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CANADIAN

# ELECTRICAL NEWS

AND

# STEAM ENGINEERING JOURNAL.

VOL. I. TORONTO AND MONTREAL, CANADA JANUARY, 1891. No. I.

## MR. J. J. WRIGHT.

THE subject of the accompanying portrait was born in Yarmouth, England, in 1850, and came to Canada about twenty-one years ago. Mr. Wright was in the States at the time of the Centennial Exhibition, of 1876, at which time electricity was beginning to attract attention as a possible means of giving light. He there became acquainted with Prof. Thomson, who was then occupying the Chair of Chemistry in the High School, in Philadelphia, Pa., at which time he in conjunction with Prof. Houston of the same school was commencing experiments which have led up to the brilliant results of to-day. Mr. Wright built all the machinery during these experiments; he also built and put up the first electric street lamp on the continent of America, which was placed on the corner of 21st street and Washington ave. in the year 1879. He was amongst the first to handle electric light wires in the construction of underground service, ha ing constructed a line of underground wire for electric lighting in Market street, Philadelphia, and another between the City Hall and 4th street. Mr. Wright was a member of the National Conference of Electricians convened by the United States Government, and whilst in Philadelphia was a member of the Franklin Institute of Science and Arts, and is now connected with the Electric Light Association of the United States.

In the spring of 1883 Mr. Wright returned to Canada and built a small plant for the supply of light which was operated on Yonge street near King, and since then he has identified himself with the electric lighting interests of this city as manager of the Toronto Electric Light Company. He also built and put in operation the electric locomotive which has been used at the Industrial Exhibition for the past few years—which may be considered the pioneer electric railroad in Canada.

MR. J. J. WRIGHT.

## SAFETY VALVES—THEIR HISTORY, ANTECEDENTS, INVENTION AND CALCULATION.

BY WILLIAM BARNET LE VAN.

The function of a safety valve, as used on a steam boiler, is to discharge steam so rapidly, when the pressure within the boiler reaches a fixed limit, that no important increase of pressure can then occur, however rapidly steam may be made. It should be so constructed and arranged, that should any accident occur, it may be opened by hand and the steam pressure lowered very rapidly, even when the grates are covered with a mass of incandescent fuel, and steam is being generated rapidly, without increasing the pressure in the boiler over 10 to 15 per cent. above that to which the valve may be loaded.

The grate surface, all things considered, is the best unit of measurement for determining the size of safety valves. The ordinary rate of combustion runs from 10 to 15 pounds of coal per square foot of grate, and the rate of evaporation may be taken at 9 pounds of water per pound of coal as the maximum.

The higher the pressure the smaller the orifice will have to be; and on the other hand, the lower the pressure the larger must the outlet be. A boiler in which the pressure does not exceed 40 pounds per square inch, may require from 30 to 40 square inches of area; while the same quantity of steam would escape through 4 square inches of area in a boiler carrying 150 pounds pressure.

A safety valve should not exceed 4 inches in diameter; when a valve of larger area than 4 inches is wanted, an extra safety valve should be added. The area of a valve increases nearly as the square of its diameter; the circumference, directly as the diameter. The escape of the steam is around the circumference, and it will be understood, of course, that a point would soon be reached in which the area would be of little account if carried to large diameters and figuring on ordinary valves. For example, if the grate area required a common valve 6 inches in diameter, it would have a circumference of 18.84 inches; the same area would be furnished by two 3½-inch valves, the combined circumferences of which would equal $9.621 \times 2 = 19.242$ inches.

As the safety valve is the main reliance in case of neglect or inattention of the engineer or fireman, it is important to carefully examine its mode of operation, and the ordinary methods of construction and calculation for safety. However, before proceeding as above, we will endeavor to give the early history of the safety valve, as well as the antecedents, invention and the manner of proportioning and calculating all its parts. As this is a subject that has already been very carefully traversed, I do not pretend to offer much that is new or original, but will try to give that which will be the most useful, for the benefit of a portion of the rising generation, as well as for some others who may be interested, and in as simple language as is consistent with plainness; so that any one who can solve simple equation in algebra, and who knows the simple definitions of trigonometry, and the elements of physics, shall understand it. Mathematics will be dispensed with as far as possible; but in each case, where possible, written rules, together with the particulars of working examples, will be given, so that the reader may study the subject for himself.

### STEAM.

As the first result of the application of heat to a solid substance is to dilate it, and the next to melt it, so also the further application of heat converts it from a liquid into a vapor or gas. The point at which successive increments of heat, instead of raising the temperature, are absorbed in the generation of vapor, is called the "boiling point" of the liquid. Different liquids have different boiling points under the same pressure, and the same liquid will boil at a lower temperature in a vacuum, or under a low pressure, than it will under a high pressure. As the pressure of the atmosphere varies at different altitudes, liquids will boil at different temperatures at different altitudes, and the height of a mountain may be approximately determined by the temperature at which water boils at its summit.

DIFFERENCES BETWEEN GASES AND VAPORS.

Vapors are saturated gases, or, gases are vapors surcharged with heat. Ordinary steam is the saturated vapor of water, and if any of the heat be withdrawn from it, a portion of the water is necessarily precipitated. This is not so in the case of a gas under ordinary conditions. But if the gas be forced into a very small bulk, it will follow that any diminution of the temperature will cause a portion of the gas to condense into a liquid. Superheated steam resembles gas in its qualities, and a portion of the heat may be withdrawn from such steam without producing the precipitation of any part of its constituent water. (*Bourne*).

Steam was among the motive agents of the most ancient idols of Egypt (as the statue of Memnon, and others), and some of the deified images of Europe; and it is curious to note that it should formerly have been employed with tremendous effect to delude men--to keep them in ignorance—while now it contributes so largely to enlighten and benefit mankind.

