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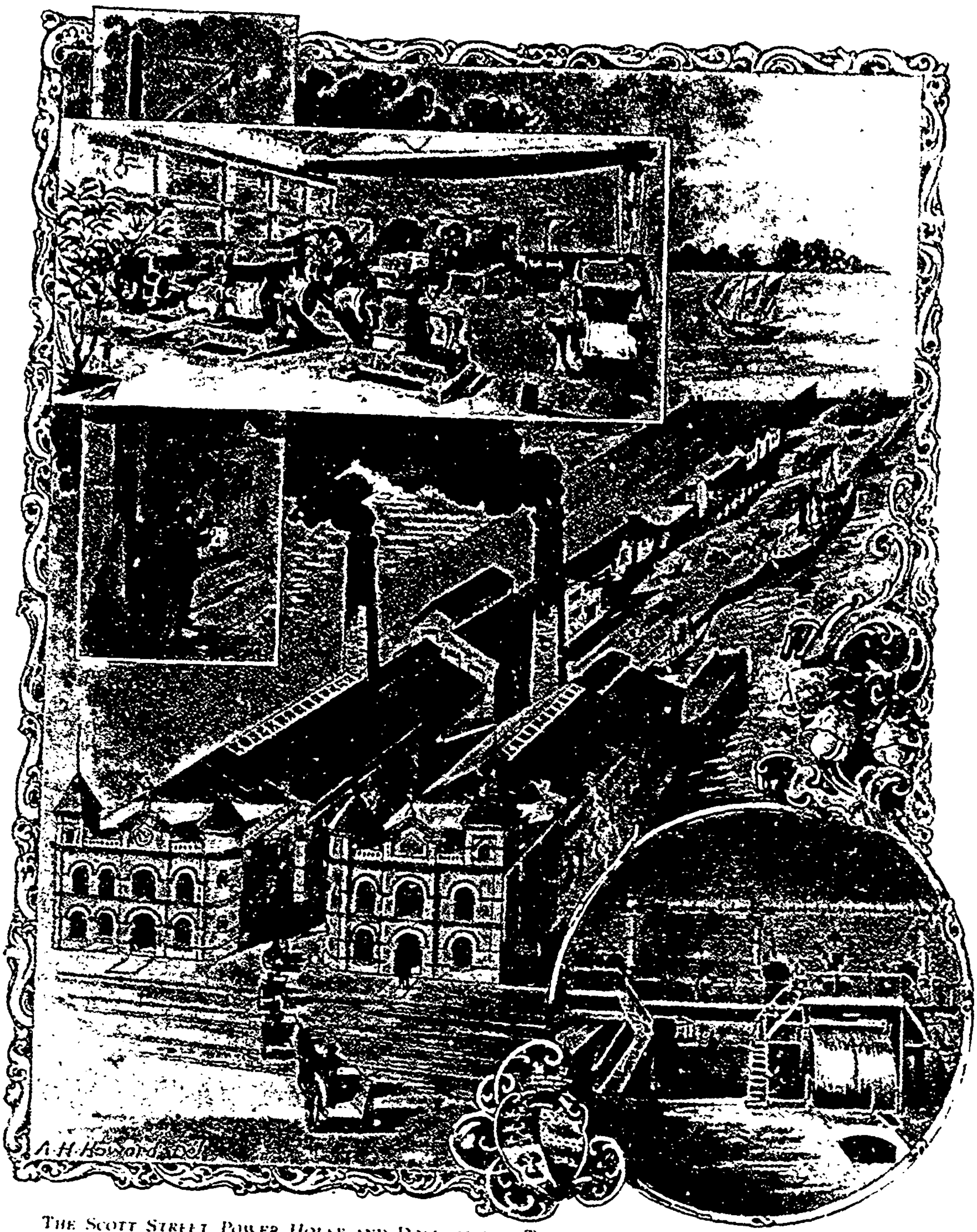


THE SCOTT STREET POWER HOUSE AND DOCK OF THE TORONTO ELECTRIC LIGHT COMPANY, LIMITED.

(For Illustrated Description see following pages.)

THE NEW WORKS OF THE TORONTO ELECTRIC LIGHT COMPANY.

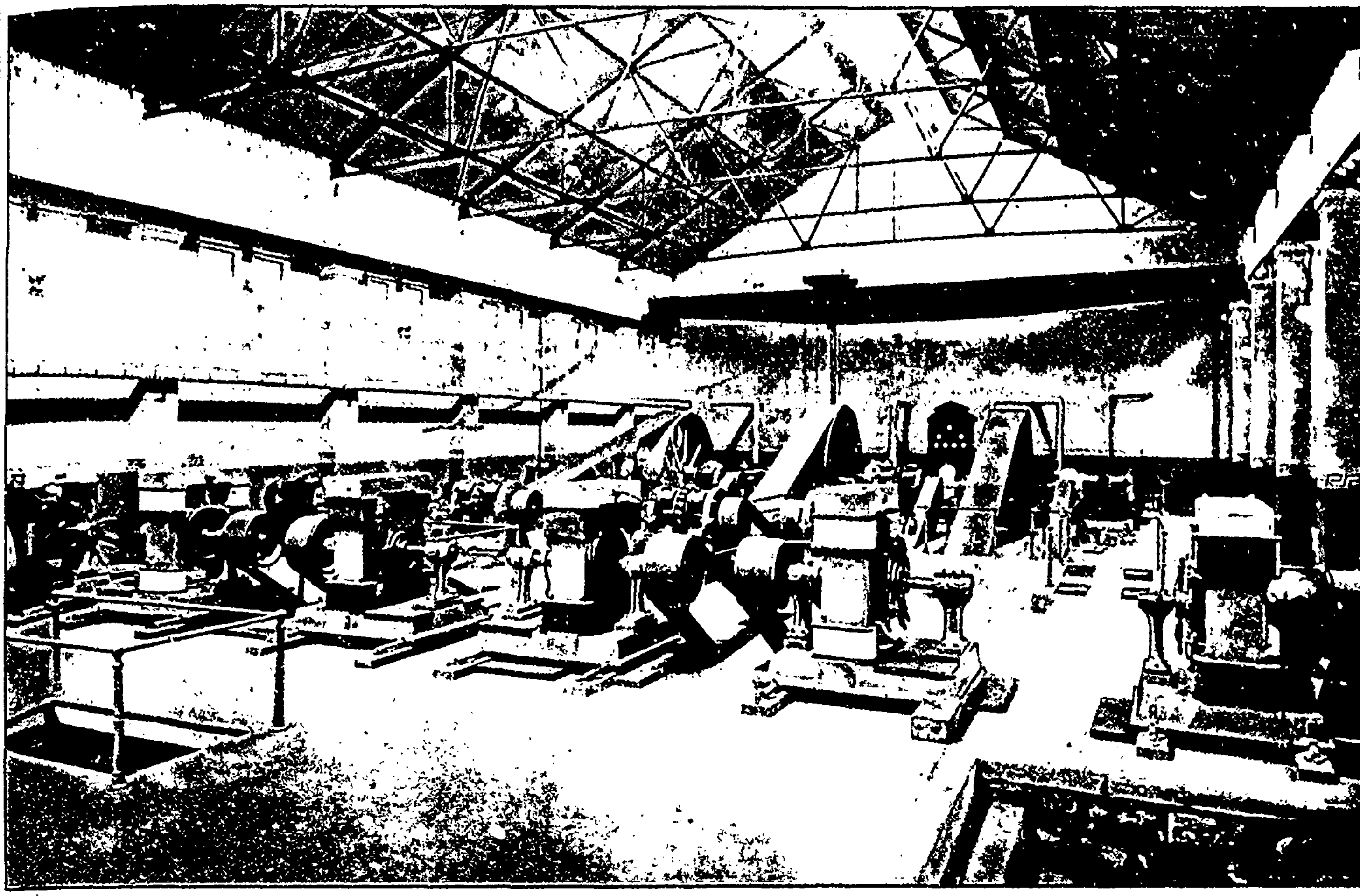
On the 21st day of January, 1897, the arc light station of the Toronto Electric Light Company was totally destroyed by fire. The building was of frame covered by corrugated iron, and had served the needs of the company in the early stages of its career. The continual increase in the number of dynamos and engines had necessitated the building of platforms to carry the dynamos above the shafting, and finally the building became very much crowded. Although there was considerable timber in the structure it was thought that owing to the continuous presence of the employees the risk was not great. Events proved differently, however. So sudden was the outbreak that all the engines could not be stopped, and the men had to make a hurried exit by the windows, leaving even their personal effects behind. Owing to rapid temporary work the lighting of the city was very little interfered with, and work was at once commenced to clear the ground for a new structure. Steam derricks were erected, and the dismantled dynamos, shafting and engines lifted out and cleared away. While the ground was being cleared plans were got out for new structures, and it was determined that, whatever might be the next cause of trouble, it would not be fire. There is absolutely no wood or any combustible substance used in any part of the construction. We are enabled to present our readers with a general view of the reconstructed works and some of the details of the various buildings. The arc light station No. 1 is shown by photographs taken of each end from the center of the building. At one end will be seen the arc light switchboard, which is built of pressed brick with terra-cotta trimmings, and is surmounted by a clock driven by electricity, which is one of a number distributed around the works, and forming part of the general time system that is being introduced into various parts of the city. Each arc circuit has ampere meters on the face of the switchboard large enough to be seen from any part of the room, and behind the wall there is a slate shelf for standard ammeter, which can be plugged into any circuit desired, and also polarity indicators to ensure the currents flowing in the proper direction.

When the ground was cleared the first thing done was to drive piles for the foundations to the solid rock. Such piles as were under the old building were utilized, and new ones driven where necessary. The piles were cut off level at the lowest water line, and on them was laid a solid bed of concrete over the entire space, 2 feet 9 inches in thickness. Upon this the dynamo foundations were built, and were carried up to a height sufficient for headroom under the arches which connected them together. This formed tunnels for the shafting, the pedestals for which were anchored to the concrete bed. Intermediate arches, wherever necessary to continue the floor between dynamo foundations, are carried on heavy I beams on cast iron pillars. Stairs to these tunnels, doors, window frames, roof beams, railings, etc., are all of iron. There is also a twenty ton travelling crane which can be used over any part of the floor. This has been of great advantage in handling the machinery during installation, and will no doubt effect a considerable saving in time in the event of the machinery being handled for repairs. The shafting is all extremely heavy and runs in self-oiling bearings of the best design. There appears to be nothing omitted that experience has shown to be advantageous in the operation of an electric light installation.

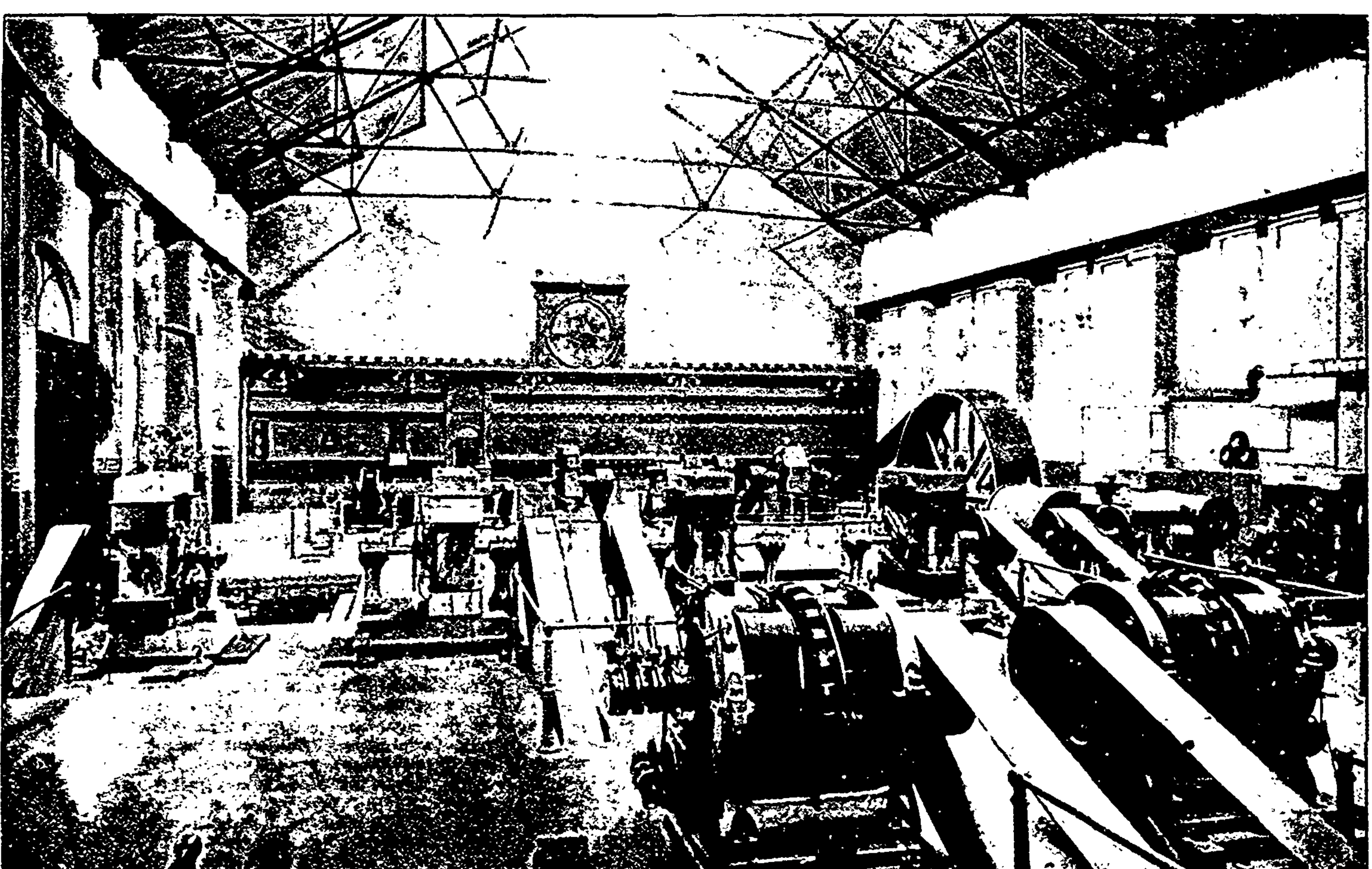
3,000 H.P. ENGINES IN NO. 3 STATION, TORONTO ELECTRIC LIGHT CO.

The building in front and to the east of the general offices of the company is now being finished, and will be utilized as store rooms for all supplies, show rooms for incandescent fixtures, and meter department. This building is erected entirely of brick and iron, with concrete floors and terra cotta partitions. It also contains accommodation for nightwatchman and for lineman on duty at night, with horse and quick hitching attachment for sudden calls. This saves time that would be necessary to get a horse and rig from the general stables, which are situated at the rear end of the lot.

Station No. 3 is also a brick and iron building of a similar character to the arc light station, and is equipped with two pairs of upright Corliss engines of 1000 to



Engine End of No. 1 Arc Light Station, Toronto Electric Light Co.



Switchboard End of No. 1 Arc Lighting Station, Toronto Electric Light Co.

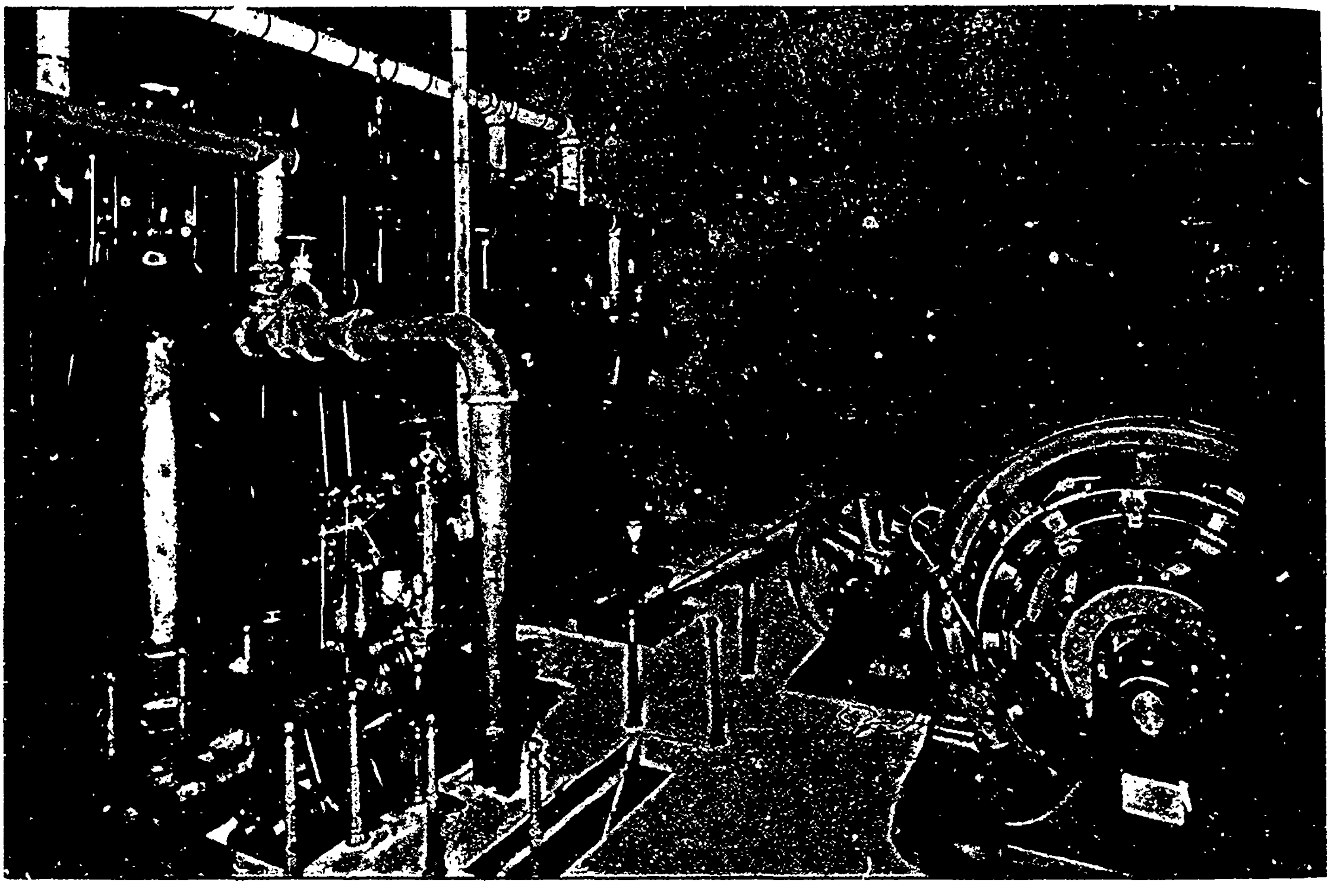
1500 h. p. each. These engines are shown in our illustrations. There are four dynamos in this building—two of 500 k.w. capacity 250 volts for motive power purposes, and two alternators of 450 k.w. capacity each. One of the illustrations shows a direct current generator, but owing to the limited space available for the purposes of the photographer, it does not give a very clear idea of the surroundings. In this cut may be seen one of the automatic cut-off air pumps and condensers, which are used throughout the installation.

