite "wet" and a good conductor at 30,000 volts. To-day wood is not used as a high-voltage insulator unless first dried in a vacuum oven, then boiled in oil or otherwise treated to prevent the re-entrance of moisture. This method of treating wood is applied in a general way to almost all insulating materials, and a plant for manufacturing high-voltage apparatus is not complete without drying ovens, vacuum ovens, dripping tanks and vacuum impregnating tank.

By these improved methods of treatment the moisture danger is largely eliminated during the period of manufacture and factory test, and to prevent the apparatus from taking up moisture during transit it is usually shipped in a hermetically-sealed case. Instances may arise, however, when the apparatus cannot be so shipped, or the case may be damaged, or during installation the apparatus may become wet, thus necessitating drying out before it is put in operation.

On high voltages the necessity for perfectly dry insulation is even more imperative than on low voltages, and as transformers are usually wound for a much higher voltage than other electrical apparatus, drying out is more frequently required on them than on other apparatus.

One of the chief difficulties in the installation of transformers is to know whether drying out is required; also when the drying out is completed. An inspection of the transformer, when it is received, and a knowledge of the manner in which it has been handled during installation, may often make it clear that drying out is necessary, but when there is any doubt as to its condition, drying should be done. The insulation resistance should be taken at frequent intervals as the drying progresses, and the values plotted in a curve, for this is the only way of judging of the condition of the insulation.

In general, it is well to be on the safe side—drying out whenever there is doubt as to the condition of the apparatus, and continuing the drying out process until it is certain that the insulation is thoroughly dry.

Granting that we have received our transformers at the transformer station, how are we to know the condition they are in as regards to moisture: Probably they come in cases lined with tin and sealed to exclude all moisture—all well and good if the tin remains sealed, but if a hole has accidentally been punched through it why, then, it is useless and might just as well be left off altogether. However, if the lining is in good condition, and there are no evidences of moisture on the transformer, such as rust on the laminations or inside of case, drying out is usually not necessary. But if the lining was not perfect it is better to run no chances and dry out the transformer by some one of the following three methods, insulation readings being taken at various intervals during the process, and finally at the working temperature of the transformer.

Methods of Drying Out.

The three methods usually used are as follows:

(a) By internal heat.
(b) By external heat.
(c) By external and internal heat.

(a) By internal heat. Alternating current required.

The transformer should be placed, if possible, in its case, though this is not essential, as it may be left in its shipping case or even placed on the floor of a dry room. If dried out in a case the cover should be removed to give free circulation of air. The low-tension winding should be short-circuited, and a sufficient voltage impressed on the high-tension winding to circulate the desired current through the coils. For large transformers (250 to 500 k.w.), approximately one-fifth normal full-load current will be sufficient to raise the coils at the desired temperature, viz.: approximately 90 degrees C. (194 degrees F.) For small transformers a somewhat larger current will be required.

For circulating this current through the windings, from 1% to 2% of the normal high-tension voltage at normal frequency will be required, thus for a 10,000 volt transformer from 100 to 200 volts is necessary. For controlling the current a rheostat may be placed in series with the high-tension winding.

(b) By external heat.

The transformer should be placed in a wooden box, the packing case answering the

* Death & Watson, Electrical Engineers and Contractors, Toronto.

purpose very well. An opening should be made near the bottom and another at the top of the box to permit a circulation of air and also to serve as a means of controlling the temperature of the air inside the box. The heat may be applied by circulating current through resistances, the iron grid form is frequently most suitable, placed at the bottom of the box. It should be applied at such a rate that the transformer coils will be maintained at approximately 90 C. (194 F). Care should be taken to protect the transformer from direct radiation from the heaters. Care must be taken also to see that there is no inflammable material near the heaters which may catch fire. This method of drying out has an advantage over the method outlined in (a) in that direct current may be used for heating.