Steam has, of course, been noticed ever since the heating of water and cooking of food were practiced. The daily occurrence implied by the expression "the pot boils over," was as common in antediluvian as in modern times; and hot water thus raised was one of the earliest observed facts connected with the evolution of vapor. From allusions in the most ancient writings, we may gather that the phenomena exhibited by steam were closely observed of old. Thus, Job, in describing Leviathan, alludes to the puffs, or volumes, that issue from under the covers of boiling vessels: "By his neesings a light doth shine, and his eyes are like the eyelids of the morning; out of his nostrils goeth smoke [steam] as out of a seething pot or cauldron." In the early use of the vessels last named, and before experience had rendered the management of them easy and safe, women would naturally endeavor to prevent the savory contents of their pots from flying off in vapor; hence attempts to confine it by covers; and when these did not fit sufficiently close, a cloth, or some similar substance, interposed between it and the edge of the vessel, would readily suggest itself, and a stone or other weight placed upon the top to keep all tight would also be very natural. Then, as the fluid began again to escape, further efforts would be made to retain it by additional weights. In this manner, doubtless, many a contest was kept up between a pot and its owner till one gained the victory, and we need not the testimony of historians to determine which one this was. In those times it was not generally known that a boiling cauldron contained a spirit, impatient of control, that the vessel was the generator of an irresistible power, and the cover a *safety valve;* and that the preservation of the contents and the security of the operator depended upon letting the cover alone, or not overloading it; hence it no doubt often happened that the confined vapor threw out the contents with violence, and then it was that primitive cooks began to perceive that there was death as well as life in a boiling pot. In this manner, we suppose women were the first experimenters with steam (engineers), and the earliest witnesses of steam boiler explosions.

Ancient priests, both among the Jews and Gentiles, were, from their ordinary duties, necessarily conversant with the generation of steam. Its elastic force could not, therefore, escape the shrewd observers among them. Sacrifices were frequently *boiled* in huge cauldrons, several of which were permanently fixed in the vicinity of temples—in "boiling places," as their locations are named by Ezekiel, "where the ministers of the house shall boil the sacrifice of the people."

It would seem, moreover, as if some of the boilers were made on the principle of Papin's digester, in which bones were softened by "high steam"; at any rate, a distinction is made between seething pots and cauldrons, and from the manner in which both are mentioned they seem to have been designed for different purposes; the former to seethe or soften bones, the latter to boil the flesh in only. "They roasted the passover with fire, but the other offerings sod they in pots and in cauldrons," (ii. Cor. chap. 35, p. 13). "Set on a pot, set it on, and also pour water into it. Gather the pieces thereof into it, even every good piece, the thigh and the shoulder; fill it with the choice bones. Take the choice of the flock and burn (or heap) also the bones under it, and make it *boil well,* and let them *seeth the bones* of it therein." (Ezek. 24, p. 3, 5). The belief that the Jews had close vessels in which steam was raised higher than in common cauldrons, is also rendered probable from the fact that the Chinese, a contemporary people, employ similar ones, and which, from their tenacity to ancient devices, have probably been used by them from time anterior to those of the prophets. ("Davis' Chinese," ii. 271; "John Bell's Travels," i. 296, and ii. 13).

Some of the ancient philosophers, who were close observers of nature, compared the earth to a cauldron, in which water is heated by internal fires; and they explained the phenomena of earthquakes by the accummulation of steam in subterraneous caverns, until its elastic energy rends the superincumbent strata for a vent. Vitruvius explains by it the existence of boiler springs. In the reign of Justinian, Anthemius, an architect and mathematician, illustrated several natural phenomena by it; but of this we should probably never had heard had it not been for a quarrel between him and his next door neighbor, Zeno, the rhetorician. This orator appears to have inherited a considerable share of credulity and superstition, which gave his antagonist the advantage. Anthemius, we are informed, had several steam boilers in the lower part of his house, from each of which a pipe conveyed the vapor above, and by some mechanism, of which no account has been preserved, he shook the house of his enemy as by a real earthquake, upon which the affrighted Zeno rushed to the Senate, "and declared in a tragic style that a mere mortal must yield to the power of an antagonist who shook the earth with the trident of Neptune."

The boiler engineer of to-day, noting the curious things in bronze and in copper exhumed at Pompeii, and gathered together in the Museo Borbonico, at Naples, will linger near a small vessel for heating water, little more than a foot high, in which are combined nearly all the principles involved in the modern vertical steam boiler—fire box, smoke flue through the top, and fire door at the side, all complete; and, strange to say, this little thing has a *water grate*, made of some small tubes crossing the fire-box at the bottom, an idea that has been patented twenty times over, in one shape or another, within the period of the history of the steam boiler.

The boilers of the fast boats built by the Herreshoff Company, of Bristol, R. I., are similar in construction to those found in the Thermae at Pompeii, taken from impressions left in the mortar or cement in which they were embedded. Some idea of the capacity of these boilers may be derived from the fact that a single establishment could accommode *two thousand persons* with warm, or rather *hot*, baths at the same time. Seneca, in a letter to Lucilius, says "there is no difference between the heat of the baths and a *boiling furnace";* and it would, he observes, appear to a reasonable man as a sufficient punishment to wash a condemned criminal in them. The persons who had the charge of heating in close vessels and distributing daily such large quantities of water, must necessarily have been conversant with the mechanical properties of steam, and the economical modes of generating it.

*(To be Continued.)*

## TRADE NOTES.

Says the Port Hope *Guide:* "We noticed a large shipment of Spooner's Copperine going to Goldie & McCulloch, Galt, a day or two since. It's a production of our town—it's the metal above all other metals, and this settles it. There will not be a hot box for miles around Galt as long as Copperine holds out."

The Dominion Leather Board Co., of Montreal, have purchased the property and water power at Sault au Recollect, near Montreal, formerly owned by Messrs. McNiven & Cole, including saw mill, grist mill and what is familiarly known as Sault au Recollect Paper Mills, and are making alterations in saw mill to use it for their leather board and friction board mill, and will run the paper mill on building, roofing, sheathing and flooring felts.