Station No. 2, or the most westerly of the lot, is a similar construction to the building that was destroyed, with the exception that it is lined inside as well as out with sheet iron, and the floor joists and uprights are also cased in sheet iron. It contains a double tandem upright Corliss engine of 1000 horse power capacity, and also the general distributing switchboard for all the output of current for power and incandescent light purposes. It is the intention to rebuild this as soon as the weather permits, and replace the present structure with a building of a similar class to the new ones. The foundations have already been built of stone and concrete, and it is expected that the building will be completed in the early summer. The engine will have a new fly wheel of 60 inches face, and the shafting will be rearranged and placed in brick tunnels, as in the new buildings, and the space that will be gained will be arranged for the installation of two direct connected units of 1000 h.p. each.

The company have also decided to erect coal handling and storing machinery of the latest type, so that coal arriving by vessel can be unloaded and delivered in the boiler houses with the minimum of handling and expense.

The whole of the works above specified, including the rebuilding of one of the boiler houses, and the construction of the iron roof, have been done by the employees of the Toronto Electric Light Company, including the original designs and all the labor necessary in the carrying out of the various works the only exception being the pile driving and the construction of the travelling crane, which were done by contract.

The detail of the foundation work, some of which was of a very difficult character, having to be laid under water, as well as the general arrangement of the buildings, are of a very interesting character and would well repay a visit by anyone interested in such matters. Visitors are always welcome and will be shown anything and everything in connection with the operation of this extensive plant.



Direct Current Generator, 250 volts, 500 k.w., Toronto Electric Light Co.

A LETTER OF THANKS.

Montreal West, February 9th, 1898.

To the Editor of the Canadian Electrical News.

Sir,—Permit me to thank those of your readers who so kindly forwarded samples of boiler scale and feed water in connection with articles now in course of publication in the Electrical News.

Personally the results have been indeed gratifying. With the exception of P. E. Island, I have received samples from every province in the Dominion ; and what is more pleasing, samples have been received from steam users, engineers, and manufacturers of scale resolvents, as well as dealers in this line of goods.

This is also a gratifying evidence that the Electrical News is widely read, and that the subject is an interesting one to all classes of readers.

Unfortunately articles of this kind cannot be written in popular style. I shall in future, however, endeavor as much as possible to avoid the use of technical terms.

I cannot too highly express my thanks to those engineers with whom I entered into private correspondence for their very flattering appreciation of the work upon which I have been engaged.

Yours very truly,

Wm. Thompson.

The United States Consul Morris, of Ghent, Belgium, states that the most extensive product of the world is charcoal thread, which is employed for incandescent lamps, the article for the most part being manufactured at Paris, and coming from the hands of an artisan who, for the present remains unknown in order to better protect the secret of manufacture. It is by the gramme—15½ grains—that this product is sold at wholesale, and, in reducing its price to the basis of pounds, it is found that the filament for lamps of twenty candles is worth $8,000 per pound, and that for lamps of thirty candles is rated at $12,000 per pound ; the former have a diameter of 0.020 of a millimetre—one millimetre equals 0.0394 inch—and the latter of 0.0045 of a millimetre.

CORROSIVE AND SCALE-FORMING AGENTS IN BOILER FEED WATERS.

By Wm. Thompson.

[Article 3].

Having discussed the presence of corrosive agents in solution, we now require to turn our attention to the presence of impurities likely to occur as dissolved solids and solids held in mechanical suspension, some of which are liable to form scale or encrustation.

The total solids contained within a boiler feed water may be in either of one of two conditions, in mechanical suspension, as small particles, or in chemical solution; and water may contain impurities as per following table:

In mechanical suspension:	Organic matter	Animal. Vegetable.
	Inorganic matter	As sand, mud, etc.
In solution:	Organic matter	Animal. Vegetable.
	Inorganic matter	Scale forming. Non scale forming.

Matter in mechanical suspension, whether organic or inorganic, may be removed by filtration, but matter in chemical solution, as dissolved impurities, cannot be removed by mere filtration, but must receive treatment either by chemicals or heat, the aim being to get a precipitation whereby we have the impurities in condition first named.

I shall not attempt to deal with the whole of the chemical compounds that may at times be found in natural waters, but confine myself to those compounds of common occurrence with which we are all well acquainted. These may be classed as the oxides, chlorides, carbonates, bi-carbonates and sulphates, being the compounds formed by the union of the various acid radicles with the basic radicles or metallic elements, those most commonly found being silicon, aluminum, iron, calcium, magnesium, sodium and potassium.

Before proceeding to discuss the nature of the scale formed or the action of these various compounds within the boiler, it is first necessary to briefly explain their presence in the water. One of the commonest and most important of these groups of salts, and a group with which we are most frequently called upon to deal, is the carbonates. They are very widely distributed, being found in considerable quantities nearly the world over. Carbonate of calcium is found in the well known forms of limestone, marble, chalk, coral deposits, etc. Carbonate of magnesium occurs quite frequently as magnesite and in combination with carbonate of calcium very largely as dolomite.

Carbonate of iron occurs less frequently, and not so largely diffused in nature, as siderite or spathic iron.

The carbonates of the alkaline bases, sodium and potassium, occur very largely in the alkaline districts, but being soluble at all temperatures found in boiler practice, do not play such an important part in engineering practice as scale-forming agents as do the carbonates of the alkaline earths.

The whole of the carbonates are formed by the union of carbonic dioxide (Co_2) with some one of the metallic oxids, such as calcium oxid (CaO), magnesium oxid ($Mg\,O$), sodium oxid (Na_2O), etc.

The usual chemical reaction taking place may be classed as a double one, carbonic dioxide (Co_2) first combining with water (H_2O) to form carbonic acid (H_2Co_3). The metallic oxids just named enter into combination with carbonic acid as follows:

Calcium Oxid.		Carbonic Acid.		Calcium Carbonate.		Water.
CaO	+	H_2Co_3	=	$CaCo_3$	+	H_2O.

and

Magnesium Oxid.		Carbonic Acid.		Magnesium Carbonate.		Water.
MgO	+	H_2Co_3	=	$MgCo_3$	+	H_2O.

In this case the bi-valent basic radicles of calcium and magnesium replace the hydrogen of the carbonic acid and the liberated hydrogen enters into combination with the oxygen of the metallic oxid; consequently from the combination of two chemical compounds as shewn in equation two new compounds, consisting of either of carbonates of calcium or magnesium and water, are formed. The combination between the oxid of sodium and carbonic acid is practically the same with this exception: Sodium is a univalent metal, consequently has the power to replace only one atom of hydrogen, therefore one molecule of sodium oxide must always consist of two atoms of the metal sodium in combination with one atom of oxygen. The chemical reaction for the production of sodium carbonate therefore is:

Sodium Oxid.		Carbonic Acid.		Sodium Carbonate.		Water.
Na_2O	+	H_2Co_3	=	Na_2Co_3	+	H_2O.

As a rule, out of all the scale-forming material found in feed waters, none occurs so frequent, nor yet in such large proportion, as does carbonate of calcium; next in order carbonate of magnesia may be said to occur. Carbonate of iron occurs in limited areas and never in large quantities.

The carbonates of calcium and magnesium are very slightly soluble in water, and very rarely exist as such in quantities exceeding two grains per imperial gallon, and it is very rare that they are present in the water separately, as they usually exist in water together, and in this case the total held in solution never exceeds the maximum quantity of either which the water is capable of dissolving. This small quantity of dissolved solids would have but little effect in a boiler feed water, and draws our attention to a very important fact. If the carbonates of calcium and magnesium are, as stated, nearly insoluble in water, how is it that they predominate as scale-forming impurities and are so often found in chemical solution in boiler feed waters in such large quantities?

If we turn back to the article on dissolved gases, we shall find that many gases are very soluble in water, and it is this fact that plays such an important part in explaining the presence of insoluble carbonates.

Wherever organic decomposition or combustion is taking place carbonic dioxide (CO_2) is being constantly evolved. This at ordinary pressures and temperatures exists as a gas, and is therefore a constant constituent of the atmosphere; it is also contained in the soil as a product of organic decay.

J. A. Wanklyn, in an excellent work on "Water Analysis," published in London, England, states that "in many natural waters there is more carbonic acid gas in some form or other than any other single foreign material." As already seen, carbonic dioxide is very soluble in water; some is absorbed by falling rain, and a still greater quantity as it passes through the soil. We have already noted the very wide distribution of the various carbonates in nature, and although the carbonates of lime and magnesia are nearly insoluble in water, they are very soluble in water containing carbonic acid.

The carbonates of lime and magnesia appropriate a portion of the carbonic acid equal in quantity to that already existing in combination with their oxids to form the carbonate, thus forming what is known in chemistry as a bicarbonate, according to the following equation:

Carbonate of Lime.		Carbonic Acid.		Bicarbonate of Lime.
$CaCo_3$	+	H_2Co_3	=	$CaH_2(Co_3)_2$.

and

Carbonate of Magnesia.		Carbonic Acid.		Bicarbonate of Magnesia.
$MgCo_3$	+	H_2Co_3	=	$MgH_2(Co_3)_2$.

Both the bicarbonates of lime and magnesia are very soluble in water, and the presence of carbonate of lime and magnesia in boiler deposits may then be explained as follows: The rain reaches the earth charged with a certain quantity of carbonic acid, and in passing through the soil takes up a still greater supply, and after passing through the earth rarely escapes contact with some of the carbonate rocks, which dissolve in it. After passing over these rocks and forming new solutions, the water again reaches the surface and forms the supply of our rivers, lakes or wells, from which we take our boiler feed supplies. These bicarbonates are very unstable salts, and are much more soluble in cold water than hot, owing to the fact that a rise in temperature drives off the excess of carbonic acid and the bicarbonate is as a consequence reduced to the carbonate, in which condition it is nearly insoluble. When a temperature of 180° F. is reached a large percentage of the carbonic acid is driven off, and the bicarbonate consequently suffers reduction to the carbonate, and at 290° F. the precipitation is complete. Thus we are readily enabled to account for the presence of the carbonate salts in boiler encrustation.

Next to the carbonates, the sulphates play an important part in feed waters. The sulphates of magnesium, sodium and potassium are all readily soluble in water, and although they play an important part in the treatment of boiler feed waters, need not be referred to here.

Probably no scale-forming salt has given more trouble or been more destructive to boilers than has sulphate of calcium. Sulphuric acids readily attack nearly the whole of the metallic oxids and especially those under consideration, forming sulphates and water, thus:

Calcium Oxide.		Sulphuric Acid.		Calcium Sulphate.		Water.
CaO	+	H_2SO_4	=	$CaSO_4$	+	H_2O.

Calcium sulphate or sulphate of lime is found in nature widely distributed, occasionally in the anhydrous form as anhydrite, and much more commonly as the hydrate known as gypsum. When gypsum is heated to about 240° to 250° F., it loses a large proportion of its water of crystallization and becomes what is known to us as plaster of Paris. This product is, as we know, capable of taking up another portion of water and "setting" to a close, hard stony mass. The anhydrous sulphate is nearly insoluble in water, but the hydrated form dissolves fairly readily and up to about 120° F., as the temperature increases the solubility increases. Above 212° F. solubility decreases very rapidly, and at 300° F. it becomes almost entirely insoluble. Unlike the carbonates the presence of carbonic acid gas has no effect upon its solubility, its solubility being entirely due to the solvent power of the water itself. When the hydrated sulphate of lime precipitates it loses a portion of its water of crystallization, and when it reaches the boiler plate the balance, and it is consequently converted into the anhydrous state, and this change in crystalline form is largely the cause of precipitates containing sulphate of lime being bound into such hard compact masses and forming such a troublesome scale.

As already stated, sulphuric acid occasionally occurs in streams, etc. If bicarbonate of lime or magnesia are present free acid will not exist until the salts of calcium and magnesium have been reduced from carbonates to sulphates. The same reduction takes place when water containing sulphuric acid is passed over limestone rocks, and since rain water has been shown by numerous chemists to contain traces of sulphuric acid, the presence of sulphate of lime is largely accounted for. The chlorides of the various metals under consideration are frequently present in feed water, especially sodium chloride, which is simply common salt. Since, however, the whole of the metallic chlorides we have occasion to refer to are easily soluble in water and do not form scale except in extreme cases, we do not require to refer to them at any length, particularly since we shall require to discuss them fully at a later stage, chiefly as to their effect on the scale-forming agents.

The oxides of silicon and aluminum are frequently found in scale, and when present in any quantity form a very troublesome scale. They are not easily soluble in water, but often occur in large quantities where muddy water is used without previous filtration.

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Correspondence is invited upon all topics legitimately coming within the scope of this journal.

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Legal Rights of Telephone Companies. JUDGE Cox of the Supreme Court of the District of Columbia has lately given a decision of much interest to telephone companies and telephone subscribers. An hotel keeper at Washington was threatened with the removal of his telephone if he continued to permit the free use of the instrument to his patrons. He applied to the court for an injunction to restrain the telephone company from carrying out their threat. While granting the injunction Judge Cox imposed certain restrictions upon the plaintiff as to the use which might be made of the telephone. One is that while boarders in the hotel may telephone for a baggage waggon, they are not entitled to use the instrument to order theatre tickets or stock reports. These restrictions are based on the fact that the guest in the hotel does not get free cabs, telegrams, newspapers, or boot shines. Judge Cox very correctly points out that "When the subscriber allows others to use his telephone it is an abuse of the time of the telephone operator. It is also an infringement on the rights of the Bell Telephone Company, which receives a royalty from the defendant. Furthermore it is an infringement of the rights of other subscribers. It is very annoying for a subscriber to call for a certain number and be told that the connection he wants is busy, that being due to the fact that a non-subscriber is using free of charge, the telephone with which connection is desired."

Canadian Electrical Association. THE Committee on Legislation of the Canadian Electrical Association thought it advisable, notwithstanding the shortness of the late session of the Ontario Legislature, to make an attempt to secure a measure of relief to gas and electric lighting companies, from unfair and unjust municipal competition. With that object in view a short bill was prepared which came before the Municipal Committee. After discussion those representing the Association consented to a suggestion of the chairman and other members of the committee, that the matter should stand over for a year. The committee thought that in view of the early adjournment of the House, and the pressure of business consequent upon an unusually brief session, there was not time to give the bill the proper amount of consideration. The discussion, however, brought out the fact that there could be found no solid objection to the principle of the Bill, while on the contrary the injustice of the present law was brought into clearer prominence. The necessity and propriety of some measure of relief which will prevent the confiscation of electric light investments may be considered now to be generally admitted, and there is reason to hope will be forthcoming at the next session of the legislature. The electric light companies throughout the province, who are all more or less interested, should give the Canadian Electrical Association their hearty support in this movement.

Electric Lighting for Profit.