Instead of placing the heater inside the box containing the transformer, it may be placed outside and the heat carried into the box through a suitable pipe. Where this plan is used the heat may be generated by the direct combustion of gas, coal or wood, but none of the products of combustion should be allowed to enter the box containing the transformer. Heating by direct combustion is not advised except in case where electric current is not available.

(c) Internal and external heat.

The transformer should be placed in a wooden box as in (b) and external heat applied, while at the same time a small amount of current is circulated through the transformer windings. The method of circulating the current should be the same as given in (a), and the method of applying the external heat the same as given in (b). The current should, of course, be considerably less than when no external heat is used, the value being determined, to a certain extent, by the amount of external heat applied. This method is used occasionally where direct current only is available, a certain amount of current being passed through the high-tension winding only, as the low-tension winding is ordinarily wound for so heavy a current that it cannot be obtained economically from a direct-current circuit.

The length of time the drying-out should be continued will depend largely upon the condition in which the transformer is received, and unless in very bad shape, a week's run should be sufficient to put the transformer in good condition. In certain cases, however, it has been found necessary to continue the run for a somewhat longer time.

It will be found that when the current is first applied and the transformer heats up the insulation resistance will drop very rapidly, until the desired temperature is reached; then, as this temperature is maintained constant, the resistance will gradually increase. It will also be found that variations from a constant temperature will cause wide changes in resistance. Resistance readings should be made every few hours and the drying continued until the resistance no longer increases, or increases at a very slow rate.

Precautions to be Observed.

In order to dry out the transformer, it is necessary to maintain it at a temperature which approaches the point where fibrous materials deteriorate. Great care must, therefore, be observed during the whole period of drying out to see that the temperature does not reach a value much in excess of 90 degrees C.

For measuring the temperature of the transformer coils, several thermometers should be used. These should be placed well in between the coils, near the top of the transformer, and screened from air currents, so that they will indicate the maximum temperature of the windings. As the temperature will rise quite rapidly at first, it is necessary to watch the thermometers carefully to see that the maximum allowable temperature is not exceeded.

As the transformer is soaked with oil, on account of the test which it receives in the works, the material is in an inflammable condition, and while hot it may be ignited very easily by a very small arc or from a blaze of any kind. Before beginning the drying-out, it is well to have some chemical extinguisher, or at least a supply of sand, at hand, which may be used in case of necessity. In general, it is not safe to attempt the drying out of transformers unless constant attention can be given to them.

Cooling of Transformers.

When an alternating current is passed through a coil having an iron core, such as a transformer, besides the copper loss we always have hysteresis and eddy current losses also. However, by proper designing and the use of good material and the exercise of some care in the process of manufacture these losses may be reduced to a minimum, but they are a constant quantity, however small, as long as the transformer is connected to the primary mains.

The copper loss is a variable quantity depending on the square of the load carried. At full load the copper loss is generally made as nearly equal to the iron losses as possible. The energy expended in supplying these losses has no choice but to appear as heat in the iron and coils, and therefore some method has to be adopted to carry off this heat so as to keep the temperature down to a point where it will not be injurious to the insulation. This is accomplished by the use of oil (oil in conjunction with water) and air under pressure.

Self-Cooling.

The oil-insulated self-cooling transformer is wound for voltages as high as desired and for capacities as great as 5 k.w. This transformer depends for its cooling upon radiation from the surface of the case in which it is mounted. The only satisfactory case yet devised for a self-cooling transformer of large size is one made of heavy sheet iron, corrugated in such a manner as to give a very large surface. The corrugated cases are mounted either in an angle-iron framework or with the sides set into a cast-iron base. A cast-iron top is usually provided and in this are placed suitable bushings for the primary and secondary leads. The self-cooling transformer has one great advantage over all other types, in that no extraneous devices are required for cooling, so that when once installed it will operate indefinitely with practically no attention.

The capacity of the self-cooling transformer is limited to approximately 500 k.w. For greater capacities than this, the cost and dimensions of the case become excessive.