Mr. H. W. Petrie, dealer in machinery of all kinds, who has been energetically building up a business all over Canada, announces the removal of his headquarters from Brantford to Toronto. This step became necessary because his increased transactions require the best facilities for transportation, also buildings and appliances for handling heavy machinery, etc. Therefore he has built new brick premises 40 x 124 feet, near the Union Station, on Front St., west of the Walker House, with massive beams, steel girders, steam hoists, and every facility for handling heavy goods, and lighted by electricity.

A piece of mica was recently taken from the mines near Buckingham, Que., which measured 7 feet 6 inches in height and 38 inches thick. This is said to be the lagest solid piece in America.

## PLANT EFFICIENCY WITH OPEN AND CLOSED CIRCUIT TRANSFORMERS.

By William Stanley, Jr.

Several contributions on the relative merits of the closed and opened circuit transformers for the distribution of electrical energy, have lately appeared in *The Electrical Engineer*. In various letters, Mr. Swinburne has maintained that the open circuit transformer is more efficient than is its opponent of the closed magnetic circuit type, and that, consequently, American engineers were applying and advocating apparatus lacking maximum efficiency.

When, in 1885, I constructed the first closed transformer, and adapted it for commercial lighting, I had in mind the very differences which are now being discussed, and at the same time there seemed to me to exist certain objections to open circuit transformers which still appear to me to be of such magnitude that I believe, in America at least, the open circuit transformer is at a disadvantage. Of these objections I have seen no mention; they are briefly as follows:

In the open circuit transformer of the Ruhmkorff, the Gaulard and Gibbs, or the hedgehog type, high efficiency is due to the fact that the fluid (or air) portion of the magnetic circuit causes the current phase to lag behind the E. M. F. more than in the closed magnetic type, and in a well constructed transformer of the open circuit type this lag is nearly 90 deg. at no load, that is, when the secondary circuit is open. Now in these transformers the value of the primary current varies comparatively little with the load derived from the secondary circuit, and when such a transformer is gradually loaded, the primary current will remain, roughly speaking, constant, while the lag of the current behind its E. M. F. will diminish; the phases of current and E. M. F. more nearly coinciding as the energy taken from the transformer is increased.

In the closed circuit type of transformer, however, the *value of the primary current in amperes* is very nearly in direct proportion to the load upon the secondary circuit. Thus while the primary current in the open circuit type remains, roughly speaking, constant, possibly varying 10 to 20 per cent., the primary current in the closed type is proportional to the load.

Let us examine briefly the station requirements for the two contrasted types. With the open circuit type eight-tenths of the station plant, that is, eight-tenths of all the engines and dynamos, must run continual to supply the primary currents, for the ampere value of these currents is about constant; while with the closed circuit type of transformer, the engines and dynamos in service vary in proportion to the number of lamps burning. Thus, in a station having 10 dynamos and engines of equal size, in many places one dynamo and engine will easily supply all the energy necessary during twelve or fourteen hours out of the twenty-four, when the closed circuit or American type of transformer is used; while, with the open circuit type advocated by Mr. Swinburne, at least eight of such engines or dynamos would be required to do the same work. The question arises, therefore, Which system uses the least fuel, and costs the least?

For the sake of simplicity, we will allow Mr. Swinburne's transformer to have 100 per cent. efficiency. We will also allow the closed circuit transformer an efficiency of 95 per cent., which can be proven to be commercial practice in well designed transformers. Placing the engine losses at 10 per cent. and neglecting the losses in the mains, we find that with the open circuit type the loss is eight times as much as with the closed type, neglecting transformer losses; or 7.6 times, including these losses. In short, it requires about seven to seven-and-a-half times as much coal to maintain current for open circuit as for the closed circuit type, because, during the idle period of the day, approximately seven to eight times as many dynamos and engines have to be run, and the principal losses occur in these eldments instead of in the transformers. During the remainder of the day, about one-half of the time, that is, a quarter of a complete day, the efficiencies of the systems employing these two types would be equal; and during the remaining quarter of the day the efficiency of the open type would be 5 per cent. greater.

I therefore dispute Mr. Swinburne's statement that an open circuit transformer is as efficient an element of a system of distribution as its American brother. With higher frequency the open circuit transformer will make a better showing, and probably will be used, providing we can arrange means to obviate the extra losses.

By the way, why use the words converter or transformer? Would not Cyclotrope or Ergotrope, meaning that which transfers from a circuit, and that which transfers energy, be more appropriate?

## WANTS TO BE THE FIRST SUBSCRIBER.

Toronto, Nov. 25th, 1890.

Editor Electrical, Mechanical and Milling News.

Dear Sir,—Having learned that you are about to make some changes in your paper, and that you intend to devote your entire space to electricity and steam engineering, I hope such is the fact, and that we may be able to say we have a Canadian publication treating directly on these matters. I think I may say for the greater part of the engineers of Canada that they will endorse and support such a paper. Count me in as the first subscriber.

Yours fraternally,

A. M. Wickens.

## SPARKS.

The town of Napanee has arranged with the Bell Telephone Co. for an electric fire alarm.

The Bell Telephone Co. are making extensive improvements in their system in Kingston. Mr. T. Wadlands has charge of the work.

It is said that 13 per cent. premium was offered for some new shares of its stocks which the Quebec and Levis Electric Light Company lately placed in the local market.

It is understood that owing to ill-health, Mr. E. O. Jones has resigned his position as Vice-President of the Ball E. L. Co., Toronto, and will go south for a time.

The boiler in McDonald's sash factory at Fergus, Ont., exploded recently. Pieces thereof and boards from the roof of the building were driven through the air in all directions, but luckily no one seems to have been killed.