AN able paper on this subject was recently read before the Northwestern Electrical Association by Mr. Alexander Dow. The text of the paper was that at the present time the policy of electric light managers should be to sell electric energy to every accessible user, at the lowest price which will realize a fair profit on the capital invested. It was argued that the few who are still following old methods and asking high prices for energy are simply advancing the cause of municipal control. Perhaps the most important subject touched upon by Mr. Dow in his paper was that of supplying light and power from the same units. He believes the best practice of to-day is to furnish arc and incandescent lights, as well as motive power, from the same dynamos and mains, thereby greatly reducing the cost of plant and distribution lines. While this is a subject which should be considered in the original design of a station, Mr. Dow points out that there are instances where old stations have been re-arranged, with very satisfactory results. Only for railway work does he advocate the installation of separate units, giving as his reason that there has not yet been devised a satisfactory system whereby a supply of 500-volt current can be combined with a general lighting distribution system. In the winter season the load on street railways coincides with the heaviest load on the lighting system for an hour or so each day. Mr. Dow concludes his paper with a plea for greater educational work among electric light men, municipal authorities and municipal theorists.

Acetylene Gas.

IN view of the effort that is being made, principally by the eight or nine companies engaged in the manufacture of acetylene gas machines, to introduce acetylene gas throughout this country, we publish in this number the rules which have been adopted by the insurance authorities of Germany and Canada for regulating its use. A careful perusal of these rules should be sufficient without further argument to show the extremely dangerous character of acetylene, and it is well that the dangers attendant upon its use should be understood at this stage, when as yet it has come into use in but few places. We are surprised to learn that in one or two towns an effort is being made to displace the electric light by acetylene gas. We cannot imagine that the effort will be successful, but should the citizens of these towns be induced by specious arguments, and the novelty of the new light, to adopt it in preference to the electric light, they will assuredly have cause to regret their action. A material that is not allowed to be kept within a building, even when gas machines of approved design are used, except at an additional cost for insurance of 10 cents per $100 per year, or 20 cents per $100 for a three years' risk, must indeed be dangerous in its character. Further than this the German regulations provide that persons engaged in handling the carbide should be free from heart and lung diseases and should wear a respirator and eye protectors. These two features of the regulations are sufficient to show the dangers attending its use. It is difficult to believe that a material which must be surrounded by so many safeguards will find extensive and permanent use. Certainly, no well conducted electric light concern need have any fear of successful competition from this source. We are not in a position to speak definitely with regard to the price at which acetylene can be supplied, but the fact that the Wilson Carbide Company at Merritton are contending in the courts for the privilege of operating their works on Sunday, on the ground that only by so doing can the business be conducted at a profit, and their statement that the operation of the works thus far has resulted in a deficit of some $7,000, would seem to show that the cost of production is so great as to allow but a small margin of profit.

Efficiency of Motors.

COMPETITION in the manufacture of motors has been the result of some concerns turning out cheap work and of course inferior articles. It is very seldom the purchaser of a motor ever asks the efficiency, he being content to get a certain size for the lowest possible price, and taking the rest for granted. The result of this is disastrous to the company supplying the power and instances of this kind are very numerous the supply company getting the name of being extortionate in its charges, whereas the trouble is originally with the motor. We have heard of smaller size motors (from 15 h.p. down) taking as high as 4 e.h.p. for 1 B.H.P. This is certainly not as it should be, and shows room for improvement. Purchasers will pay a higher figure for motors when the efficiency is higher, and they will find that it pays ultimately when they are paying for their power by meter measurement. If, however, they are by "contract" and the contract is based, as is usually done, on the amount of machinery to be driven, it is only natural to expect a "boost" at the expiration of the contract if a meter has been put on as a check, which is done in all well-regulated plants. The customer would never think of the motor being the cause of the trouble, but he certainly thinks and does not hesitate to say the company is robbing him, whereas as a matter of fact he is robbing himself, for he is getting an E.H.P. for say 2 cents per hour and paying about 6 to 7½ cents per B.H.P. Let manufacturers settle down to making first-class apparatus giving the highest possible efficiency and they will find purchasers. If there were not any poor machines made none would be bought, and we are certain that the manufacturers themselves are largely to blame for this state of affairs.

Economy of Water Power.

WATER power is always assumed to be more economical than any other source of energy, since it is supplied naturally gratis. We think, however, there is considerable room for discussion on this point. The cost of installation, together with the purchasing of water and pole line rights, brings fixed charges up to such a point as to make it very doubtful, indeed, whether power delivered from a water-driven plant for considerable distances can be done at a less cost than that produced locally by steam. Where water power is limited and a reserve steam plant has to be kept, the advantage is still more doubtful. Changing plants from steam-driven to electrically driven from some distant water power, should receive the most careful consideration, as no doubt is usually the case. Difficulties, such as breaking down of pole line, generators and turbines being disabled, etc., all tend of course to increase the risk. Certainly the chances of a shut-down are greater in the case of a distant plant—a most important consideration. Where there is a large load the cost per light per year may be reduced to such a figure as to render it an impossibility for water power to enter into the system if it has to be delivered from a considerable distance. This, however, can only be done by first-class apparatus, such as boilers, engines and generators. First cost, we regret to say, enters more into consideration with purchasers than it should do. This should be secondary, efficiency being the main point at issue. If a boiler maker supplies a boiler and guarantees an efficiency of 85% and fulfils same, it is surely worth a great deal more than one which will give only 60%. In how many cases does the efficiency of the boiler enter into consideration? This is a question worth pondering over. If an engine builder guarantees a 500 h.p. engine to run on 13 lbs. steam per h.p. hour, and fulfils his guarantee. this engine is a far better investment than one taking 26 to 30 lbs. and costing only one-half of the other. We believe there is an utter lack of attention on this point, and the sooner a thorough system of testing boilers and engines in steam and electrical plants is inaugurated the better. When this is done and old boilers and poor engines discarded, the question of substituting water power for steam is never likely to be a very serious one with local plants, especially when the water power is at some considerable distance and the power is generated in large quantities by the local plant.

SAFEGUARDS AGAINST ACETYLENE GAS.

The dangers attending the manufacture, compression and liquefaction of acetylene gas are provided against in Germany in a series of rules issued by the Imperial Insurance Office, of which the following is a condensation:

Rules for Employers and Foremen. Liquefaction of acetylene must be carried out apart from the manufacture and compression, but if the gas is compressed to eight or more atmospheres, the compression also must take place in a separate apartment. The apartments must be well lighted and ventilated, have doors opening outwards, and be heated only by steam or hot water. External sources of light only may be used, or, in urgent cases, safety lamps may be resorted to. The carbide must be kept in moisture-proof vessels, which vessels must be stored in well-ventilated dry apartments (not cellars). The vessels should be opened only as needed for immediate use. As little dust as possible should be made in breaking up the carbide, and persons engaged in the work should be free from heart or lung diseases, and should wear a respirator and eye protectors. The gas holder must be situated in an open, or in a well ventilated apartment away from the generating room, and it must be provided with a pressure gauge. An efficient washer must be placed between the generator and the holder. The gas must be generated by the gradual addition of carbide to a large excess of water, and not by adding water to carbide. Compression of acetylene to more than ten atmospheres pressure must only be carried out in strongly cooled apparatus. In the liquefaction of acetylene, the condensing vessel must be emptied at the close of operations, and the cylinders used for the conveyance of liquefied acetylene must have been tested to 250 atmospheres pressure, and have their contents signified on the outside in white. Before and after filling, the cylinders must be weighed with precision, and no more than 1 kilo. of acetylene per three liters capacity (20.8 lbs. per cubic foot) be admitted. The charged cylinders must not be exposed to heat. The cylinders and all apparatus which comes in contact with liquefied acetylene must be entirely free from copper, and sharp angles in valves and apparatus avoided.

Rules for Workmen.—Naked lights and lucifer matches must not be used in apartments of acetylene works and safety lamps must not be opened. In breaking lumps of carbide, as little dust as possible should be made. Water must never be added to carbide, and only small pieces of carbide added to water. The prescribed temperatures must be closely observed in the compression and liquefaction of the gas. The cylinders used for liquefied acetylene must answer to, and be filled in accordance with, the prescribed conditions. On opening a cylinder, take care the acetylene issues very gradually.

A copy of the rules must be hung in a suitable place in the apartment. Fines are imposed for breaches of regulations.

The following are the regulations governing the installation and use of acetylene gas, adopted by the Canadian Fire Underwriters' Association, November, 1897:

For each approved Standard machine installed and maintained in accordance with the following rules, in the building insured, or in any building connected therewith, an extra of 10 cents per $100 for annual risks, and 20 cents per $100 for three year risks must be paid on the building and its contents.

If the apparatus in the building insured, or in any building connected therewith, has not been approved by the association, or if it is not installed or maintained in accordance with said rules, double rates must be paid.

No charge to be made for an approved Standard machine when installed outside in a first class building (having no communication with the building insured), or in a building of any construction detached not less than 15 feet.

REGULATIONS.

1. No apparatus for generating acetylene gas shall be installed until that particular pattern of machine has been examined and approved by the association. Any manufacturer of such apparatus desiring to have the use thereof sanctioned by this association, must furnish the secretary with a copy of working drawings and specifications of materials used in making the machine, one of which he shall exhibit in full working order, and submit same to such tests as may be required by the inspector of the association. The expense of such inspection shall be paid by the manufacturer. If the apparatus is approved by this association, the manufacturer shall sign an agreement that all machines made and sold by him shall be shewn by the drawings and specifications fyled with the association.

2. Every generator shall be of suitable capacity, substantial construction and on approved principles, the interior parts easily and readily accessible for examination, double generating chambers required, as there is no means of telling whether carbide is exhausted and gas may give out after dark.

3. All danger of corrosion must be eliminated and no copper or any alloy thereof to be used in the machine.

4. There must be no possibility of escape of gas whilst the charge of carbide is being renewed.

5. In generators where the carbide is alternately dipped into, and raised out of the water, suitable precautions shall be taken to prevent the carbide being accidentally precipitated into the water, and thereby causing a too rapid generation of gas.

6. In machines where the pressure of the gas causes an inverted vessel to rise and fall inside of another that contains liquid, the clear space between the two shall be at least one inch all round, not only to secure free motion, but that the surface of the water may be plainly visible without the aid of a glass tube.

7. Liquid seals must be in their natural condition, not liable to be thickened by deposit of lime or other foreign matter.

8. The liquid seals (except those from which the gas is properly piped away) shall be of sufficient depth to resist any possible pressure of gas inside the generator, and in no position shall they be less than six inches.

9. The supply of water to the carbide shall be immediately and automatically cut off before the pressure of gas inside the generator exceeds three inches of water, and a properly protected water gauge, or gauges, shall be so placed as to show the actual pressure of gas inside the generator and gasholder.

10. Suitable escape pipes must be provided, through which the gas shall freely and safely pass from the generator and gasholder into the external air at a pressure not exceeding three inches of water, and before it becomes possible for it to escape by any other means.

11. The pipes for the conveyance of gas from the generator to the gasholder, and those for the escaping gas, shall be at least one inch internal diameter.

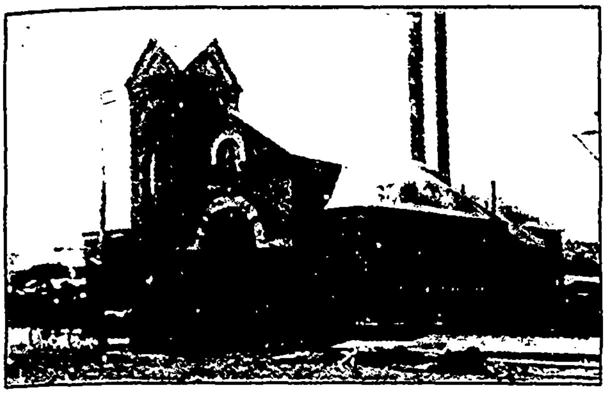
12. The apparatus must be located in a dry room, without artificial light or fire heat, and have good ventilation to the outer air near the ceiling.

13. The generator must be charged and the deposit removed by daylight.

14. The deposit, when removed from the generator, to be placed at safe distance outside the building, as the same may contain carbide that is not entirely decomposed.

15. The use of liquid acetylene or of gas generated from liquid acetylene is absolutely prohibited, also lamps from which gas is generated from carbide therein.

16. Storage of Carbide.—None permitted inside building, except in generator room, and then only in air tight metal cases, each case to contain only one charge, and the total quantity shall be limited to the requirements for one week, and in no case exceed 50 lbs.



New Westminster Lighting Station.

MUNICIPAL ELECTRIC LIGHT PLANT AT NEW WESTMINSTER, B.C.

(Description Furnished by the City Authorities.)

New Westminster, British Columbia, was the first city on the Pacific Coast—and one of the first in Canada—to adopt the principle of municipal control of electric lighting both for street and commercial purposes. It was not without a struggle, however, that the desired end was attained. Early in 1890 a private company came forward with a proposition to furnish the corporation with fifty 2,000 c. p. arc lights at a rate of 45 cents per night each. This would have cost the city over $8,000 a year; but the number of lights required to light the city properly was at least 90, and these would have cost, at the same rate, in the neighborhood of $15,000 per annum.

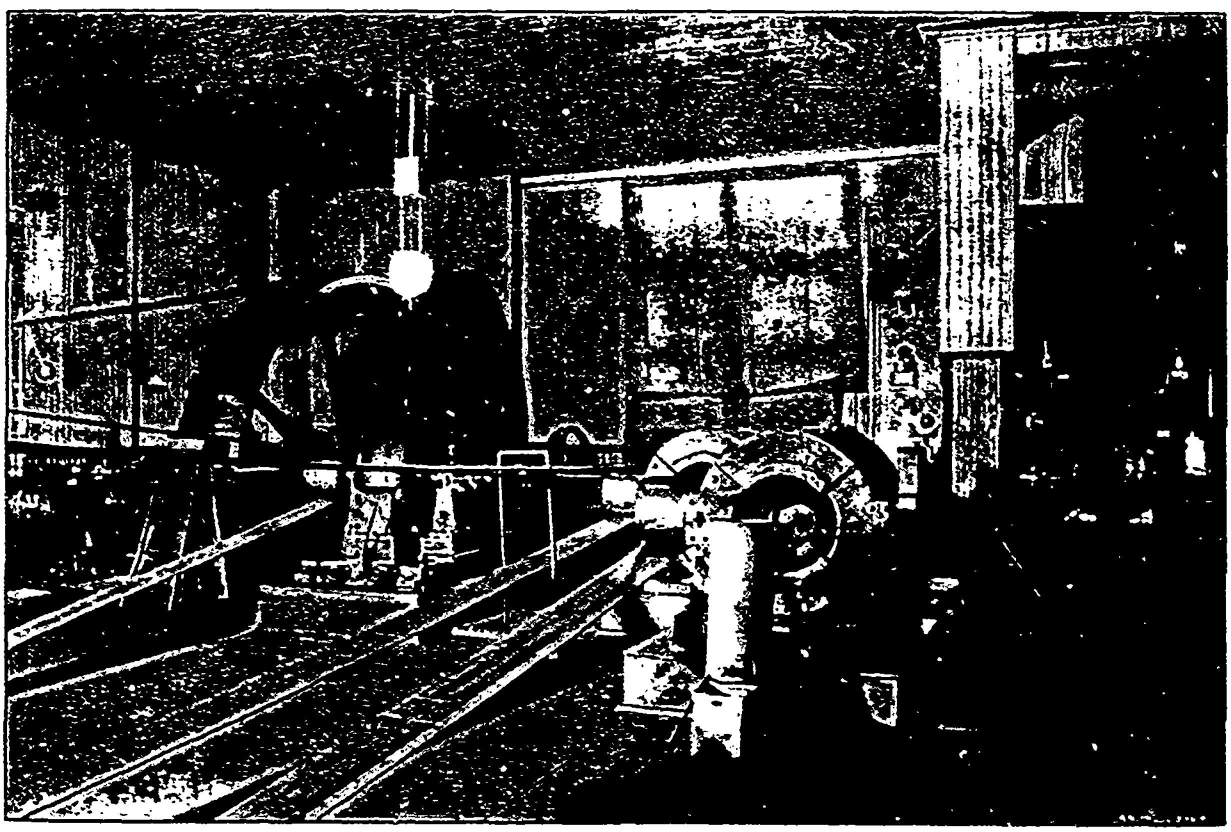
The question of the municipal control and ownership of the water and light franchises had already received a good deal of attention from the public, and New Westminster at this time had decided upon controlling the public water service. A system of waterworks was under construction and was soon afterwards completed at a cost of about $450,000, which system is to-day one of the best on the continent. The city council of 1890 was composed of a set of thoroughly wide-awake business men, and they decided, with commendable promptness, in order to be first in the field, to proceed at once with an electric lighting system. Like the sentry who was ordered to "shoot first and challenge afterwards," the council, without proper legal authority, entered into the necessary engagements for buildings and plant, and afterwards applied to parliament to legalize the expenditure, which was done.

The result has been entirely satisfactory, and to-day he ratepayers of New Westminster would not, under any circumstances, permit the lighting franchise to pass out of the control of the corporation. The city is one of the best lighted on the continent, and the actual cost of street lighting to the ratepayers has been reduced to a mere trifle. The success of the enterprise was, of course, due very largely to the ability of the management, and to the hearty and generous support of the public.

When it was decided to proceed with the works, the Council's first step was to secure the services of a skillful electrician to superintend the construction. Mr. P. Bowler, an expert from the Royal Electric Company, of Montreal, was finally engaged, and the selection, as events have since proved, was a most judicious one. On the completion of the installation Mr. Bowler assumed full control of the system, and still holds the office of city electrician.