For many classes of service where no attention can be given to the apparatus, the self-cooling transformer is the only satisfactory type. This promises to be the case in single-phase railway work, where one or two transformers will be installed in out-of-way sub-stations, or perhaps in certain cases on poles where inspection can be made at rare intervals only.

Artificially-Cooled.

System 1. Then we have the oil-insulated artificially cooled type. This transformer can be wound for any desired capacity or voltage. Its construction differs from that of the oil-insulated self-cooled transformer principally in the form of case and in the cooling devices. A number of different methods have been proposed and tried for carrying off the heat, but one method is now almost always used. This consists in forcing or siphoning water through coils of brass or copper tubing placed inside the transformer case below the surface of the oil. This method of cooling is the most simple and direct of any of the artificial-cooling systems.

The case for containing the oil is usually made of boiler-plates riveted and caulked. A cast-iron case and cover are provided and the terminals of the water cooling coils and the leads from the primary and secondary windings are carried through this cover. This form of cooling is used on all the large stepping up transformers of the various Niagara Power companies, and is the only type which would give entire satisfaction where break downs are strictly prohibited.

System 2. Then again we have another type of oil-insulated artificially-cooled transformer. This system is only used to a limited extent and consists in drawing the hot oil away from the transformer tanks, circulating it through a cooling coil which is immersed in running water, and then returning the cooled oil to the transformer case. The circulation is maintained by means of a small motor-driven pump. The advantage of this system over the first one mentioned is that in case of a leak in the cooling system the oil will escape into the water instead of the water into the oil; but as there are very few cases on record where trouble has resulted from leaky water-coils, this advantage does not seem to be of great moment. To effect this single advantage, a pump, a motor, a cooling tank and a system of oil piping are required for the cooling system, and there is the possibility that should a deposit form in the oil it will gather on the inside of the tubes and prevent the circulation and cooling of the oil.

Air-Cooled.

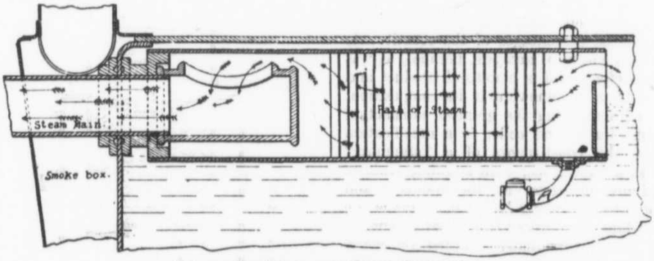
The air-blast transformer, as its name implies, is one in which the heating is accomplished by means of a forced draught of air. It may be wound for pressures not exceeding approximately 33,000 volts, in units of any desired quantity.

The transformer proper is mounted in a cast-iron housing, so arranged that air, which is admitted at the base, may pass through the cooling ducts between the coils and through those in the iron. Two separate air-passages are provided, one for cooling the coils and the other for cooling the iron. The transformers are usually placed above an air-chamber in which a pressure usually less than one ounce per square inch, above the surrounding air, is maintained. The air is supplied from large steel-plate fans, which are usually directly connected to induction motors. The power required for cooling is small, being usually one-tenth to one-fourth of one per cent. of the transformer capacity.

In the air-cooled transformer before being admitted to the windings the air is passed through fine screens, which remove the dust and other foreign matter from it, in this way keeping the windings clean and the ventilating ducts open; so some method must be followed in the case of the oil used in cooling. The quality must be up to a certain standard and required specifications must be fulfilled.

Internally Submerged Steam Separator; a Puzzle

The accompanying illustration is of a steam separator installed by the Ideal Steam Separator & Supply Co., 73 Adelaide Street East, in one of the boilers at the Central Prison, Toronto. Owing to the location of the boiler it was impossible to install the steam main on top of the boiler. It had to be located as shown in the sketch. Thus the steam main at the boiler was practically half full of water, as a glance at the water level as indicated in the illustration will readily show. As a consequence the boiler supplied very wet steam.