A quick piece of cable service is reported from Montreal. A cablegram was sent from that city over the commercial cable to London at 10.27, and at 10.40, just thirteen minutes, a reply was received. The message had been sent from Montreal to Canso, thence to Ireland, and on to London. A transaction was effected on the London Stock Exchange, and the reply was written, sent, and received in the time named.

The Winnipeg Electrical Railway is completed and will go into operation at once. The electric motor car—the first ever brought into the Canadian Northwest- was constructed at St. Catharines, Ont. The company regard this line somewhat in the light of an experiment, but they little doubt that the motor will stand the cold of winter, which a few have been inclined to question. Providing the experiment proves entirely satisfactory there is every reason to believe that the company, having a prior right, will be granted permission by the City Council to extend their system to the main thoroughfares.

A simple method of removing magnetism from watches consists in the use of a compound horseshoe magnet placed with its poles upward, and a support about three feet above it. From this support the watch to be demagnetized is suspended in a cardboard tray which hangs by a twisted thread. As the end untwists the watch is gradually removed from the magnetic field. This is much handier than the ordinary way of demagnetizing watches, which entails the use of an electro-magnet energized from a battery or other source of current, or the employment of permanent horseshoe magnets.

The electric lighting company of Concord, is using a device by means of which, it is stated, a saving of 30 per cent. is effected in the cost of arc lamp carbons. The trimmers bring to the station all the short pieces of carbon collected on their daily rounds. These are sorted and matched together, to form a carbon about eight inches in length. These pieces are placed in a machine which forms a dowel on one piece and a socket in the other, and they are cemented at the joints. The cement with which they are joined is heat-proof and is a good conductor, so that there is no change in light indicated when the joint is reached. The spliced carbons are used only in the lower holder. Carbons thus joined have been used by the company for over a year, and the process is considered entirely successful.

A despatch from St. Catharines says a by-law to allow the Reliance Electric Light Company to erect poles and string wires in the city of St. Catharines in opposition to the present existing company was passed Monday night, the mayor being called upon to exercise his franchise, the vote at the third reading being a tie. The stockholders of the St. Catharines Electric Light Company at present in existence are all prominent citizens, and considerable feeling has been fomenting in the triangular fight between the two electric companies and the gas company. The last named company have been laying new mains. The St. Catharines Electric Light Company have purchased a 600 Thomson-Houston dynamo, and the Reliance are offering lights at 20 cents each per night, against the St. Catharines company's 30 cents each per night. In the meantime the city is blowing out the gas, and is almost asphyxiated with the clamoring vituperations of the ratepayers.

## MR. A. E. EDKINS.

We have pleasure in presenting to our readers the accompanying portrait of Mr. A. E. Edkins, President of Toronto Branch No. 1 of the Canadian Association of Stationary Engineers. Mr. Edkins, who is about 30 years old, was born in Birmingham, England, where he received an ordinary common school education. At the age of 16 he was apprenticed to the machinist's trade with Messrs. Part & Co., of Lancashire. After remaining with this firm about three years, he came to Canada, and was engaged by Messrs. Manning & Macdonald, who placed him in charge of machinery and plant used in the construction of public works. In this capacity he remained four years. He had charge of the electric plant during the construction of the Lachine Bridge, near Montreal, and on its completion was drafted into the service of the C. P. R.

About three years ago Mr. Edkins came to Toronto and entered the service of Messrs. A. Jardine & Co., as engineer-in-charge. On the termination of his agreement with this firm a year ago, he took the management of the steam and electric plant of Messrs. T. Eaton & Co., where he may be found at present.

Mr. Edkins is a young man of excellent character and ability, whose zeal for the advancement of the interests of the Toronto branch of the Canadian Association of Stationary Engineers has resulted in placing him in the positions of Secretary, Vice-President, and finally President of that organization.

MR. A. E. EDKINS.

## THOUGHTS ON ELECTRIC UNITS.

In mechanical work we use quite a variety of units for measurement, and these units are quite well understood by most intelligent mechanics. Electric measurements are mechanical, and the units adopted are directly related to the mechanical units with which we are familiar. The variations are in sizes of the units and their names. The reasons for adopting new units for electric work are similar to those which induce us to measure coal by the ton, butter by the pound, gold by the pennyweight, diamonds by the carat. We understand that the carat is a certain small part of a ton, but we do not care enough about this relationship to learn what part of a ton a carat is. The human mind has a better idea of the "fitness of things" than to measure diamonds by the same units as we do coal. Therefore when scientific men were called upon to establish units for electric measurements, they sought such sizes as the force demanded, and then worked to establish accurately some standards to represent the units adopted. As these units were new they required new names, and what better course could have been adopted than to apply the names of those men who had taught the world so much of electricity as to make a need for these new units of measurement?

An electrician knows that his units are certain small parts of the common mechanical units, but he dosen't think of this relationship, except in those calculations, involving horse power parlance, any more than the diamond dealer thinks of the relation between the carat and the ton. The units mostly in use are the ohm, the volt and the ampere.

We know that any conductor offers resistance to the passage of electricity, just as we know that pipes offer resistance to the passage of water, and a unit was established for measuring this resistance. It was called an ohm, in honor of the German mathematician who originated the simple formula so much used by electricians.

A unit was established to measure the force which "pushes" electricity through conductors. It is called a volt, in honor of Volta, the great Italian electrician. We have two units for expressing the force which pushes water forward, used according to circumstances. If the water is flowing through pipe systems like city water works we use the "pound" to measure the pressure, but if flowing down streams, as used for water power, we use the "foot of head" as the unit.

A unit of quantity was also established, and was called an ampere in honor of a famous French electrician. There are many other units in use by electricians, but the three mentioned are those most in use, and a full understanding of these is of vast importance to the mechanic. When the uses of these units are well understood it then becomes easy to appreciate the others that have been adopted, but are much less frequently used.