A substantial brick building, two stories in height, 60 x 100 feet, was erected in a central location for a lighting station. The ground floor was divided into two apartments, boiler room 60 x 40 feet, and engine and dynamo room 60 x 60 feet—separated by a 12 inch brick wall. The upper story has been fitted up with the necessary appliances for repairs, which are all done on the premises, even to the re-winding of the armatures, by the regular staff, and so far the electrician has had no occasion to send any part of the electrical apparatus out of the building for repairs.

In 1890 the plant put in consisted of one 180 h. p. Reynolds Corliss engine, size 20 x 42; two Inglis 80 h. p. boilers, with one 150 h. p. feed water heater; one 50 light 2000 c. p. arc dynamo, and one 650 16 c. p. incandescent dynamo. The engine is belted to a counter shaft, and the dynamos in turn are belted from the counter shaft. Forty 2000 c. p. arc lights were at once installed for street lighting, and ten were reserved for commercial purposes. The demand for incandescent lighting was brisk from the first, and within four months the incandescent dynamo was overloaded, with applications for light still coming in. The city was growing rapidly and the council of 1891 found itself compelled to increase the capacity of both the incandescent and street lighting



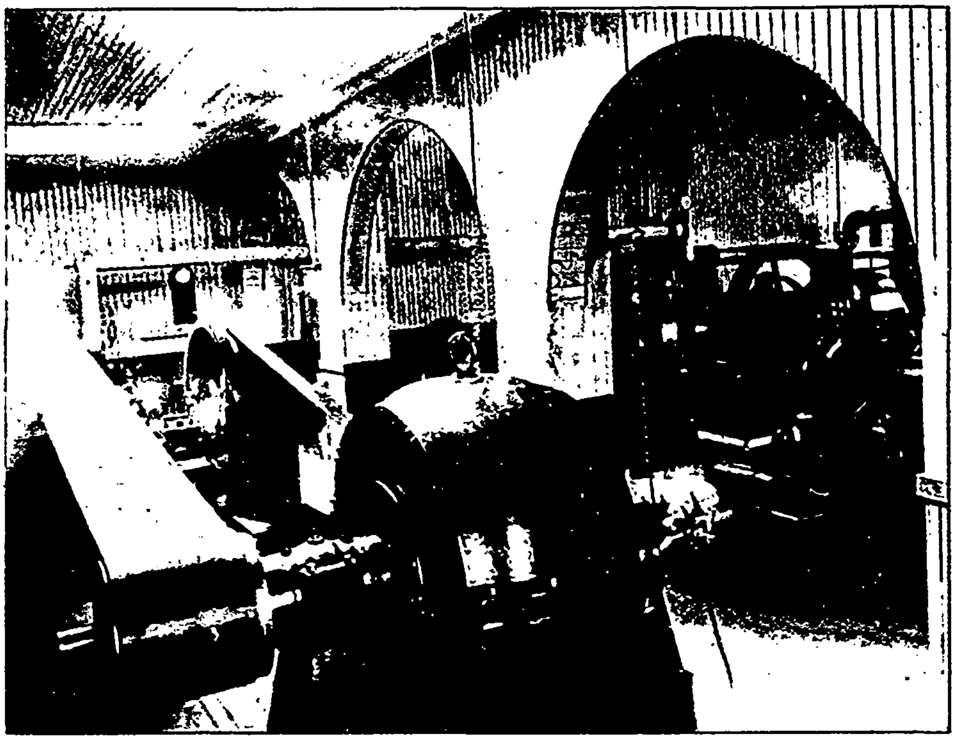
New Westminster Lighting Plant, Showing Corliss Engine and Arc Dynamos.

at once. The ratepayers did not hesitate to vote the additional sum required. The plant was increased by two additional 80 h. p. Doty boilers; one 150 h. p. high speed Doty engine; one 1500 16 c. p. incandescent dynamo, and one 50 light 2000 c. p. arc dynamo, with the necessary lamps. The number of street lamps was then increased to 90, and ten months later the incandescent system was again overtaxed.

When the works were first established the rate for incandescent lighting was fixed at $1 per 100 ampere hours where meters were used, and a fixed rate of $1.12 for 16 c. p. lights where meters were not used, both rates being subject to a discount of 20 per cent. for prompt payment. The works in 1892 were producing a larger revenue than anticipated, and it was considered advisable to reduce the rates for private lighting to 78 cents per 100 amperes, with the same rebate, and this rate still prevails.

The reduced rates produced an increased demand for light, and in 1893 the council was again compelled to reinforce the plant by adding another 1500 light machine and a 150 h. p. Ideal engine. Since then no additions have been made, although the still increasing demand will speedily compel a further extension of the system. The cost of the system as it now stands is $116,441.62.

All the electrical apparatus was supplied to the corporation by the Royal Electric Company, of Montreal, and has given good satisfaction.



No. 1 Alternator, New Westminster Lighting Plant.

Mr. P. T. Bowler,
City Electrician, New Westminster, B. C.

The following figures will show how the revenue has increased annually since the inauguration of the system:

1891	$10,520.67	1895	$22,858.77
1892	18,221.15	1896	27,535.40
1893	22,167.39	1897	30,756.98
1894	21,585.05		

In 1897 returns were highly satisfactory. The revenue from private lighting amounted to $19,642.73, and street lighting, with a rate of 35 cents per lamp per night, produced $11,114.25, or a total of $30,756.98, against receipts of $27,535.40 in 1896. The expenditure in 1896 was $21,327.01, and in 1897 $21,388.22. Thus with an increased expenditure of only $60.61 an increased revenue of over $3,000 was produced. Let us now deduct the total expenditure from the total receipts, and a profit of $9,374.76 remains. Deduct this profit from the charge for street lighting, and it will be found that street lighting in 1897 cost only $1,739.49, or about five cents a night for each 2000 c.p. lamp. Another year of this progress, and not only will New Westminster be getting street lighting free, but there will be something over to go into the general revenue.

The 1897 expenditures were made up as follows. Interest, 5 per cent. on $116,000; clerk, 12 months at $35, $420; electrician, 12 months at $125, $1,500; engineer, 12 months at $80, $960; assistant engineer, 12 months at $65, $780; dynamo tender, 12 months at

Switchboard, New Westminster Lighting Plant.

$62.50, $750; two firemen, 12 months at $57.50 each, $1,380; two trimmers, ditto, $1,380; one cleaner, ditto, $690; one wireman, ditto, $690; one wireman, 12 months at $40, $480; fuel, 12 months, $2,700; carbons, $500; oil and waste, $300; repairs and new plant, $1,000; miscellaneous, $2,058.22. The fuel used is mill slabs and sawdust delivered in the boiler room by the Royal City mills at the cost above noted.

His Worship Mayor Ovens, in his inaugural address to the city council on January 3rd, 1896, very accurately stated the present position of the electric lighting problem in New Westminster in the following words: "The rapid growth of our electric light business now brings us face to face with the necessity of either increasing the present plant or refusing new business. It would be most undesirable to check the growth of an enterprise which in a year or two promises to pay a handsome profit after giving us our street lighting free of cost. There are two ways out of the difficulty. The first is to add to the present plant; the second is to make use of some convenient water power and bring the current to the city by cable. By adopting the latter plan, the cost of maintenance would be reduced by one-half, and as we would then have an uninterrupted service day and night, the revenue could be largely increased by supplying motive power to factories, elevators, etc."

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

NOTE.—Secretaries of Associations are requested to forward matter for publication in this Department not later than the 28th of each month.

TORONTO NO. 1.

At the open meeting, Feb. 15th, Bro. Wickens continued his talk on the steam engine indicator, and at the close was tendered a hearty vote of thanks.

At the regular meeting the Legislative Committee reported that all the members of the Dominion government resident in Toronto had been written to asking their support for the Engineers' License Law and Boiler Inspection Act, which is to come up at the present session, and a number of them have promised their support. The regular open meeting will be held Tuesday evening the 8th. Mr. St. John has kindly consented to give a talk on the strength of boilers. The president requests a large attendance and invites all engineers to be present.

KINGSTON NO. 10.

A special meeting of Kingston No. 10 was held in Congress hall, on January 26th, 1898. It was called for the purpose of visiting the members of parliament, Mr. B. M. Britton for the city, and Mr. David Rogers for the county, re legislation. The following members of the association were present: President Simmons, vice-president Asselstine, past-president Donnelly, Bros. Hoppins, Blomely, Woodrow, Davis, Tandvin, Linton, Strong, Gascoyne, Selby, Derry, Bajus, Turnbull, sr., Tait and Orr. We also had with us certificated members of the Ontario Association, viz., David Leslie, R. McArdle, James Ross and George Hazlett, of Winnipeg branch. The members proceeded to Mr. B. M. Britton's office, where they were received and made welcome. Upon the arrival of Mr. David Rogers the business was then proceeded with by President Simmons presenting an address, together with a copy of the act, to Mr. Britton, after which Bro. H. Hoppins, in a few well chosen remarks, presented a copy of the address and the act to Mr. David Rogers. Both gentlemen made a very courteous reply. After a few questions were asked and answered regarding the working of the association, Mr. Britton said he would support the bill, and that he would also give any assistance he could to make it a success. Mr. Rogers said that he could see no objectionable feature in the bill, but he would not pledge himself until he made further enquiries. At a regular meeting held on the 3rd of February a resolution was passed that a hearty vote of thanks be tendered to Mr. B. M. Britton and Mr. David Rogers for the kind reception they gave the deputation of engineers, and also that a copy of the minutes of the special meeting be sent to the ELECTRICAL NEWS for publication.

JOHN L. ORR, Secretary.

ENGINEERS' EXAMINATION QUESTIONS.

As most engineers are desirous of qualifying for a first-class certificate, it is the intention to publish in this journal from time to time, explanatory answers to the questions that have been asked on recent examination papers by the Ontario Association of Stationary Engineers, Montreal City Inspector and other associations by whom a standard of qualification is required. It is hoped by this means to assist engineers in fitting themselves for examination. Herewith is given an answer to the first question asked on the examination paper of the city of Montreal:

QUESTION 1. What is the highest safe working pressure of a common horizontal tubular boiler, made of ½" steel, with an ultimate tensile strength of 60,000 pounds per square inch of section. Factor of safety, 5; double rivetted. Length, 14 feet, diameter, 66 inches, and 76 three inch tubes?

ANSWER: The strength of a boiler is the strength of its weakest part, which is evidently on the lines of rivet holes, where a certain amount of the entire plate has been removed by the punch or drill. Many eminent engineers, such as Fairbairn, Kirkaldy and Elder, have experimentally investigated this subject, and the mean results arrived at on boilers as usually made, were that with a double rivetted joint the loss of strength mainly due to the rivet holes, is 30 per cent. of the entire sheet, and with single rivetting 44 per cent. This increased loss of strength with single rivetting is due to a distorting leverage, caused by the tendency of internal pressure to bring the centre of the plates in line. In double rivetting this effect is greatly resisted by the increased lap of the joint. The above results, put in a better form for practical use, are, that the strength of a double rivetted boiler is 70 per cent. of the solid sheet, and if single rivetted 56 per cent.

In the question the factor of safety is 5. This means that the greatest tensile stress that the material of the boiler is to be subjected to when at work is one-fifth of the ultimate or breaking stress. This amounts to 12,000 pounds per square inch of section of the plate, of which, owing to the joints, 70 per cent. in double rivetting is the highest permitted, and 56 per cent. in single rivetting. Now, 70 per cent. or seven-tenths of 12,000 is 8,400, which is the greatest tension in pounds per square inch of plate section that is permitted.

The sectional area of ½-inch plates per lineal inch is one-half of a square inch. At a tension rate of 8,400 pounds per square inch, the equivalent rate per lineal inch of plate is 4,200, and this is the highest tension allowed. Leaving algebra and integration in the books, it can be practically proved that in a circular boiler shell the tension per inch in pounds on a longitudinal line, or a line parallel to the centre line of the boiler, is equal to the pressure per square inch multiplied by the half diameter of the shell in inches, and also that the tension on a ring line is exactly one-half of that, provided the head sheets are entire. But, by subtracting the surface removed for the insertion of flues or tubes, the proportion becomes still less. It is for this reason that in calculations on the strength of circular shells no attention is paid to ring lines. The question now takes this form: What number multiplied by 33 gives a product of 4,200? Dividing 4,200 by 33, the quotient is 127.27, which is the answer to the question in pounds.

Irrespective of the thickness of plate or the diameter of boiler, in calculating the safe working pressure of double rivetted boilers, with plates of 60,000 pounds tensile strength, the number 8,400 is, during the process, always arrived at, and hence may be used as a constant. The following table goes a step further, the constants being on the same basis, but in proportion to the thickness of plate, and all that is required to answer such questions is to divide the constant opposite the thickness of plate by the half diameter of the boiler in inches:

Constant for	¼"	sheets	2100
"	5/16"	"	2625
"	⅜"	"	3150
"	7/16"	"	3675
"	½"	"	4200
"	9/16"	"	4725
"	⅝"	"	5250
"	¾"	"	6300
"	13/16"	"	6825
"	⅞"	"	7350
"	1"	"	8400

Examples: What is the highest safe working pressure of a boiler of the above description, 42 inches diameter and plates ¼" thick? Constant 2100, divided by 21, gives 100 pounds.

What is the highest safe working pressure of a boiler of the same description, 72 inches diameter and plates ¾" thick? Constant 6300 divided by 36, gives 175 pounds.

If these boilers had been single rivetted the base constant would be 6720 instead of 8,400, and in the first example the highest allowed pressure would be 80, and in the second 140.

A valuable addition to engineering literature is the Engineers' Manual, compiled and issued by Toronto branch No. 1 of the Canadian Association of Stationary Engineers. The book bears evidence of being carefully prepared, and the many tables and other valuable data contained therein has apparently been selected with a view of furnishing to Canadian engineers a work that would be of every-day service. A special feature is the electrical department.

THE INDICATOR.*

By A. M. Wickens.

[No. 3.]

Many of you will remember that in our first "Indicator talk, we examined the instrument and attempted to show how it was constructed, what were the particular functions of its different parts, and the necessity of keeping all in perfect order. Our second talk took the form of applying our indicator to an engine, with piston and valves tight and valves correctly set, and I have no doubt but that some of you will remember the appearance of the diagram we made. For this evening we will take up the reading of the diagrams, and the application of the hyperbolic curve to them what is known as Boyle's law, or the law of the expansion of gases.

In this the pressure of a gas at a constant temperature varies inversely as the space it occupies, or in other words, double the volume, and you reduce the pressure one-half. This action is plotted out upon the diagram in the shape of a curve, and where everything is correct the steam expansion curve should follow very nearly to the theoretical one. This can only be attained when the engine and valves are in perfect order; and the steam should not contain more than 2 per cent. of moisture. It is not possible to read a diagram correctly without applying this curve to it; even if you know from the appearance of the diagram that something is wrong, you cannot tell how bad it is without applying this curve. One of the greatest troubles in applying the curve is that we do not know the volume of our clearances in our cylinders, for to be really correct it is necessary to know the amount of clearance; for instance, if we apply the curve regardless of clearance it would start from the wrong place and finish the same, and if the clearance was 4 per cent. of the piston displacement, our curve would be that much out of place, which would lead us to a wrong conclusion. If we intend to figure the water consumption as accounted for by the indicator, it is absolutely necessary to take the clearance into the problem.

There are several ways in which the curve may pe put upon the diagram, one by figuring the pressure for the different volumes, and another by geometrical means. I will apply both means to the same card, and we will see how they come out. In all calculations and measurements in connection with the expansion of steam, it is necessary to work from a line of perfect vacuum; this line you can put upon any card by measuring below the atmospheric line with a scale of the spring used to take the diagram, 15 lbs., then from this line we measure or figure.

Take diagram No. 1 upon the board; the cut-off occurred at

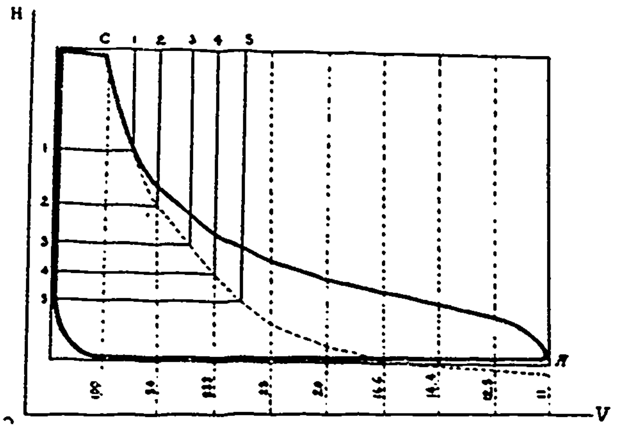


DIAGRAM 1.

one-ninth of the stroke. The spring used to take this diagram was a 16, so that each sixteenth of an inch represents 1 lb.; now, fifteen-sixteenths of an inch below the atmospheric line, marked A, we draw another line parallel to it; this is the line of perfect vacuum, and all our work must be done from it. We now apply the scale, and measure from it to the top of the diagram, and find we have 6¼ this represents just 100 lbs. pressure. We had this pressure when the steam valve closed at one-ninth of the stroke; then at two-ninths of the stroke we would have 50 lbs., at three-ninths 33.3 lbs., at four-ninths 25 lbs., at five-ninths 20 lbs., at six-ninths 16.6 lbs., at seven-ninths 14.4 lbs., at eight-ninths 12.5 lbs., and at the finish of the stroke 11 lbs. pressure. Now, if we measure up from the line of perfect vacuum each of these heights with our scale, and draw a line for each, the curve will just touch the end of each ordinate. If we want to put the curve on graphically, erect a line to represent the clearance, put the line of perfect vacuum on same as before, assume some point where the two lines are to coincide, (say at C, the point of cut-off), draw a line at right angles to the vacuum line that cuts this point, then divide the card up into any number of spaces, making them closer together at point of cut-off. Now, from the intersection of the lines H and V at O, lay your straight edge to point 1, and mark upon the line C where it crosses; do the same at each of the other points, then draw lines from each of these points at right angles to the line H, and where they meet the ordinates is the place to locate the curve (do this in two colors). You will therefore see that the expansion curve follows almost the same points by either method.