Internally Submerged Steam Separator.

Two years ago an electric light plant was installed, and because of the large quantity of water which came with the steam from this boiler it was found necessary to cut off the steam supply from this boiler.

The Ideal Steam Separator & Supply Co. undertook to equip this boiler with a steam separator which would do away with the water in the steam. This special internal separator, shown in the illustration, was designed and installed. It has now been in successful operation for over eighteen months. A letter from the Department of Public Works certifies to that, the letter containing this statement, "the trouble from water being carried over to engine is completely remedied."

The illustration gives a good idea of the installation, except that the character of the passages through which the steam passes is not shown. There are three of these running straight through the separator, two of which are the same size and the third slightly smaller. This separator is about 33 inches long.

The method of draining this trap is through the pipe A, there being a lift valve, opening outwards, at the end of this pipe. It is claimed by the makers that the water which accumulates in this separator automatically drains itself through this pipe and lift valve; and the proof that it does drain in this way is that upon inserting a pipe through the shell of the boiler and the separator, provision for which has been made, and thrusting the pipe to within ¼ inch of the lower side of the separator, no water comes from the pipe—nothing but steam. The boilers are emptied only about once a month.

The report from the Department of Public Works sh ws conclusively that they are getting dry steam, and it is claimed that it is 99.5 per cent. dry. A very considerable saving in fuel is being affected since the installation of the separator. It is quite evident that the separator is doing its work, and the water from the separator must be automatically drained back into the boiler; but ow?

A glance at the water level in the boiler will show the peculiarity of this. If the water is to drain, there must be conditions of steam pressure, temperature and velocity existing inside the separator, which are not so in the boiler. From the construction of the separator there seems to be no reasons why material difference of conditions should xist.

Coal Pile Extravagance*

By Henry Stanley Renaud.

"The greatest possibilities for saving or wasting about a steam plant are undoubtedly in the coal pile, but as it is a dirty proposition and many of its features not well understood, the subject does not receive the consideration to which it is entitled." So spoke W. L. Abott, chief operating engineer of the Chicago Edison Co., in a paper read before a meeting of the National Electric Light Association.

Many power plants, and the power departments of numerous manufacturing establishments, buy their supply of coal on the statement of the local coal dealer as to its quality, or on the strength of the name of a special kind of coal. The reputation of a particular mine, or the general integrity of the house handling it, is made the basis of most coal transactions. This state of affairs does not take into consideration the fact that the quality of coal in any given mine varies greatly as the mining goes on. This uneven quality is due to two causes: First, the natural change in the character of the vein; second, the care, or rather lack of care, of the miners in rejecting impurities, and in the further preparation, in picking out slate and other foreign substances. Nor does it allow for the possibility of actual substitution before the coal enters the control of the consumer.

* Abstract of Paper Read Before Meeting of National Electric Light Association.

Coal Can be Bought Scientifically.

This antediluvian system of purchasing fuel is absurdly sentimental. Coal can now be bought on as scientific and accurate a basis as that which controls the sale of gold, silver, sugar, alcohol or fertilizer. Our manufacturers can, with advantage to themselves, follow the example of the farmers of this country, who require a chemical analysis of all the fertilizer they buy.

When the subject is broached to the superintendent or manager of a power plant, that the coal consumed under his boilers should be contracted for on specifications and analysis, he immediately "goes up in the air" and emphatically states that he cannot afford to waste money on chemical analysis and scientific tests. Usually he will not even listen to, or read about, an actual demonstration of the saving brought about by expert advice and assistance, but will greedily absorb a pseudo-scientific article in a popular magazine, or Sunday newspaper, on "How to Burn Ashes when Made into Cakes with Glue," or about some wonderful (?) apparatus which will decompose water into its component hydrogen and oxygen, and make these elements available to re-combine to generate heat!