These three units are directly related to one another. The ampere, for instance, is the quantity of electricity which would be forced through a conductor which had a resistance of one ohm by an electric pressure of one volt. To know the work to be done by an electric current we must know both the force and the quantity, which is the same as we require in water power calculations. To say, for instance, that 1,000,000 gallons of water pass a certain place in one day would not convey any idea of the power to be obtained therefrom. The hydraulic engineer must know the number of feet fall that he could obtain for this water. Tell this engineer that you have 1,000,000 gallons per day with a drop of 20 feet, and he could very soon tell you the horse power it would give. So also with electricity; to say that we have 10 amperes would give the electrician no idea of the work that could be done by the current. He must know the force behind it. If, however, you say that you have 19 amperes and a force of 100 volts he could very soon calculate the amount of horse power obtainable, and he could also tell what could be accomplished with this current in the various ways in which it is used.

The ampere is in reality the measurement of the rate of flow, so to speak, of the electric current, and it does not really give an idea of the quantity passing, because for this we need also to specify the time. Perhaps the best comparison is that of a trotting horse. To say that a horse passes us at a 2:40 pace would give us no idea how far he travels, but to say that he travels at a 2:40 pace for 2 minutes and 40 seconds would give us the idea that he had travelled just one mile. Using the second as a unit of time, then if we have one ampere for one second we have in reality a unit of quantity, and electricians have called this coulombe. This term has not come into general use, however, and another unit of quantity has been adopted in practical work. In this case the hour is used for the unit of time, and to express this unit we simply connect the two terms by a hyphen, viz., ampere-hour, and this is the unit used for most electric meters. Unfortunately this unit conveys no idea of the work that can be done by the current. For instance, one ampere-hour of electricity, with pressure of 50 volts, would only be worth one-half as much as one ampere-hour with 100 volts, and if an electric light company furnishing electricity with a pressure of 50 volts should charge the same price per ampere-hour as another company supplying electricity at 100 volts, the former would be receiving twice the rental of the latter. This difficulty has given rise to the practice of registering the work in lamp hours when used for lighting, and the most satisfactory meters to the public are those which indicate the work in this way. In these cases the 16-candle power lamp is used for the standard.

There are two methods of distributing electricity in practical work, one in which the current is kept constant and the force is varied according to the amount of work to be done: the other in which the force is kept constant and the quantity is varied in proportion to the work done. Suppose we had at the top of a hill a supply of water which we wish to use for power, and suppose that on one side of this hill we could descend into a valley in the depth of 100 feet, and on the other side we could only descend 10 feet, and suppose, furthermore, that we wished to operate ten water wheels from this water power. If we put these ten wheels side by side and connect them by a pipe large enough to supply them all, the pressure of the water would remain constant and the quantity flowing would depend upon the number of water wheels working; or, in other words, upon the amount of work done. On the other hand, supposing we put these wheels on the other side of the hill, one wheel below the other, ten feet apart, and connect them with a pipe one after the other. To make this comparison complete it must be considered that each wheel is on a shelf or terrace in so far as the pipe is not in a straight line up and down the hill, and because each wheel is supposed to require a head of 10 feet only. Now, in this case the quantity of water passing remains constant, whereas the pressure or total drop can be considered as practically proportional to the number of wheels working. To operate all ten wheels on this system requires a total fall of 100 feet, and the same water works all the wheels; whereas, to work the ten wheels by the other system requires a fall of only 10 feet, but each wheel takes its own separate supply of water. Although this comparison is a little difficult, it is essentially the same as the two methods of distributing power by electricity. If, for instance, we have ten lamps, each of which requires a current of 10 amperes in quantity with a pressure of 10 volts, and we connect these lamps one after the other, then the same current of 10 amperes would work all the lamps, but the force would be 10 times 10 volts, or 100 volts, whereas if we connect these lamps side by side, then each would require its own supply of electricity, the same pressure would work them all, but it would require 10 times as much electricity to supply them. *Electrical Industries.*

## THE WORK THAT IS IN STEAM.

THERE is only a certain amount of work that can be got out of steam, no more, says a writer in *Power and Transmission*, and without expansion there is much less than there is with. It would be well for us to be able to figure out just how much heat and work there are in steam at any desired pressure, both with and without expansion.

The maximum work that can be got out of steam without expansion may be found by multiplying 144 by the pressure in lbs. per square inch in vacuum and by the volume of steam at the desired pressure, as compared with that of water at the maximum density of 39° F., then dividing by the heat units per cubic foot of steam from 32° to the desired temperature, and by the volume of steam of the corresponding temperature compared with that of water at the maximum density of 39° F. This volume is got by Fairbairn & Tate's formula:

$$V = 25.02 + \frac{49513}{I + 0.72}$$

in which $V$ represents the volume due to the temperature and $I$ is the total steam pressure in inches of mercury.

Suppose that we wish to know how much maximum work there is in steam at 60 pounds above vacuum, or rather more than 45 pounds per square inch by the gauge. That maximum work will be

$$\frac{144 \times 60 \times (428.32 - 1) = (144 \times 60 \times 427.32)}{170.58 \times 428.32}$$

$\div (170.58 \times 428.32)$ equals say 50.5 foot lbs., or $50.5 \div 772 = 6.54$ per cent. of the total power.

Suppose that we increase the steam pressure to 120 pounds total, or pounds above vacuum, then we shall have the maximum amount of work

$144 \times 120 \times (227.56 - 1) = 144 \times 120 \times 226.325.20 \times 227.56$

56) $\div (325.20 \times 227.56) = 52.9$ foot pounds, about 6.85 per cent. of the total work. Thus by doubling the steam pressure above vacuum we have increased the maximum amount of work about 5½ per cent.