We can also figure from the diagram the amount of water used per h.p., or we can measure the steam at any point in the stroke, and from that compute the amount of water used (not all). Now, if we measure the steam just before the exhaust valve opens, we will have the amount of water used.

We will take diagram No. 2, and add the clearance space to the diagram. This clearance we add to the volume of the cylinder up to the point we have picked upon for our measurement (one clearance only). Multiply the volume of cylinder up to point to be measured by the pressure at that point, measured from the line of perfect vacuum. The weight of a cubic foot of

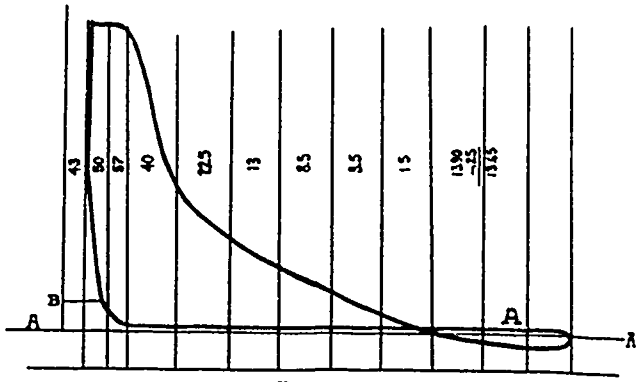


DIAGRAM 2.

steam of any pressure can be obtained from any of the hand books having such a table. This diagram was taken from a Corliss engine, cylinder 16 x 30, running 125 revolutions per minute. The area of this piston is 198.6 square inches. The clearance is four per cent., and amounts to 248 cub. inches. We will fix the point A to be measured, as it is just before the exhaust valve opens, and it is .9 of the stroke, or 27 inches. The volume of steam up to this point is

$$\frac{198.6 \times 27 + 248}{1728} = 3.2466 \text{ cub. ft.}$$

The pressure at A is equal to 13.5 lbs. and the weight of a cubic foot of steam at that pressure .035 of a pound, so we have 3.2466 × .035 = .11363 of a lb. This is the weight of the steam used each time the cylinder is filled. From this is to be deducted the amount of steam saved by compression in closing the valve before the stroke is finished. We will take a point on the diagram say at B; this point is such that we know the exhaust valve has closed, and we find that it represents about 1.28 in. on the return stroke—this is about three-eighths of an inch and is bearing the same proportion to .9 as 1.28 is to 30 inches, the length of the stroke.

We then have $\frac{198.6 \times 1.28 + 248}{1728} = .29$ of a cub. ft.

The pressure at this point is just 20 lbs. and the weight of a cub. ft. of steam at that pressure is .0511 of a lb.; this multiplied by .29 gives us .01482 of a lb. The weight of steam accounted for per stroke is .11363 − .01482 = .09881 of a lb., and the quantity per hour is .09881 × 250 strokes × 60 min. = 1482.15. Now, how much water per h.p is this? The constant for this engine will be

$$\frac{198.6 \times 625 \text{ ft.}}{33{,}000} = 3.76$$

The M.E.P. upon the card is 13.65, hence we have 13.65 × 3.76 = 51.32 h.p., and the water per h.p. per hour will be

$$\frac{1482.15 \text{ lb. water}}{51.32 \text{ h.p.}} = 28.8 \text{ lb. water.}$$

We will now compute another diagram from the same engine, No. 3. We use the same constants. The pressure at .9 of the stroke is 26.7 lbs., and the weight per cubic foot is .067 of a lb.,

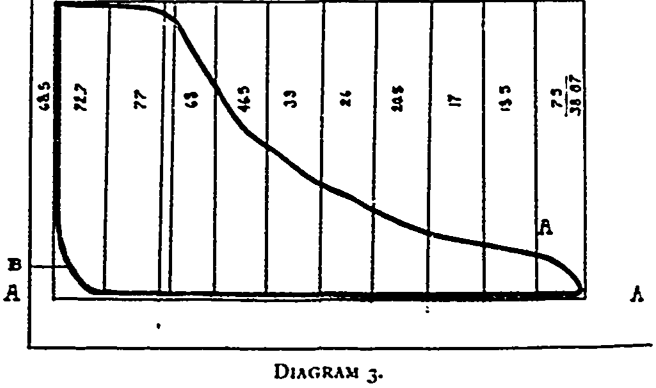


DIAGRAM 3.

then 3.2466 × .067 = .2175 of a lb. The steam saved measured same as before, 20.2 lbs., the weight is .0513 of a lb. Now .29 × .0513 = .0149, and .2175 − .0149 = .2026 of a lb. per stroke. Then .2026 × 250 × 60 = 3040.2 lbs. of water per hour. Our M.E.P. in this case is 38.07; this multiplied by 3.76 = 143.143 h.p., then 3040.2 ÷ 143.143 = 21.24 lbs. water per hour per h.p., or a gain of as 4 is to 3.

By this you will see that the later cut-off is very much cheaper than the earlier one; and it is safe to say that all engines are wasteful at early cut-off, or light loads, and that every cylinder gives us the best economy when the load is reasonably heavy and the cut-off occurring at about one-third of the stroke.

[The diagrams used were taken in actual practice, and for the purpose of the lecture were enlarged to double their original size. As they appear herewith they are about one-half the original scale.—The Editor.]

* Paper read before Toronto Association C.A.S.E., February 8th, 1898. (For second paper see Electrical News for December, 1897.)

KINGSLEY WATER TUBE BOILERS.

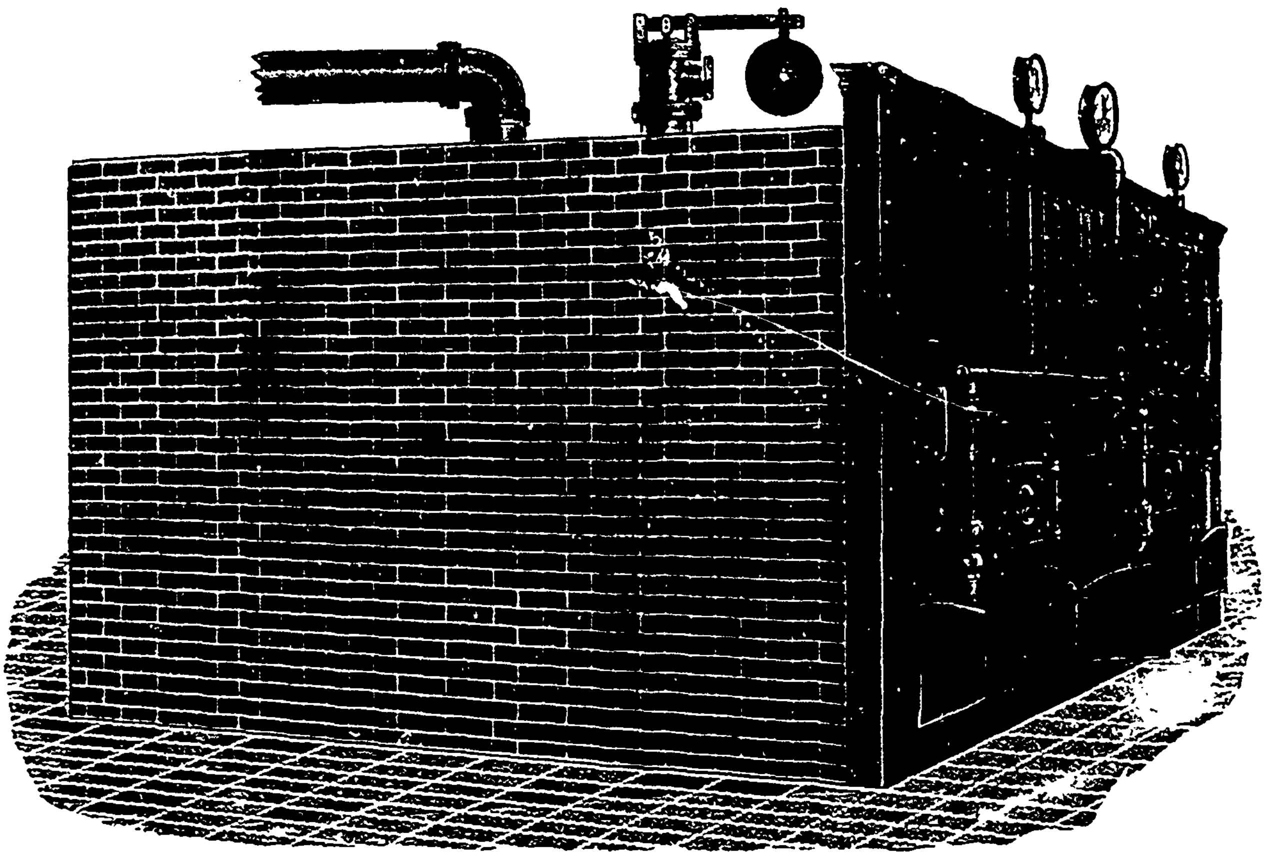
The Kingsley patent water tube boilers, herewith illustrated, are constructed with two shells, an outer and an inner. The outer shell has vertical parallel sides and semi-circular top and bottom. The inner shell is fixed parallel to the sides and bottom of the outer shell by means of two flanged heads and numerous stay-bolts, leaving a uniform space about four inches wide between the two shells, extending the full length of the boiler. The crown sheet is horizontal, and extends continuously the full length of the boiler. It is flanged down three inches along each side for its entire length, and forms the top of the inner shell by being riveted to it along each side.

The tubes are threaded at their upper ends with standard pipe threads, and are screwed into the crown sheet. The bottom ends of the tubes are plugged with ¼ inch iron and are then welded solid. The tubes are made of standard 2 inch iron lap-welded pipe. They are short enough in the fire-box to leave an ample combustion chamber, and are longer behind the bridge wall. Any tube can be readily screwed in or out of the crown sheet without touching any other tubes.

The crown sheet is strongly stayed by stay-bolts screwed simultaneously, at various angles, into the semi-cylindrical top of the outer shell and into the crown sheet. These stay-bolts and those connecting the two shells are headed on each end. The parts of the two flanged heads forming the ends of the steam chamber are likewise stayed by rods screwed simultaneously into each, these rods being headed at each end or fitted with nuts.

or sediment, but, on the contrary, we think they are brighter than new." Hundreds of tubes have been screwed out and examined for sediment, in various parts of boilers which have been running for different periods, and have been found perfectly clean; in fact, any scale formed in manufacturing the tubes appears to be loosened and removed by the ebullition and rapid currents when the boiler is under steam. After such investigations there can be no reasonable doubt on this point. The reason for this exceptional cleanliness of the tubes is clear when we consider the construction of the boiler. The feed water, entering at the front of the boiler, between the shells, below the level of the grate-bars, in passing up becomes intensely heated before reaching the crown-sheet. It is well known that water, heated to a few degrees above the boiling point, parts with most of its impurities, as mud and carbonates of lime; and at a temperature of about 300 degrees Fahrenheit, equal to 52 lbs. steam pressure, it can no longer retain in solution the sulphates of lime, magnesia, etc., which form the much-dreaded scale in boilers. In this boiler these impurities, being separated by the intense heat, precipitate into the space between the cells, at the bottom of the boiler, where the heat is not sufficient to bake them into scale, and whence they can be washed out occasionally through the hand holes. This boiler is, therefore, by its construction, a perfect feed-water purifier, and no sediment or scale can gather in the drop tubes, because only purified water reaches the crown-sheet from which the tubes are supplied.

The boiler, being internally fired, has the fire-box entirely surrounded with a water-jacket. The incandescent gases from the fuel, passing up among the short tubes in the fire-box, are drawn backward among the long tubes to the end of the boiler, whence they divide and return, half on each side, between the outer shell and the brick casing towards the front of the boiler. From this point the now nearly exhausted gases can either be carried by means of a saddle over the front of the boiler direct to the chimney, or they can pass down into a flue under the boiler along to its back end, and thence to the chimney. There is no appreciable difference in economy of evaporation between these two methods of circulation of the gases. The tubes are "staggered" in the crown sheet and are spaced at such distances that the gases which pass zig-zag and strike each tube at right angles, while being confined on all four sides by the water-jacketed shell of the boiler, lose nearly all their available heat before they are returned on the sides. For this reason this boiler can be operated also as a locomotive boiler. The gases are passed out of the chimney only sufficiently hot to ensure a good draft.



Representing Two Kingsley Water Tube Boilers of 150 H.P. Each.

The water is contained in the tubes and in the space between the shells, and extends up a few inches over the crown sheet. As this water service extends unbroken for the full length and width of the boiler, no rapid fluctuations of water level can take place, although the boiler is a very rapid steamer. It is possible to supply any capacity of water or steam space by extending the outer shell upward above the level of the crown sheet to any desired height. It is sometimes desirable to thus increase the steam space where large volumes of steam are required at one time, which occurs in various industries.

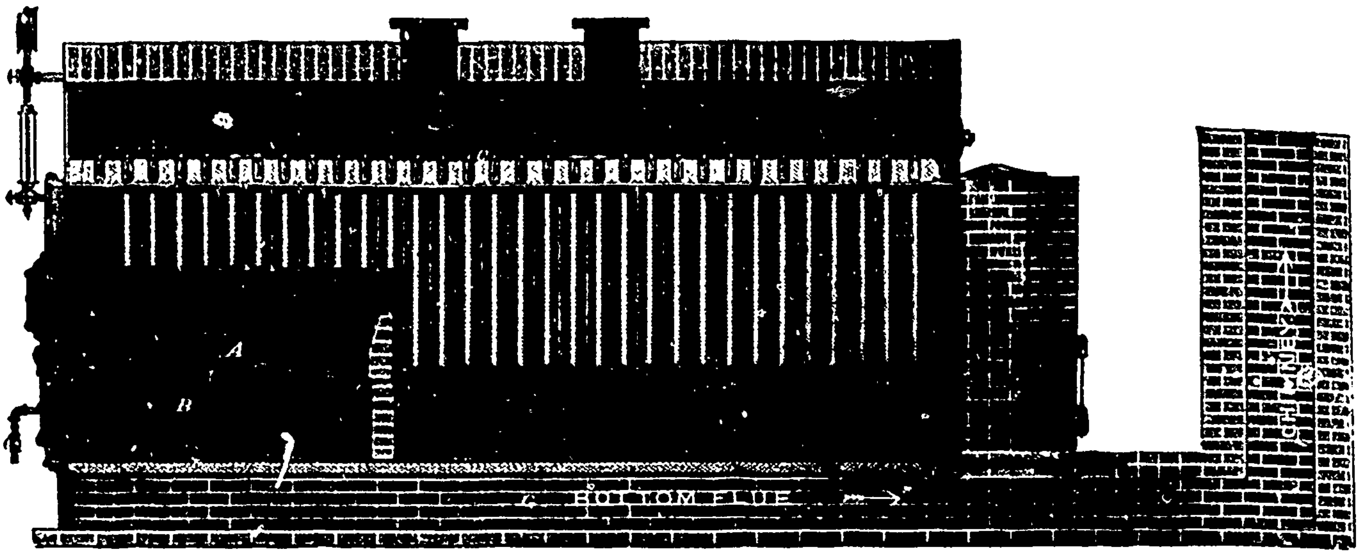
Regarding the construction and efficiency of this boiler the manufacturers say: No steam drum is used on these boilers. This is claimed to be an advantage over most water tube boilers, as well as many other types, as a steam drum elevated far above and away from the hottest fire can of itself act only as a condenser, as it is the tendency of steam to cool and condense immediately on leaving the direct action of the fire. In the Kingsley boiler the tubes, being vertical and short, liberate steam very freely, and without friction or impediment, which in all water tube boilers with inclined tubes causes a large percentage of water to be carried up with the steam. This is also one reason why this boiler produces dry steam even under the heaviest forcing.

By those who have not investigated, an argument may be advanced regarding the deposit of sediment in the tubes. This, the manufacturers claim, can conclusively be answered by referring to boilers which have been in use for upwards of ten years. One of these, in Chicago, being fed on the dirtiest of feed waters, has been in use for nine years. The users, a short time ago, wrote: "We have never had any trouble with the tubes filling with scale

This boiler requires the same size of chimney as any other type of boiler. For hot water heating for buildings there is no change in the construction of the boiler, the steam space being simply filled to the top with water. The fuel economy is the same as for steam purposes. The circulation of the water is the most direct that can be desired, as there is a continual uninterrupted rise from bottom to top of the boiler.