"When we consider," said Mr. Abbott, "that $100 saved is $100 added to the surplus which is as good as $500 increase in the gross receipts, and that to add $500 monthly to the gross earnings would require an investment of, say, $25,000—when we consider this, we may relize what a valuable asset is an engineer who is prolific in methods for keeping cost down, or is ready to adopt such methods from others."

Results of Tests on Different Coals.

The present advanced methods of testing fuels as to their comparative and relative values as heat producers afford sure means of getting what is paid for, and also of securing the best possible fuel for the particular type of furnace used, etc. By way of example, following are results of tests on three different coals which were tested in our laboratories, for commercial purposes:

Sam.	Moisture.	Volatile	Carbon.	Ash	Sulphur.	Heating Power B.t.u.
A...	3.72	39.27	45.61	11.40	0.49	12,006
B...	3.63	41.10	52.14	3.13	0.57	13,205
C...	0.58	16.80	77.00	5.62	0.62	14,553

If we take C as a standard, dividing the B.t.u. recorded for each by 14,553, would give the relative heating values thus:

A........................	82.5
B........................	90.7
C........................	100.0

So that if C sells for $3 a ton, B is worth only $2.72, and A (on its merits) could bring only $2.47½.

If a contract called for a delivery of 10,000 tons of coal C and one-half of the order were filled with coal A, where would the loss be shown? See the gain to the dealer:

10,000 tons of coal as per contract at $3......................	$30,000
5,000 tons of coal C, worth $3.....	15,000
5,000 tons of coal A, worth $2.47½.	12,375
	$27,375
Gain to dealer..................	$2,625

Assume that the coal is delivered in lighters, holding 500 tons each (most lighters hold considerably more), and that a chemical analysis and a heating power test are made on each lighter of coal. The usual charge of reputable chemical laboratories for proximate analysis and determinations of sulphur and heating power is about $25 per sample; this includes sampling. For the 20 analyses and tests from 20 lighters (10,000 tons) there would be a charge of $450. Then:

Gain to dealer by substituting coal A for coal C, as per above..........	$2,625
Cost of analyses................	450
Saved to consumer by scientific examination................	$2,175

OTHER CONSIDERATIONS THAT AFFECT THE VALUE.

The above demonstration is based entirely on the heating power of the coals as expressed in British thermal units. However, other considerations affect the comparative values of coals which may show slight differences in B.t.u. One of these is the cost of ash removal. Take the following two analyses by way of example:

D....	0.95	14.61	71.80	12.64	2.46	13,532
E....	4.69	38.06	54.23	3.02	0.59	13,390

These two coals show little difference in B.t.u., with a small balance of 142 B.t.u. per pound in favor of D. The determining factor here in the proper valuation of these two coals is the ash. Suppose both these coals to be offered at $3 per ton, and the cost of disposing of the ashes to be 25 cents per ton. Then:

10,000 tons of coal D, at $3 per ton.....	$30,000 00	
1,264 tons of ash to be removed (12.64%), at 25 cents.........	316 00	
Total cost of using 10,000 tons coal D...............		$30,316 00
10,000 tons of coal E, at $3 per ton.......	$30,000 00	
302 tons of ash to be removed (3.02%), at 25 cents..........	75 50	
Total cost of using 10,000 tons of coal E..		$30,075 50
Saved by buying coal E...........		$240 50

Let us now consider the coal from the standpoint of the moisture content. Since water is what is used to put out fires, it requires no great amount of argument to demonstrate that it is not a desirable feature to have present in coal. And no manager or superintendent will knowingly buy water which he does not want at the price of coal. Without consideration of the amount of heat required to evaporate the moisture in coal, let us figure the cost of two coals on the "dry basis." Take the following analyses:

Sample	Moisture.	Volatile.	Carbon.	Ash.	Sulphur.	Heating Power B.t.u.
F....	4.69	38.05	54.23	3.02	0.59	13,390
G....	0.32	16.26	72.93	10.49	1.98	13,995

Suppose both these coals to be offered at $3 per ton:

Ten thousand tons of coal F carries 469 tons of water (4.69 per cent.) at $3—$1,407, leaving 9,531 tons of dry coal for $30,000, i.e., raising the price per ton of dry coal to $3.15.