When it comes to figuring out the maximum amount of work which can be realized per heat unit in steam with expansion, we must multiply 144 by the total pressure in pounds per square inch, by the volume compared with that of water of maximum density, and by 2.31 times the logarithm of the stroke of the piston, divided by the period of full steam, plus 1; and divide this by the same elements as before, the heat units per cubic foot of steam from 32° to the temperature of the steam used and the volume of the steam compared with that of water at 39° Fah.

This is a very "long-winded" rule and is much better expressed by a formula:

$$E = \frac{144P(V-1)(2.31 \log. S + 1)}{HV}$$

Instead of 2.31 times the logarithm of the relation between full stroke and the time of full steam, the expression "hyperbolic logarithm" may be used.

To work out a couple of examples under this rule and formula: Suppose that we have steam as before of 60 pounds pressure above vacuum or about 45 pounds by the gauge; and that the cut off is at ¼ the stroke. Leaving out clearance and all other disturbing and complicating causes, we get the following:

$V - 1 = 427.32$

1 + hyperbolic logarithm of 4 = 2.38629

$H = 170.58$. Then we have

$$\frac{144 \times 60 \times 427.32 \times 2.38629}{170.58 \times 428.32} = 120.58$$

which is, of course, just 2.38629 times the result that we got with steam at 60 pounds and no expansion.

Now, trying steam at 120 pounds pressure above vacuum, we have

$$\frac{144 \times 120 \times 226.56 \times 2.38629}{325.20 \times 227.56} = 126.2$$

or, of course just 3.38629 times the proportion where there was no expansion but the same pressure above vacuum.

Now we will try cutting off at ⅛ instead of at ¼. The expansion ratio is 8, the hyperbolic logarithm of which is 2.0794, so that we shall have with eight-fold expansion, 3.0794 times the duty that we had without any expansion.

We may compare these six results with advantage:

| | Proportion of work Realized. | |
|---|---|---|
| | 60 lbs. Pres. | 120 lbs. Pres. |
| No expansion at all | 6.5 | 6.8 |
| Four-fold expansion | 15.6 | 16.3 |
| Eight-fold expansion | 20.1 | [illegible] |

## HEATING FEED-WATER.

THERE is something very remarkable in the slowness with which steam users recognize the great saving they may make in their weekly coal bill by the use of feed-water heaters. In many places the gain, which might be secured at no very great outlay, would make all the difference between a dividend and no dividend. At a meeting of a paper manufacturing company a short time since, it was mentioned that this one firm used 200 tons of coal per week, and that the recent increase in the price of coal made an increase of £2,600 per year in the fuel bill, which made a reduction of 4 per cent. in the dividend, or from 12 to 8 per cent. This is only one of many works whereat such large quantities of fuel are consumed, and it is well-known to engineers that it is the exception rather than the rule to heat the feed water on its way to the boilers. Yet by this means some firms are making a saving which represents a large income. A very moderate estimate of the value of a heater which raises the feed-water from a normal temperature to about 200 degrees, is the saving of 10 per cent. of the fuel used. This, where coal costs a £1 per ton, and where, as in the above case, 220 tons per week are used, represents a yearly saving of £1,250 per year; or probably a dividend of from 50 per cent. to 60 per cent. per year on the capital expended on the feed water heaters. *The Engineer.*

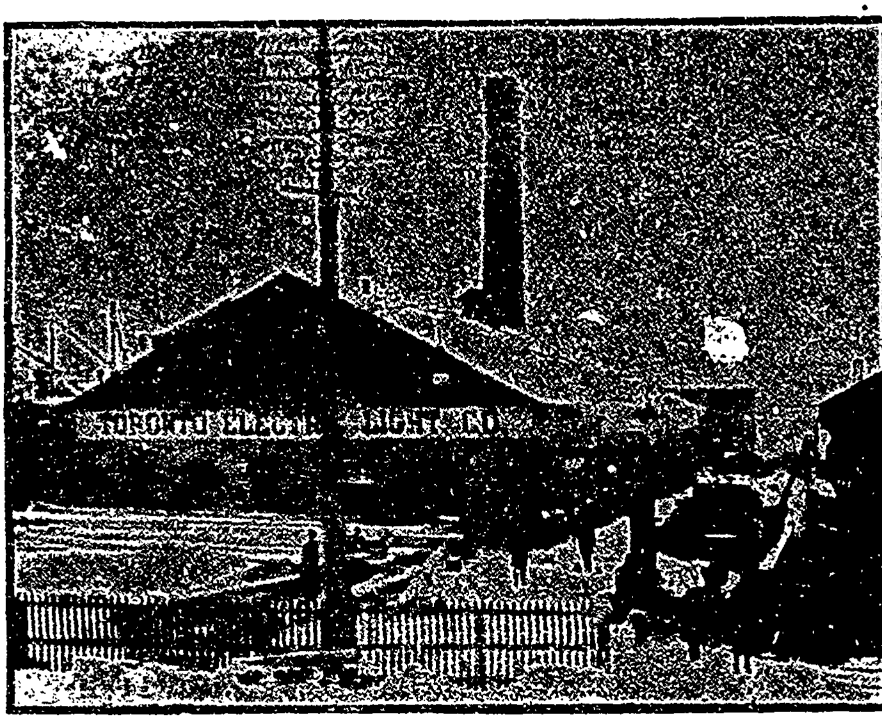
In the recent technological examination in England in which scholars compete, it is a sign of the times that electric lighting attracted more than twice as many as telegraphy.

## TORONTO ELECTRIC LIGHT COMPANY.

The above company was incorporated on the 25th day of September, 1883, but since then its constitution has undergone several important changes.

The present officers of the company are: Mr. A. H. Campbell, President; W. H. Howland, Vice-President; Samuel Trees, Treasurer; H. M. Pellatt, Secretary, and J. J. Wright, Manager, with a board of nine directors, viz: Hugh Blain, A. H. Campbell, W. H. Howland, John Leys, S. F. McKinnon, H. M. Pellatt, Samuel Trees, F. B. Polson, and Thomas Walmsley.