For marine purposes there is no change in the essential design of the boiler, the difference being in details and setting, as the brick casing could not be used. It has been installed for the highest pressures, and is as easily cleaned and as durable as any boiler made.

The economy of installation is apparent when we note that this boiler occupies one-third less ground area than the other ordinary types of horizontal water tube boilers or the return tubular boilers, and less than one-half their cubic contents. It requires only 6½ feet in height. The brick casing is used only for the return gases, and hence never requires renewing. As there is no fire-brick furnace to renew periodically, the repairs are reduced to an absolute minimum.



LONGITUDINAL SECTION, KINGSLEY WATER TUBE BOILER.

It is not necessary to refer to the exceptionally high evaporative economy of this boiler, as this could be readily predicted from its construction. The advertisement of this boiler will be found on another page.

TRADE NOTES.

The Montreal Electric Co. have recently removed to more commodious premises at No. 1898 Notre Dame street.

The Richmond County Electric Co. has purchased a 60 k.w. S. K.C. two-phase generator from the Royal Electric Co.

The Buckingham Reduction Company, of Buckingham, Que., is installing a 200 k. w. power generator. The order was given to the Royal Electric Co.

The Ossekeag Stamping Co., of Hampton, N. B., has purchased from the Royal Electric Co. a 200-light incandescent plant for lighting their works.

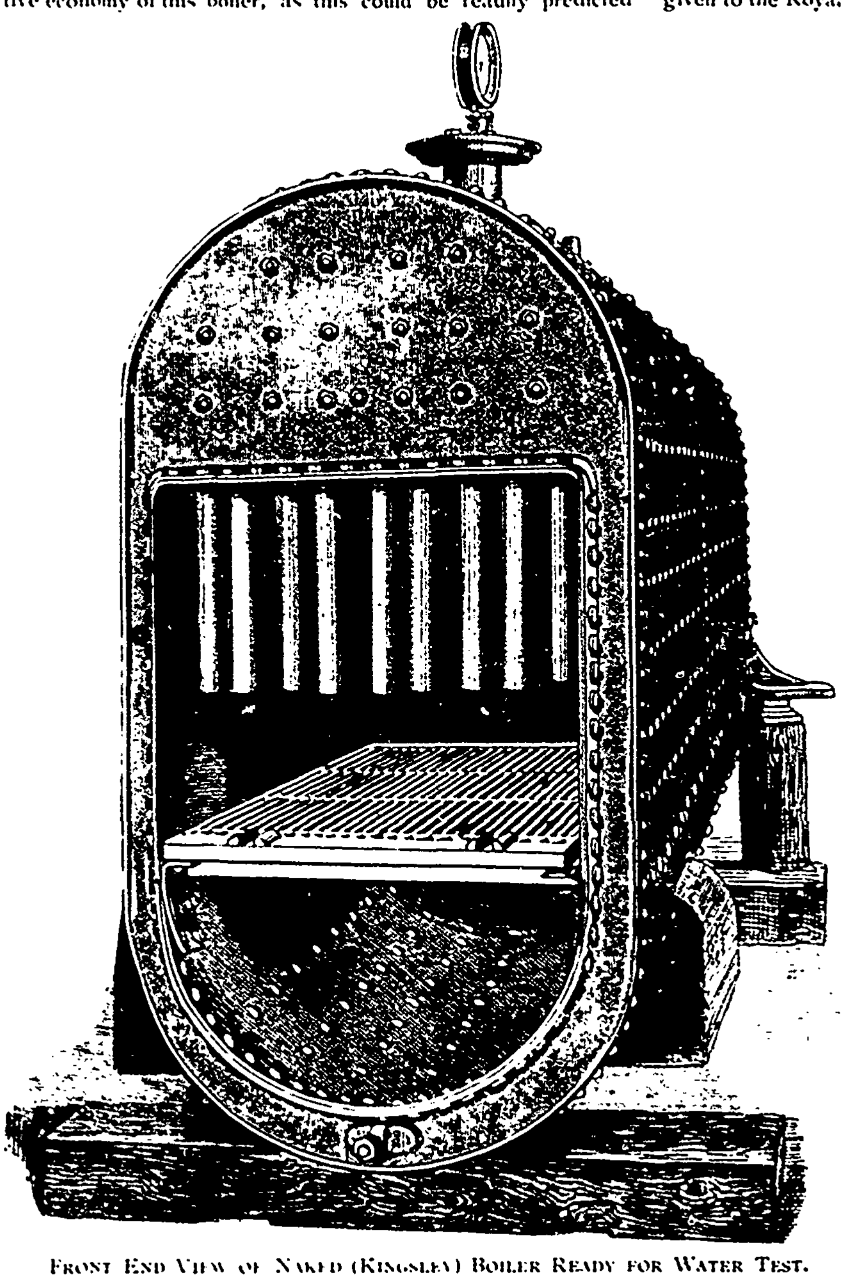
W. B. Davey will immediately commence operations for the lighting of Grand Forks, B.C. The order for the electrical machinery complete, including a 1,500-light alternator, has been given to the Royal Electric Co.

The T. & H. Electric Co., successors to Kay Electrical Mfg. Co., report recent sales of electric motors from 1 to 15 h.p. to the following firms: Norton Mfg. Co., Max Bernstein, Leitch & Turnbull, Bain & Sache, Electric Light & Power Co., G. H. Meakins, Domestic Specialty Co., Tolton & McKay, City Brass Foundry, Hand & Teale, Post-Office, Geo. D. Membery; also a 20-light dynamo to Bain & Colville, a 400 gal. plater to the Ontario Plating Works, and a 150 gal. plater to D. Moore & Co., Limited.

A very satisfactory statement is presented by the annual report of the Canadian General Electric Company for the year 1897. It shows the company to be practically free from debt, and to have assets of $1,278,258.47. Dividends at the rate of six per cent. per annum were paid 30th June and 31st December, and the sum of $40,000 was carried forward to reserve fund. The volume of business during the year was exceptionally large, while the value of overholding contracts in process of completion is more than $100,000 greater than at the close of the previous year.

The Packard Electric Co., of St. Catharines, have established a club house and recreation grounds for the use of their employees. The club house consists of two rooms finished in natural wood oiled, and with a large old-fashioned fire place. The grounds are extensive, and have a rink for winter sport, and a field for lacrosse, etc., for summer sports, also provisions for bathing. Mr. E. E. Cary, manager of the company, was elected Hon. President; Mr. Bingay, president; Frank Adams, vice-president, with a complete staff of officers. Suitable by-laws were adopted. It is gratifying to record this evidence of friendly relationship between employers and employees.

The contract for street lighting in the town of Lindsay, Ont., expires on May 1st next, and a resolution has been passed in the Council authorizing the Fire and Light Committee to obtain particulars as to the cost of an electric light plant to be operated by the town.

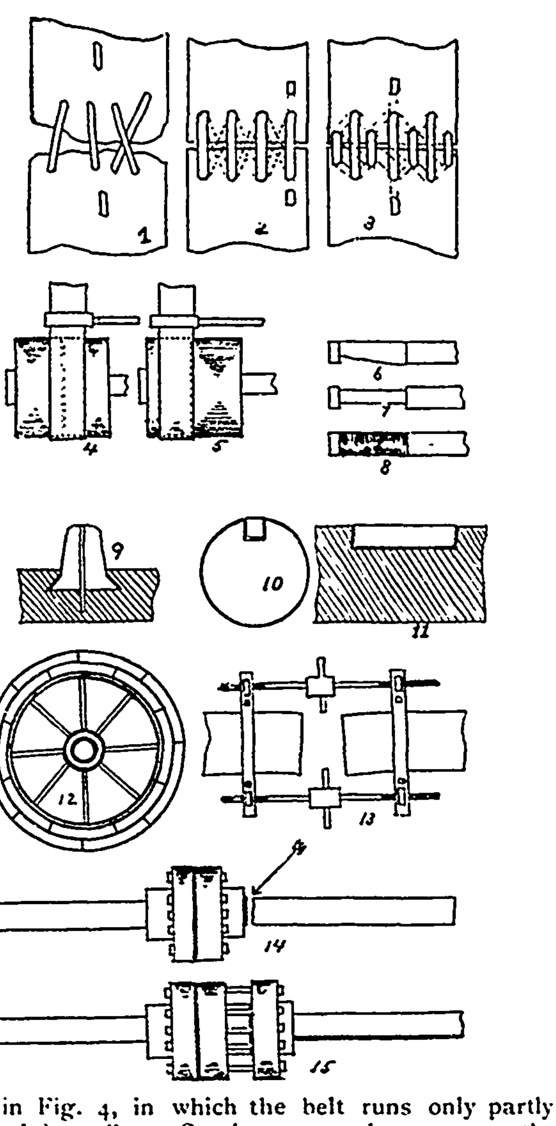


FRONT END VIEW OF NAKED (KINGSLEY) BOILER READY FOR WATER TEST.

POWER AND TRASMISSION KINKS.

In order to get the most out of any power transmission, the belting and all mechanical parts must be run to best advantage. If belted with a loosely laced belt like that shown in Fig. 1, the system will not run well, as the splice, being open, will slip upon the pulleys. The samples given in Figs. 2 and 3 show the plan of procedure which may be followed by the crosses on the back which are represented by the dotted lines. By thus making good, substantial unions that draw the butts of the belt together evenly and securely, less trouble will be had regarding the driving mechanism.

Do not run the belt too tight, as it will strain the bearings, cause friction, and consequently there will be loss of power. If too loose it will be likely to slip on the pulleys and cause loss of time as well as uneven work. It should be slack enough to be readily transferred from the tight to the loose pulley without excessive strain on the shipper. I have often found a machine doing poor work owing to the belt shipper being



set as in Fig. 4, in which the belt runs only partly on the tight pulley. Set it to run clear over on the pulley as in Fig. 5.

When a shaft it worn down as shown in Fig. 6, take it to the shop and turn it down like Fig. 7, then wind with steel wire as represented in Fig. 8, and a fairly good job will result.

When a cog breaks off of a gear, shape a new cog and dovetail it in, in the manner shown in Fig. 9, and insert a steel pin to prevent the cog from working sidewise. When a bearing throws oil in a place where it is desired that no drippings shall fall, cut a key-way in the centre of the bearing, about half the width of the box, and put in a felt pad as shown in Figs. 10 and 11; the pad absorbs the oily matter.

A lag pulley with wood is shown in Fig. 12, by bolting on sections of pieces cut to correct size to form a smooth surfacing. On the surface put a cement composed of two pounds of black pitch, two pounds glue, one pound linseed oil. I have often travelled far to some mill or shop in response to a call from the proprietor, who has written to the makers of his new machines to the effect that the same do not work right, and upon arrival at the factory have discovered the cause, not in the machines themselves, but through some defect of setting up or starting. The pulleys, for instance, are sometimes the whole source of the trouble through being too small. The builders of the machines cannot tell just what size pulley to furnish always, consequently the selection of the driving pulley often falls to someone at the mill. High speed is the aim nowadays, and yet pulleys of but six or seven inches too small in diameter are frequently used to drive machines. This has many bad effects on both machine and belt. If the pulleys were larger in diameter, the results would be much better. The writer has often proved this to manufacturers by lagging up the driving pulleys on the shaft in the manner shown.

A good belt tightener for large belts is shown in Fig. 13, consisting of the two double end bolts at either side, arranged in the ordinary way, but threaded right and left, so that when turning the centre pivots, both ends of the belt are drawn toward each other simultaneously.

A shaft recently broke short off near a coupling, as shown in sample 14. We desired to run the mill until Saturday night, and as the shaft would not bear shortening, we put another coupling on the broken end, keyed it firmly and inserted bolts clear through from the former couplings, as shown in Fig. 15, and the mill was kept running.--Power and Transmission.

NEW ENGINEERING SOCIETY.

The members of the engineering staff of the Royal Electric Co., Montreal, have formed an association, to be known as the Royal Electric Engineering Society, the primary object of which is the advancement of knowledge in engineering subjects. At the inaugural meeting on February 14th a constitution was adopted and officers nominated. The membership includes some *fifty charter and associate members and twelve* honorary members. The meetings are to be held every two weeks from October 1st to April 30th.

The first regular meeting of the society was held on the 24th ultimo, at which officers for the current year were elected as follows: Honorary president, Mr. Wm. H. Browne, general manager Royal Electric Company; president, W. M. Bucke; vice-president, W. T. Dix; *corresponding secretary*, R. F. *Morkill; recording* secretary, W. G. Angus; treasurer, L. A. Howland; librarian and curator, F. Cushing; committee, J. Burnett, L. Mudge, K. B. Thornton.

The Auburn Power Company at Peterboro' have ordered a direct connected sub-station unit from the Canadian General Electric Company, consisting of a 75 h.p. induction motor direct *connected to a three-phase induction motor. From this outfit* current will be supplied at 500 volts to small power users throughout the town of Peterboro', it having been found that the high price of induction motors prevented their general use.

The General Engineering Company of Ontario, Limited, have during the last month purchased the patents and assets of the Weeks-Eldred Co., of Toronto. The capital has been increased to $40,000. J. L. Caverhill, Montreal, has been elected president, and James Milne vice-president and general manager of the new company. The company have closed orders for the equipment of the steamer *North King*, of Kingston, and *Boon's* dredge, Collingwood harbor, also the Kingston penitentiary.

The Canadian General Electric Company have closed a contract with the E. B. Eddy Co., of Hull, for a 500 and 350 light multipolar direct current generator for lighting their mills at Hull. With these machines they will install standard marble panels containing instruments of the latest type. The contract also covers the supply of material for the wiring of the place in strict accordance with the latest requirements of the Fire Underwriters.

Mr. G. O. S. Conway, of Stonefield, Que., is said to have been successful in forming a company to develop the water power at Grenville and to erect a pulp mill in connection therewith. The scheme includes the installation of an electrical plant for the purpose of lighting the Carillon and Grenville canals, the villages of Carillon and Grenville, and the town of Hawkesbury, and also to furnish power for the proposed electric railway to operate on the north shore of the St. Lawrence river. It is expected that the final negotiations will be completed in about three months. Exemption from taxation will be granted by the town, and also a bonus of $10,000.

EDUCATIONAL DEPARTMENT

INTRODUCTORY

After mature deliberation the publisher of this journal has decided to devote a certain amount of space each month to what may be termed an Educational Department, wherein both mechanical and electrical formula and mathematical problems will be discussed, illustrated, and as far as possible rule and example given. At the request of the editor, I have with pleasure undertaken to contribute to this department regularly each month, and before discussing actual mathematical problems, wish to briefly introduce the subject at issue.

The primary object of this department is chiefly to increase the value of an already valuable paper, by placing in the hands of every engineer who has any knowledge of the rudimentary principles of mathematics, such matter as will enable him by a little study to master the most intricate mechanical and electrical formula. Many of our most valuable engineering works and publications from time to time contain formula that is in many cases but vaguely understood, and very often entirely misunderstood, thus rendering an otherwise valuable work practically valueless to the reader.

Just at what particular point our calculations should commence became a matter of serious thought, and past experience had to be carefully considered, bearing in mind the fact that there are many really good engineers whose early education has, through force of circumstances, been deficient, and many others who, through lack of opportunity, have not been able to review their early education for years. Knowing by observation and experience the great necessity of having a thorough elementary education before attempting to digest and calculate problems, and the almost utter impossibility of the student arriving at a satisfactory conclusion of his studies without a thorough knowledge of the principle of mathematics involved, I have decided to commence at a point and carry out the programme outlined in this journal—commencing at the foundation and advancing by easy stages until the principles underlying the most obtuse and difficult formula can be readily explained and easily understood. The advantages to be derived from an education of this kind, coupled with practical mechanical ability, is too well understood to require comment.

The programme which has been outlined for the succeeding nine months will embrace:

DECIMAL FRACTIONS—Definitions and explanation of principles of, and method of reduction to common fractions, and vice versa.
SQUARE AND CIRCULAR MEASURE—Definition and explanation and practical demonstrations of.
CUBICAL AND CYLINDRICAL MEASUREMENTS—Definitions and explanations of, with practical hints.
SQUARE AND CUBE ROOT—Definitions and explanations of.
SAFETY VALVE CALCULATIONS—(Spring and Lever Types)—Principles of, with practical demonstrations.
BOILER CONSTRUCTION—Stays, rivets, joints and seams, iron and steel plate—strength of, with formula and practical demonstrations.

It is not the intention to fill these columns with a mass of figures hastily compiled without reference to any particular object; on the contrary, every problem will be carefully thought out, and only such information given as will be of use to you, and an effort will be made, based on experience and a knowledge of the requirements, to make his series of tests complete in every particular.

WM. THOMPSON.

[ARTICLE XI.]

DROP IN POTENTIAL AND SIZE OF LEADS FOR MULTIPLE ARC CONNECTIONS.

(Continued.)