Ten thousand tons of coal G carries 32 tons of water (0.32 per cent.) at $3—$96, leaving 9,968 tons of dry coal for $30,000, i.e., raising the price per ton of dry coal to $3.01.

In 10,000 tons of coal F, you pay for the 469 tons of water, at $3.......	$1,407
In 10,000 tons of coal G, you pay for the 32 tons of water, at $3.......	96
Saved by *not buying* 437 tons of water at $3..................	$1,311

Other determining features as to the value of coals, while not capable of such accurate demonstration on paper in dollars and cents, may be readily seen from observation of the heavy, black smoke issuing from a chimney, the corroded condition of the grate-bars, the excessive amount of clinker, etc. These conditions can be foreseen by chemical examination of the coal and of its ash and these undesirable elements also forestalled.

Of course, it will be readily understood, that coal cannot satisfactorily be contracted for on fixed percentages of the constituents shown by chemical analysis, because, as was stated before, coal is a natural product and bound to vary somewhat in its composition. The method giving the greatest satisfaction to both buyer and seller is a specification stating the constituents of a "standard" coal at a fixed price, with a sliding scale of premiums for exceeding the standard and deductions for falling below it. This is the plan adopted by many large coal consumers and is being gradually adopted by many more to their pecuniary advantage.—Power.

Forcing Boilers

Suppose a boiler plant, including housing, piping, accessories, etc., to cost $25 per h.p., and suppose it to be charged 12 per cent. per annum for interest upon the investment, depreciation, taxes, insurance, etc.; there will be a charge per rated h.p. of $3 per year, whether the boilers do any work or not.

Suppose that when it was running at its rated capacity it took four, and at double its capacity 4½ pounds of coal per h.p. hour. If coal is worth $4 per ton, or one-fifth of a cent. per pound, it will cost one-tenth of a cent. more per hour per h.p. in fuel to run the boiler at twice its rating. If it ran this way 3,000 hours per year, it would cost $3 more per year in fuel, and the case would be equal as between loss of efficiency from overcrowding and increased standing charges by doubling the plant.

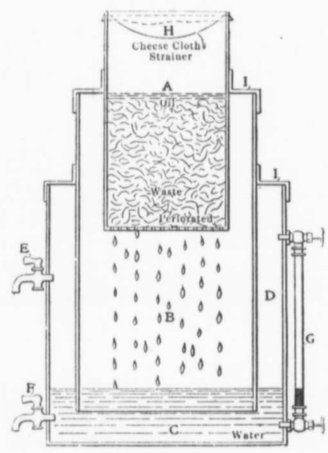
The importance of the standing charge increases as the load factor becomes less. It is expensive to buy and install a lot of extra boilers to be used but a fraction of the time on the peak of the load. Such boilers involve not only their standing charge of 12 per cent. or so, but the coal used in keeping them banked during the large part of the time that they are not in service, and the radiation from themselves and the additional piping which they require. It is not to be wondered at, then, that managers of plants with a widely varying load prefer to force boilers upon the peak of the load to putting in a large surplus to be cut in and out.

These considerations have led to considerable modification in power plant practice. The ratio of heating to grate surface has been cut down, and more coal burned per square foot of grate and of heating surface. At the Interborough (New York) station, Mr. Scott has installed a Roney furnace under each end of a Babcock & Wilcox boiler. At the proposed extension of the Delray station of the Detroit Edison Co., combined Stirling boilers with doubleside grates will be used. At the Quarry street station of the Chicago Edison Co. the ratio of boiler to turbine h.p. will be, it is said, extremely low, confidence in the result being warranted by their experience in the Commonwealth station.—Power.

A Homemade Filter

BY E. EWING.