The first year the company commenced by making a number of commercial lights for use in hotels and larger business houses, and the year following supplied the street lights for Yonge, King and part of Queen streets. To-day they are illuminating all the principal streets in the city, and in some cases beyond its limits. The company claim to have the most efficient electric plant in Canada, and they certainly possess the finest and most powerful engines in the city of Toronto. The original plant of the company, consisting of Excelsior and Thomson-Houston dynamos, was erected in a building on Sherbourne street, but it was found that larger premises would be required. Consequently the present site on the water front at the foot of Scott street was purchased, and many important new features added to the works.



The company manufacture all their own plant, having every facility for constructing their own machinery, dynamos and lamps, according to the latest and most approved practice.

On the north side of the boiler house there are six 100 h. p. boilers built by the Polson Iron Works Co., and on the south side seven more of a similar capacity, one of which is opened and cleaned out each day in turn. The consumption of coal varies very much at this season of the year, depending upon the number of lights in use, the average being from 20 to 25 tons per day. At the east side of the boiler house is the smoke stack, a pile of masonry towering 110 feet high, the inside diameter of which is five feet. The chimney, boiler, and engine houses all stand on very deep, solid foundations built upon piles driven down 25 feet to the rock. A little farther south is the machine shop, in which about 25 men are employed as blacksmiths, machinists and carpenters. Here there are various kinds of lathes, milling machines, planers, drills, screwing machines, rack and gear cutters, and other special machinery used in the construction of dynamos and lamps. Work has here been commenced on the materials, including junction boxes, manholes, etc., with which to construct a system of underground iron conduit, but this work cannot be carried on to any great extent at present owing to insufficient accommodation, and on account of the increased demand for city lighting under the new contract. In order to meet these requirements the company are extending the docks out into the bay as far as the "new windmill line," so as to provide room for the erection of additional workshops.

In an upper room over the machine shops is a special new feature of the construction department—braiding and winding machines, which are used for insulating the copper wire. There are several men and boys employed at this work, and in scraping the old braiding off wire that has been in use and requires re-insulating.

The engine house is a spacious one, and contains two pairs of high pressure condensing engines of 500 h. p. each, and two pairs of compound condensing engines of 500 h. p. each. These engines are of the Brown-Corliss type, and were manufactured by the Polson Iron Works, of Toronto, their flywheels measuring 15 feet in diameter and weighing over 10 tons each; there are four belts on these flywheels, each measuring 110 feet in length by 38 inches in width, supplied by Messrs. F. E. Dixon & Co., of this city. In the same room are three Worthington steam pumps for feeding the boilers and for fire purposes. The steam and vacuum gauges and other indicators are all mounted on an ornamental board in the centre of the engine house, so that the engineer in charge can observe at a glance the condition of the various engines in operation. Everything is kept in the best of order, being a pleasant and interesting sight for anyone to witness, and reflecting the greatest credit on those employed there.

The shafting house is on the same floor as the engine house, but is divided by a partition. From this room the tremendous power of these gigantic engines is transmitted to the dynamos on the floor above. In this room there is also a 50 h. p. engine which generates the electricity for lighting the works.

In the dynamo room there are 48 dynamos, each having an average capacity of 35 lights, and nearly all of which have been manufactured on the premises. There are at present in the city over 1,000 electric lights, and the new contract calls for nearly 500 more. At the north-end of this room is located a switch-board by means of which connections are made between the dynamos and the circuits. At the back of this room, and alongside the offices, is another large room in which is being erected a new pair of compound engines of 500 h. p., to meet the increased demand for lights which will come in operation at the beginning of the new year. In the office there is a switch-board for testing the various circuits during the day or at night when in operation. The lines are tested every few hours during the day, so that all crosses, grounds or breaks are discovered and remedied at once. The outside plant covering the city consists of over 250 miles of copper wire.

The company have a system of telegraphy for the use of the patrol and linemen at their various stations in different parts of the city. By means of these facilities constant communication can be made between the men at their stations and the works. The company's old contract with the city of Toronto expired with the year 1890, and a new one for 5 years goes into operation immediately.

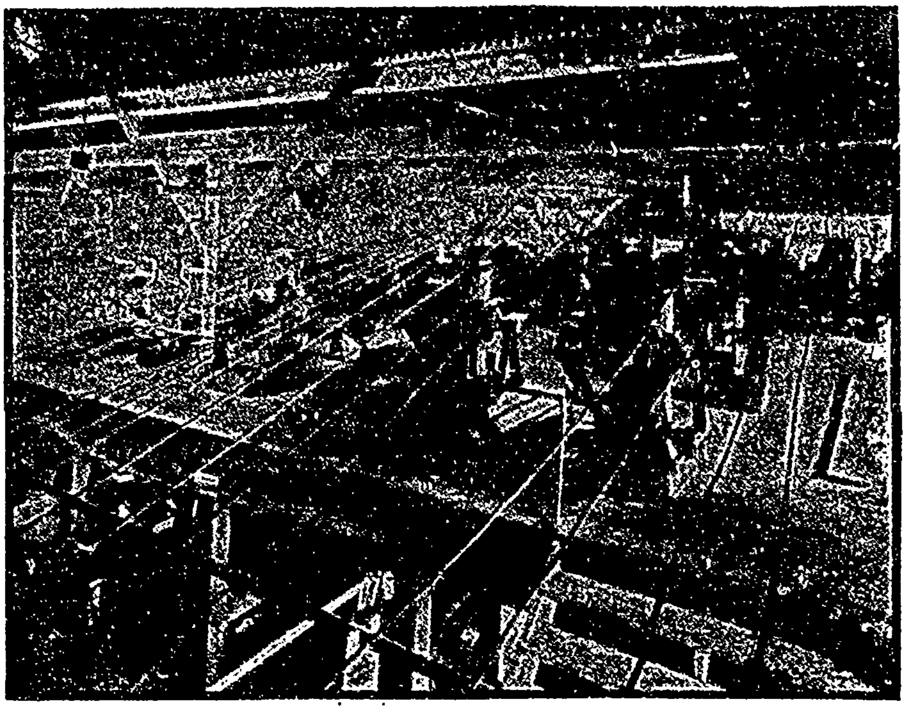
## PUBLICATIONS.