EXAMPLE 12: In Fig. 3 we have represented a pair of mains on which we have to connect four groups of lamps, consisting of five lamps each connected in multiple. The lamps have each a resistance of 200 ohms. The E.M.F. of the terminals to which leads are connected is 110 volts, and it is desired to allow a drop in potential of 10 volts, to be divided equally between each of the four groups of lamps. What must be the resistances of the four sections of wire?

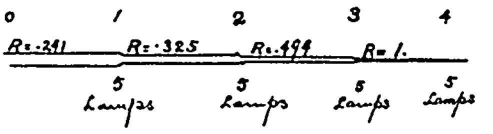


FIG. 3.

Commencing at group 1, we have an E.M.F. of 107.5 volts, at group 2 105 volts, at group 3 102.5 volts, and at group 4 100 volts, with a uniform drop of potential of 2.5 volts between each of the groups. Commencing the calculation at the extreme end of lead, or at group 4, we have 5 lamps connected in parallel, each with a resistance of 200 ohms. Then combined R of group 4 = $\frac{200}{5}$ = 40 ohms, and a total current of $\frac{100}{40}$ = 2.5 amperes. The required R of section 3 to 4 then is $\frac{1}{2.5} \times 2.5 = 1$ ohm.

Taking now group 3, calculating by similar methods, and bearing in mind the fact that the combined resistances of the whole of the groups must be the same, since the number of lamps in each group are equal, total current of group 3 then is

$$\frac{102.5}{40} = 2.56 \text{ amperes,}$$

And since the current required for group 4 must pass through the wire supplying group 3, we get:

Current of group 4 = 2.5 amperes,
" " " 3 = 2.56 "
Total current wire 2-3 = 5.06 "

The required R of section 2 to 3 then is equal to $\frac{1}{5.06} \times 2.5 = .494$ ohms.

Taking now group 2 and calculating in exactly similar manner, $\frac{105}{40}$ = 2.62 amperes, and 2.62 + 2.56 + 2.5 = 7.68, total current passing on wire section 1 to 2. $\frac{1}{7.68} \times 2.5 = .325$ ohms, required R sections 1 to 2.

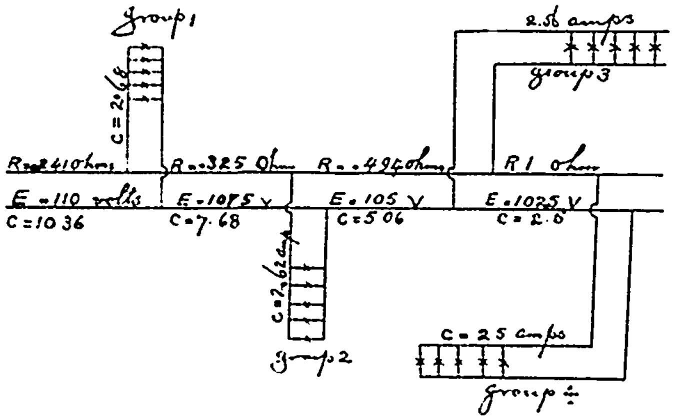


FIG. 4.

Group 1 = $\frac{107.5}{40}$ = 2.68 amperes, and 2.68 + 7.68 = 10.36, total C passing on wire section 0 to 1. $\frac{1}{10.36} \times 2.5 = .241$ ohms, required R sections 0 to 1.

Therefore we find we require, to meet conditions as set forth in our problem, a wire varying in resistance and consequently in area, as shown in Fig. 3, and where

R of section of wire 0 to 1 = .241 ohms,
" " " 1 to 2 = .325 "
" " " 2 to 3 = .494 "
" " " 3 to 4 = 1.000 "

These resistances, divided by twice the length of one side of lead, will equal R per foot required on lead.

Fig. 4 shows the whole of the results of our previous problem in detail, and at the same time it will be seen from diagram that this method of computation can be applied to almost any system of distribution on the two-wire principle, and need not here have further reference.

CALCULATION OF WORK DONE BY PUMPS.

Rule: To find the contents of the pump when full, find the area of the cylinder in inches, multiply by length of stroke in inches, and result will be capacity of pump in cubic inches of water each stroke.

Rule: To find capacity of pump per hour, first find contents of cylinder each stroke, then multiply by strokes per minute, and then by 60; result will be capacity of pump per hour in cubic inches; to reduce to cubic feet divide result by 1728.

Example: Find the contents of a boiler feed pump, stroke being 24 inches and diameter of cylinder 6 inches.

Formula: $D^2 \times .7854 \times L$ = contents; $6^2 \times .7854 = 28.2744$, area in cubic inches; $28.2744 \times 24 = 678.5856$ cubic inches, contents of pump cylinder when full.

Example: Find the capacity per hour of a boiler feed pump in cubic feet, diameter of piston being 4 inches, stroke 6 inches, and pump making 75 strokes per minute.

$4^2 \times .7854 = 12.5664$ square inches, area;
$12.5664 \times 6 = 75.3984$ cubic inches, contents per stroke;
$75.4 \times 75 = 5655$ cubic inches per minute;
$5655 \times 60 = 339300$ cubic inches per hour;
$339300 \div 1728. = 196.35$ cubic feet of water, capacity per hour.

DETERMINING THE REQUIRED SIZE OF BOILER FEED PUMPS.

This question, as practical engineers will know, covers a wide range of subjects, and it is particularly hard to lay down a hard and fast rule adapted to every condition of service. It might be assumed that the quantity of water accounted for as being used within the cylinder of an engine would be a nearly correct basis on which to arrive at the required capacity of the pump. This, however, for many reasons, is so far from being correct that I have decided not to refer at length to this method of calculation.

Clearly, a boiler feed pump should have ample capacity for all calls that are likely at any time to be made upon it, and with the quantity of water we may be called upon to evaporate per minute or hour before us, we are enabled to arrive at a fair approximation of the required capacity of the pump. Even this must be coupled with a good deal of practical common sense, and provision must at all times be made for leakage on the boiler and its accessories, and leakage and slip within the pump itself.

Example: Find the required capacity of a boiler feed pump for three boilers whose furnaces are 3 feet by 6 feet, coal consumption 15 pounds per square foot of grate surface per hour, and evaporation equal to 10 pounds of water per pound of coal.

6 feet
3 feet
18 square feet surface in each boiler
15 pounds coal consumed per hour
90
18
270 pounds of coal per hour each furnace
3
810 pounds, total coal consumed per hour
10
8100 pounds of water evaporated per hour
8100 ÷ 62.5 = 129.6 cubic feet of water per hour
129.6
4 factor of safety
518.4 cu. feet of water per hour for safety, after allowance for slip, leakage, etc., required capacity of pump.

What must be the diameter of a double-acting duplex steam pump making 100 strokes per minute and having a stroke of four inches to comply with above requirements?

$518.4 \div 60 = 8.64$ cu. feet per minute;
$8.64 \div 100 = .0864$ cu. feet per stroke;
$.0864 \times 1728 = 149.3$ cu. inches, required contents of pump;
$149.3 \div 4 = 37.325$ cu. inches, required area of cold water piston;
$37.325 \div .7854 = 47.5$, and
$\sqrt{47.5} = 6.88$ inches, required diameter of pump piston, or say, 6⅞ inches.

Then, to safely comply with the conditions set forth, we shall require a duplex steam pump making 100 displacements per minute, with a 4-inch stroke and a cold water piston diameter of 6⅞ inches.

MISCELLANEOUS QUESTIONS.

To find extra pressure required to discharge water from a given orifice:—

Formula:

$$\frac{T^2 D^4}{2000000\, d^2 B^2}$$

Where T = travel of plunger in feet per minute,
D = diameter of plunger in inches,
d = diameter of delivery valve,
B = breadth of opening or lift in inches.

Example: The cold water piston of a pump is 4 inches in diameter and has a travel of 150 feet per minute. The delivery valve is 2½ inches in diameter and has a lift of ¼ of an inch. What extra pressure is required to discharge the water?

$$\frac{T^2 D^4}{2000000\, d^2 B^2} = \frac{150^2 \times 4^4}{2000000 \times 2.5^2 \times .25^2} = \frac{5760000}{781250} =$$

$5760000 \div 781250 = 7.37$ pounds.

To find velocity at which water will travel through the discharge pipe of a pump. The velocities are in inverse proportion to the area, or what amounts to the same thing, the velocities are in inverse proportion to the square of the diameters.

Then for the purpose of determining the ratio of velocity between any two pipes we may construct the following formula:

$$\frac{D^2}{d^2}$$

Where D equals diameter of plunger, d equals diameter of pipe. And when the speed of the plunger is known the velocity of the water in the discharge pipe may be determined by formula:

$$\frac{D^2 \times T}{d^2} = V.$$

Where D = diameter of plunger in inches,
T = travel in feet,
d = diameter of discharge pipe in inches,
V = velocity of discharge in feet per minute.

Example: The plungers of a pump are 10 inches in diameter and have a travel of 100 feet per minute. At what velocity will the water travel through a discharge pipe 2 inches in diameter?

Then

$$\frac{D^2\, T}{d^2} = \frac{10^2 \times 100}{2^2} = \frac{10000}{4} = 2500 \text{ feet per minute.}$$

The work done due to the energy of motion of a moving body is represented by the formula:

$$\frac{W\, V^2}{64}$$

Where W equals the weight, V equals velocity in feet per second.

Example: The piston of an hydraulic ram is 12 inches in diameter; water in feed pipe has a velocity of 2,000 feet per minute; feed pipe to ram is ¾ inch. What is the energy of ram per pound of water used?

Velocity in feet per second equals

$$\frac{2000}{60} = 33.33.$$

It has already been shown that the velocity of water in pipes depends upon the areas or diameters squared; consequently $12^2 \div .75^2 = 144 \div .5625 = 256$. That is, 256 is the ratio of velocity of water in feed pipe as compared with the velocity of the water in the ram. Therefore, if the water in the ram moves at the rate of 1 foot per second, the water in the feed pipe must move at the rate of 256 feet per second, and the amount of work done is the same in each case. The difference in areas causes the ram to move only $\frac{1}{256}$ the speed of the pump, and what the ram loses in speed it must gain in force, since energy is indestructible, and the pressure exerted by the ram must be 256 times greater than that in the pipe to make up for loss in speed.

Energy of motion in pipe then equals

$$\frac{W\, V^2}{64} = \frac{1 \times 33.33^2}{64} = 17.35 \text{ ft. lbs.}$$

Then the work done by ram per pound of water used equals $17.35 \times 256 = 4441 - 60$ foot pds. per pound of water used.

The pressure due to velocity is found by dividing the square of the velocity in feet per second by the constant 148.3.

Example: The piston of an hydraulic ram is 6 inches in diameter; velocity of water in a ½-inch feed pipe equals 2,500 feet per minute. What is the work done by the ram per pound of water used, and what is the pressure per square inch due to velocity, and if the energy of the water had been turned into heat what would be the rise in the temperature of the water?

Velocity of water in feed pipe per second equals

$$\frac{2500}{60} = 41.33,$$

and $6^2 \times .5^2 = 36 \div .25 = 144$, ratio of velocity in ram as compared with feed pipe;

$$\frac{W\, V^2}{64} = \frac{1 \times 41.33^2}{64} = 26.69$$ *foot lbs. energy of motion per pound of* water in feed pipe; $26.69 \times 144 = 3843.36$ foot pounds per pound of water used by ram; $V^2 = 1708.16$, and pressure due to velocity in pipe equals

$$\frac{1708.16}{148.3} = 11.51 \text{ pounds per square inch.}$$

Then the pressure on the ram must equal $11.51 \times 144 = 1657.44$ pounds per square inch.

The mechanical value of a British Thermal Unit (B T U) is equivalent to raising 1 pound 772 feet high in one minute, or what is the same thing, *raising* 772 pounds one foot high in the same period of time; therefore a raise of 1° F. in the temperature of a pound of water equals 772 foot pounds of energy.

$$\frac{26.69 \text{ energy per pound of water in feed pipe.}}{772}$$

equals .0345° F. increase of temperature of water in feed pipe.

Then

$$\frac{3843.36}{772} = 4.98° \text{ F. rise of temperature in ram.}$$

Then if the whole of the energy of the ram had been expended in heat it would have given off sufficient heat to have raised the temperature of each pound of water 4.98° *Fahrenheit.*

OILS OF THE ENGINE ROOM.*

(Continued.)

We will now take the three main groups animal, vegetable and mineral and discuss their constitution and their behavior under the conditions which we will meet with in their use as lubricators. Oils from the animal and vegetable kingdom are fat oils; those from the mineral kingdom are not. In the first group, animal oils, we will find that oils from fish fat predominate, and that oils from other animal sources include in the largest proportion oils from the hog, and the balance will be very indiscriminate, refuse from slaughter houses, fat recovered from soap making, etc. Vegetable oils will be found to be the product of nuts, or nut like fruits. This includes seeds. All seeds contain oil in greater or less quantities, the oil being part of the food stored in the seed for the nourishment of the young plant. Oils are also obtained from the whole plant, as in the case of oil of peppermint, or the leaves, as wintergreen, or the petals of the flower as rose, or the wood fibre as turpentine, or the bark as cinnamon and from roots, so that you will see the oil exists in all parts of plants, but that the main supply is from the fruit. Oils from the mineral kingdom are not fats, that is, they cannot be divided by alkalies. They do not produce glycerine when decomposed as in the case of fats.

We have now ascertained the sources of oils, and will now go into the constitution of them, as this will bring us to the application of the knowledge we have obtained to understanding the changes which take place in oil when used for lubrication.

Animal fats or oils will be the first group to be considered, and under this head we have:

Fish oils—Whale, cod, shark.
Hog products—Lard oil, fat oil.
Horses and Cattle—Candle fat, suet, tallow, olein oil.

Most fats are mixtures of two or more compounds: Stearin, palmitin, olein and cetlin. Fish and other animal oils consist of olein, palmitin and stearin, which compose the fluid portion, and cetlin, the solid portion. Olein is oleic acid, or oleate of glyceryl, and when olein or the fluid part of oil is acted on by hot steam, a separation of glycerine and oleic acid ensues. Olein when mixed with an alkali forms oleate of that alkali, and glycerine is again set free. We will notice by this table that olein is a constituent of nearly all fats—animal or vegetable.

	Olein	Palmitin
Almond Oil............	Chiefly.	Very little.
Olive Oil..............	"	"
Lard Oil..............	"	Palmitin and stearin.
Castor Oil	Ricinolein.	Palmitin.
Cottonseed Oil...... ..	Olein.	"

Palm oil is composed of palmitin and olein (it rapidly becomes rancid and acquires an acid reaction). Suet is almost exclusively stearin; tallow, stearin and olein.

We observe from this that oils or fats are composed of substances which decompose at a high temperature; hence, while they in many cases would be found of great service in cold bearings, only certain of them would be of use in hot bearings, and it is here that we find mineral oils to be of advantage, as they do not decompose. Cylinder oils ought more especially to be free from decomposable substances, from rancidity, and, in a word, to be of a lubricating nature under the influence of a high temperature in the presence of moisture. The evidence that these oils do fulfill these requirements is that the oils from the exhaust are used again after filtration, etc., showing that it has not been decomposed or destroyed, as would be the case were the oil not to possess sufficient stability.

* Paper read before Hamilton No. 2, C.A.S.E., by J. W. Williams, chemist for Winer & Co., wholesale druggists.

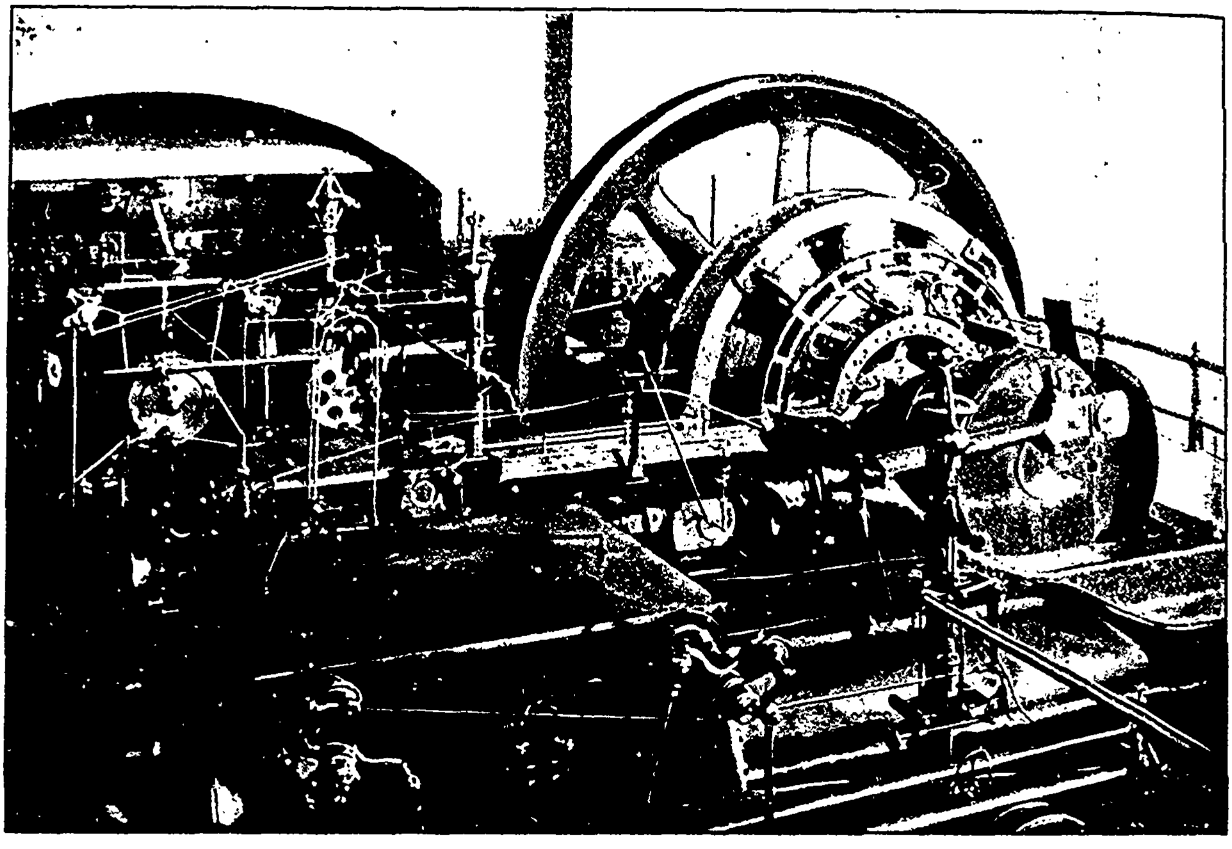
ELECTRIC RAILWAY DEPARTMENT.