A few years ago I had charge of a power plant and had quite a lot of oil which had been used, but was dirty. I wished to buy a filter, but was told I could not have one. As there were some empty transformer-oil cans



A HOMEMADE FILTER

lying around, I made a filter out of 2-, 5-, and 10-gallon cans. The sketch shows how it operated. It would filter 6 quarts of oil in 24 hours, leaving the oil as clear and clean as when it came from the dealer.

The cans were placed one inside the other as shown. The bottom of can A was perforated, and two-thirds filled with waste; a cheesecloth strainer was placed at H. At I lugs were soldered on to hold the cans up to a proper height. The bottom can was partly filled with water to break up the oil and wash it. At G is a gauge glass; F is a faucet to draw off sediment, and clean out; E is a faucet for clean oil.

I found that 90 per cent. of the dirt was removed by the waste and cheesecloth strainer. The bottom of can B was cut out and brought to within 2 inches of the bottom as at C. The weight of the oil in B forced the oil through the water into D. The cheesecloth strainer and the cans were removable, which made cleaning convenient. A cover was made to go on at H.—Power.

Better Vacuum Obtained by Changing Position of Condenser

A few years ago, in a certain city, a large pumping engine was installed to pump water from the filter into the mains about the city. The height of the water in the filter basin was such as to bring it close to the valves of the pump, so there was but little lift. A surface condenser was in the basement, several feet lower. Figure 1 shows the 24 inch suction A, with the pipes B, and B 6 inches in diameter leading to and from condenser C. E is a deflecting valve, and F, a gate valve. The water flows in the direction of the arrows, and through the tubes of the condenser.

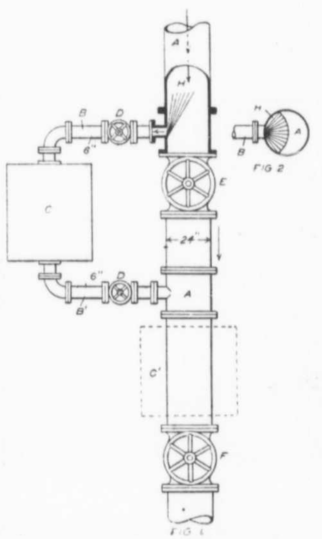


Fig. 1—Arrangement of Condenser. Fig. 2 —Detail of Deflecting Plates.

In the layout of the piping it was thought that by closing the deflecting valve E a little, the water would be drawn through the condenser in sufficient quantity to obtain a good vacuum, but such was not the case, as only 22 or 23 inches was obtained. So a sort of scoop was made of steel plated, fitted with lugs, by which it was held in place by capscrews. H shows the position of the scoop in the pipe A, and Fig. 2 is a cross section. It was thought that a greater quantity of water would be deflected into the pipe B, by this means, but the vacuum was helped little or none.

At last the decision was reached to get another condenser with 24-inch flanges at the sides, opposite each other, and place it in the suction as shown at C1. This was done, and the scoop removed, also the deflecting valve and the pipes BB1. The water now passes around the tubes and the steam through them. There is an oil separator between the engine and the condenser, and the vacuum is now 27.5 and 28 inch. —Practical Engineer.

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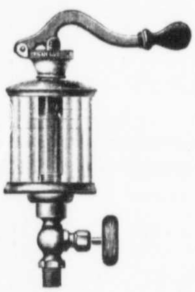

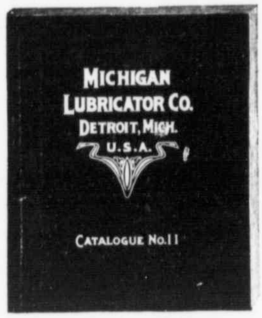

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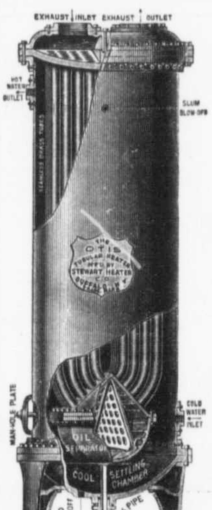

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