DIRECT CONNECTED GENERATORS FOR RAILWAY WORK.

THREE years ago the Canadian General Electric Company installed in the power house of the Toronto Railway Company the first direct connected generator to be used for railway service in Canada, the machine being designed for larger outputs and slower speeds than the belted generators formerly used. It was claimed for this type of apparatus that it was capable of meeting the severest requirements of surface or elevated railway work, and possessed the additional advantage of greater reliability. In practice it must have been found satisfactory, as the Toronto Railway Company recently placed an order with the manufacturers for a duplicate of the machine, which has just been installed, and is herewith illustrated. A Siemens & Halske machine was replaced by this latter unit.

These generators are of 850 kilowatts capacity each, having ten poles, and operate at 90 revolutions per minute. They have steel frames, the combined weight of which, with pole pieces, is about 80 tons. The armatures are of the iron-clad type and weigh about 25 tons each. The machines are regulated for a regular running load of 1,500 amperes, but by practical operation have been proven to be of much greater capacity. They are of the same type as the 1,500 k.w. generator which has since been installed for the Montreal street railway, the 400 k.w. for the Winnipeg railway, and the two 500 k.w. at Quebec.

The manufacturers claim for them many advantages, among which are the following: Removable pole pieces, facilitating repair of field spools and permitting their removal without disturbing field frame or armature; frames adjustable in every direction; compounding proportional to current, so that machines will operate perfectly in parallel with each other; cool fields and permanency of insulation; commutator separated from armature, giving advantage of deeper segments and securing successful operation of carbon brushes; great number of segments in commutator, reducing volts per bar to a safe minimum and insuring freedom from sparking; armature hub bolted direct to fly wheel on larger sizes, removing strain from shaft and keys; absence of all volts through laminations; armature laminations separated from each other by fire proof insulation, preventing loss from eddy currents and yet maintaining permanent solidity of construction; flexible leads from armature conductors to commutator. A special feature is the barrel winding, a modification of the drum winding, having all the conductors held symmetrically on the cylindrical periphery of the armature. The end flanges extended laterally like a pulley, form a support for the end connections, the conductors being firmly secured in the armature slots and on the end flanges by metal bands, so that vibration is rendered almost impossible.



850 K.W. DIRECT-CONNECTED GENERATOR INSTALLED FOR THE TORONTO RAILWAY COMPANY.

SPARKS.

Mr. Wickstead, engineer, has submitted to the town council of Cobourg, Ont., a scheme to develop the water power of Baltimore creek. The cost of furnishing 400 horse power is estimated at $55,000.

The death is announced of Mr. James Green, electrical contractor, of Montreal.

The electric light company at Milltown, N. B., recently added a new engine to their plant.

The Bell Telephone Co. are having plans prepared for a new exchange to be built on St. John street, Quebec.

The Hamilton Radial Railway Company is said to have abandoned the idea of extending its road beyond Burlington.

The Winnipeg and Fort Alexander Railway Company is asking for power to build railways, telegraph and telephone lines.

The Toronto Railway Company have just placed an order with the Canadian General Electric Company for 20 G. E. 1000 motors, with K-10 controllers.

Mr. T. H. McCauley, electrical expert for the Royal Electric Co., Montreal, recently installed the new plant for lighting the town of Fort William, Ont.

The British Columbia Railways Company have placed an order for a freight car, using "Brill" trucks and G. E. 1200 motors, with the Canadian General Electric Company.

The Canadian General Electric Company will supply the entire electrical equipment for the new St. Thomas street railway. The order covers two 100 kilowatt generators and eight two motor equipments. The contract for cars was given to the Ottawa Car Company, and for the steam engine to the Robb Engineering Company, of Amherst, N S.

SPARKS.

The Puget Sound Telegraph Co. are now extending their line to Victoria, B.C.

The annual meeting of the Winnipeg Electric Street Railway Company will be held in Winnipeg on the 8th instant.

The village of Tilbury, Ont., has concluded an arrangement with Mr. R. H. Smith to continue the electric light system.

Mr. C. W. Richardson, of Morpeth, is advocating the construction of an electric railway from Chatham to Rondeau Park.

Mr. James Fowler, of Arnprior, is endeavoring to revive the proposal to construct an electric railway from Perth to Lanark.

James Steele, of Guelph, Ont., has patented a street car fender, which is now being tested by the Toronto Street Railway Company.

C. Fraser has succeeded Mr. Brown as electrician at the Stoney Creek power house of the Hamilton, Grimsby and Beamsville railway.

Mr. T. H. Smallman and others, of London, Ont., are asking permission to build a steam or electric railway from that city to a point near Grand Bend, on Lake Huron.

It is understood that the Ottawa Electric Railway Co. will undertake the construction of a bridge 1345 feet in length over the Ottawa river between Hull and Ottawa.

Mr. J. M. Green and the St. Thomas Gas Co. have tendered for the supply of power for the operation of the St. Thomas street railway. It is likely that Mr. Green's tender will be accepted.

The Ottawa Car Company are announced to have received an order from the Hull Electric Railway Co. for five open cars, one motor and four trailers. They will also remodel the parlor car of the company, putting in longitudinal seats.

Russell county residents are advocating the construction of an electric railway between Ottawa and Metcalfe, a distance of about twenty miles. One drawback to the carrying out of the scheme is said to be the lack of a suitable water power.

The promoters of the St. Thomas street railway have let the contracts for construction, and hope to have the road in operation early in the summer. At a meeting held on the 2nd instant, the company authorized the issue of debentures for the sum of $50,000.

The Saugeen Electric Light and Power Co. of Ontario has been incorporated, with a capital of $20,000. The members are: Chas. E. Kilmer, of Southampton; C. H. Burham, of Port Elgin; Ed. Kilmer, of Walkerton; Jos. Barber and James Barber, of Georgetown.

Prefontaine, St. Jean, Archer & Decary, of Montreal, are acting as solicitors for the North Shore Electric Railway Co., which purposes constructing an electric railway on the north shore of the St. Lawrence river. This is the company formed by Mr. A. J. Corriveau.

The British American Light & Power Co. have an application before the Dominion Parliament for power to construct and operate, by electricity or other motive power, tramways in Dawson city, Fort Selkirk, and other points in the Yukon district and Northern British Columbia.

At the next session of the Manitoba legislature a company, composed largely of Winnipeg capitalists, will ask for a charter to build an electric railway from Winnipeg to St. Andrew's rapids, and through the municipalities of Springfield, St. Boniface, Kildonan, St. Paul's and St. Andrews. The company also propose to construct telegraph and telephone lines.

The Montreal Belt Line Railway Co. has given notice of an application to parliament to change the name of the company, and to extend the time for the commencement and completion of its branches. A rumor is current that the amalgamation of the Montreal Street Railway Co. and the Montreal Park and Island Railway Co. will be effected at an early date.

The Montreal Street Railway Co. have issued an order that motormen and conductors must purchase new uniforms once a year. Some of the employees regard the regulation as a hardship, but Mr. McDonald, superintendent, states that the company are determined to have their employees neat in appearance, and that one-third of the cost of the uniforms is borne by the railway company.

The Halifax & Bedford Electric Railway Co. is applying to the Nova Scotia legislature for incorporation, the object being to build an electric railway from Halifax to Bedford, with such extensions as may be approved of by the municipalities. The promoters are: Dr. Chisholm, W. E. Crowe, Ex-Mayor Keefe, Robt. O'Mullin, Arthur S. Soulis and E. T. Freeman, of Halifax, in which city the head office is to be located. The capital stock is placed at $250,000.

The Premier of Newfoundland has moved in the legislature a resolution favoring the transfer of the colony's railway system, telegraph lines and coal areas to Mr. W. J. Reid, the well-known contractor of Montreal. One of the chief features of the proposed arrangement is the extension of the telegraph system along the west coast of the straits of Belle Isle, and thence north along Labrador. It is possible that the Dominion government will be asked to subsidize the service.

The Dominion government will probably be asked to make an appropriation at this session for the extension of the government telegraph system to the Yukon country. At the present time the government telegraph line extends from Ashcroft, B.C., to Quesnelle, a distance of 225 miles. From this latter point to Telegraph Creek is 540 miles. The proposal is to build the section to Teslin Lake next season, reaching the Yukon in 1899. The cost is roughly estimated at half a million dollars.

The annual meeting of the Guelph Light and Power Company was held in the city of Guelph on February 14th. The statements presented were found satisfactory, and the board of directors re-elected as follows: D. Guthrie, president; Richard Mitchell, vice-president; G. A. Oxnard, Thos. Gowdy, James Innes, Dr. Foster and Geo. D. Forbes. A vote of thanks was passed to the directors, in acknowledging which the president referred to the efficient services of the manager, Mr. John Yule.

The Sydney Electric Light & Gas Co., of Sydney, C.B., are making extensive alterations and additions to their plant, and have placed an order with the Royal Electric Co. for one 60 k.w. and one 40 k.w. S.K.C. two-phase alternators. These machines are connected to deliver 150 volts per phase. This is the fourth order that has been placed with the Royal Electric Co. for low tension generators of this type within the last few months, and is an evidence of the growing popularity of these machines for this work.

MOONLIGHT SCHEDULE FOR APRIL.

Day of Month	Light.	Extinguish.	No. of Hours.
	H.M.	H.M.	H.M.
1	A.M. 1.50	A.M. 4.50	3.00
2	" 2.20	" 4.50	2.30
3	No Light.	No Light.	...
4	No Light.	No Light.	.....
5	No Light.	No Light.	.....
6	No Light.	No Light.	.....
7	P.M. 6.50	P.M. 9.30	2.40
8	" 6.50	" 10.00	3.10
9	" 6.50	" 11.20	4.30
10	" 6.50	A.M. 12.30	5.40
11	" 6.50	" 1.30	6.40
12	" 6.50	" 2.20	7.30
13	" 6.50	" 3.00	8.10
14	" 6.50	" 3.30	8.40
15	" 7.00	" 4.00	9.00
16	" 7.00	" 4.30	9.30
17	" 7.00	" 4.30	9.30
18	" 7.20	" 4.30	9.10
19	" 7.20	" 4.30	9.10
20	" 7.20	" 4.30	9.10
21	" 7.20	" 4.20	9.00
22	" 7.50	" 4.20	8.30
23	" 8.50	" 4.20	7.30
24	" 9.50	" 4.20	6.30
25	" 10.30	" 4.10	5.40
26	" 11.00	" 4.10	5.10
27	" 11.20	" 4.10	4.50
28	" 11.50	" 4.10	4.20
29	......	" 4.10	3.50
30	A.M. 12.20	......	
		Total	163.20

SPARKS.

The Guelph Light & Power Company recently started up their new Brush arc machine.

D. Knechtel & Son are putting in a new 130 horse power water wheel at their works at Maple Hill.

Mr. G. A. Paterson, manager of the Brandon, Man., Electric Light Co., was a recent visitor to Toronto.

A by-law providing for the installation of an electric light plant has been carried by the ratepayers of Beeton, Ont.

J. L. McKenzie & Co., manufacturers of electrical apparatus, Victoria, B.C., have been succeeded by Wm. Watson.

S. Lennard & Sons, of Dundas, placed an order some time ago with the Canadian General Electric Company for a 100-light incandescent plant.

Messrs. Edgar & Roy, of North Hatley, Que., have purchased from the Royal Electric Co. a 60 k.w. S.K.C. two-phase generator.

The Sherbrooke Street Railway Company have recently placed an order with the Canadian General Electric Company for additional G. E. 1000 equipments.

The North Shore Power Company are said to be negotiating for the operation of the waterworks system of Three Rivers, Que., by electricity.

The electric light plant owned by the village of Markham, Ont., was destroyed by fire a fortnight ago. Steps were taken immediately to rebuild.

The annual meeting of the Hamilton Electric Light and Power Company was held in Hamilton last month, at which all the officers were re-elected.

The Midland Electric Light Co., of Midland, recently placed an increase order with the Canadian General Electric Co. for a 60 k.w. single-phase alternator of the company's standard type.

The Manitoba District Telegraph Co. is seeking incorporation, the applicants being John Galt, Wm. Hespeler, R. J. Campbell, Frank A. Drummond and F. W. Heubach.

Incorporation has been granted to the Cardinal Electric Light Co., Limited, with a capital stock of $20,000. Geo. F. Benson, of Montreal, John D. Reid, of Cardinal, and others, are interested.

The Metropolitan Street Railway Company have purchased G. E. 1000 equipments from the Canadian General Electric Company. These will replace the motors burned in the fire recently at their car barn.

The Electric Light Company of Edmonton, N.W.T., has purchased a new plant complete, including a 75 k.w. S.K.C. two-phase generator, with Stanley transformers, from the Royal Electric Co.

The Chateauguay & Northern Railway Co., of Montreal, have placed an order with the Canadian General Electric Company for a 325 kilowatt steel frame generator. This will give them a total capacity of 525 kilowatts.

The Hull Electric Company have ordered thirty-six G. E. 1000 motors from the Canadian General Electric Company. These will be used as four-motor equipments, making in all fifty-two motors of this type which the Hull electric road will have in operation.

Arrangements are being completed to light the village of Harrow, Ont., by electricity. Mr. Goodchild, of Colchester South, will operate the plant.

The Sauble Falls Ranch & Lumber Co., which has recently been incorporated, has been given power to construct at Sauble Falls, Ont., works for the distribution of electricity for light, heat and power.

The Canadian General Electric Company have been awarded the contract for supplying electrical machinery for lighting and power purposes at Ashcroft, B. C. The three-phase system will be used, and the pumping for the town waterworks will be done by an induction motor.

The town council of Orillia, Ont., have engaged Mr. Wm. Kennedy, hydraulic engineer, of Montreal, to report on the probable cost of the hydraulic work in connection with the development of the water power of Ragged Rapids.

The Canadian General Electric Company have closed a contract with the Montreal Transportation Company, at Kingston, Ont., for a 25 k.w. generator of their direct connected type. This machine will be used for lighting the new elevators and other buildings of the company at Kingston.

The C.P.R. Telegraph Co. are announced to have decided to string a heavy copper wire from Montreal to the Pacific coast. It is stated that a second cable will also be laid from Vancouver to Victoria, B.C., a distance of 45 miles.

The Canadian General Electric Company are supplying three small direct connected units for the C. P. R. steamships on the Stickeen river. These machines will be 4 kilowatts each, direct connected to vertical engine of special type, running at 600 revolutions per minute.

The Deschenes Electric Co., Limited, have elected directors as follows: Alex. Fraser, president; W. J. Conroy, vice-president; David Maclaren and Robt. Anderson. The head office of the company has been established at 138 Canal street, Ottawa.

The Electric Reduction Company, of Buckingham, Que., have placed an order with the Canadian General Electric Company for a 1,000 h.p. three-phase revolving field generator, to be used for electrolytic work. The machine will be similar to those installed at Lachine and West Kootenay, except that the current will be supplied at the low potential of 75 volts.

The annual meeting of the Bell Telephone Company was held in Montreal last month. Directors were elected as follows: C. F. Sise, Robt. Mackay, John E. Hudson, Robert Archer, Wm. R. Driver, Hugh Paton, Charles Cassils, Thos. Sherwin. The eighteenth annual report, in part, said: During the year 983 subscribers have been added, the total number of sets of instruments now earning rental being 30,445. The company now owns and operates 349 exchanges and 261 agencies. Thirty-five miles of poles and 703 miles of wire have been added to the long distance system in 1897; the long distance lines now owned and operated by the company comprise 15,567 miles of wire on 6,095 miles of poles. The directors have charged to contingent fund $150,000, that amount having been expended during the year on construction rendered necessary by the introduction of trolley and other strong current wires, but which has not increased the earning power of the plant. The receipts for the year were $1,185,685.21 and the expenses $906,933.64, leaving a net revenue of $279,751.57.