The publishers of "The Electrician" Electrical Trades Directory and Hand Book, Salisbury Court, Fleet street, London, E.C., inform us that the edition for 1891 of this carefully compiled and valuable budget of information will shortly make its appearance.

A Buffalo despatch of December 8th says the Brush Electric Company has recovered judgment for $412 against the Hamilton Ont., Electric Light Company and R. M. Wanzer & Co., in the Supreme Court, being for the same cause of action on which judgment had already been obtained in a Canadian court.

## A NOVEL FORM OF MEASURING INSTRUMENT.

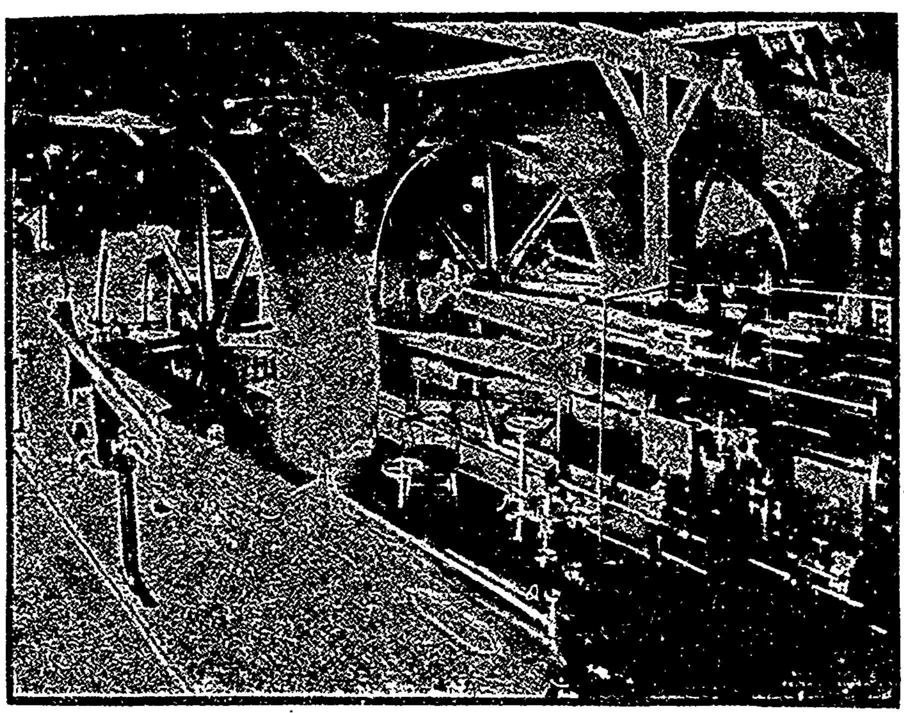
In a recent issue of *La Lumiere Electrique*, M. F. Leconte gives a brief account of some experiments carried out by him at the Liege University with a view of testing a curious form of electrical measuring instrument. M. Leconte's idea is to make a pile of circular iron discs, interposing some springy substance, between each disc, and to place this pile inside a solenoid. When the solenoid is traversed by a current, the pile of discs tends to contract owing to the formation of unlike magnetic poles at the opposing surfaces of the discs. This contraction is resisted by the springs, and by means of a suitable magnifying device the movement of a pointer along a suitably graduated scale enables one to read off the volts or the amperes. M. Leconte employed discs ranging in number from 18 to 60, in diameter (1 mm.=40 mils) from 20 mm. to 65mm., and in thickness from .2mm. to 8mm. Some of the substances employed as springs were watch-spring steel, blotting paper, packing paper, ordinary paper, flannel and black indiarubber. The tendency of the discs to move sideways was checked by punching holes through them and slipping them over vertical glass rods. The sensitiveness of such an apparatus can be increased either by adding to the number of the discs, augmenting their surface, or by providing the solenoid with a core of iron wire. M. Leconte gives curves of the scale readings obtained with a voltmeter arranged with 18 cast-iron discs, 8mm. thick, and 65m. in diameter, and provided first with indiarubber springs and then with steel springs. The curve in the first case was fairly regular between 27 and 53 volts, with steel springs the curve was very irregular, with indiarubber springs the deviation of the scale index was only 18mm. for 57 volts, and the actual contraction of the column of discs was only 2mm.; with steel springs the index deviation was only 8mm. for 50 volts.



Toronto Electric Light Company—View of Dynamo Room.

## THE LUBRICATION OF STEAM ENGINES.

The following is extracted from an interesting article on this subject which appeared in a recent issue of the *Engineer*. Engineers very commonly pay scant attention to the cost of oil used in lubricating steam engines. They regard it as an insignificant item. Even those who pay for the oil take small pains to ascertain whether they are paying more than need be paid. The results of an inquiry into the question of oil bills in any district would, we venture to say, give highly startling results. Not long since we were shown an American engine of the horizontal high speed type. It was indicating about 13 or 14 horse-power. Coal was very cheap, and we were told that the cost of fuel was as nearly as might be 1s. 6d. per day. The oil bill was 3s. 6d. a day, or more than twice the cost of coal. In another instance we found an engine indicating about 1,500 horse power and using 120 gallons of oil per week. Again we find in some cases that oil costing 2s 6d per gallon is used, in others, for just the same class of work, about 9d a gallon is paid. It will readily be seen that a lavish use of oil at 2s. a gallon runs into a great deal of money. It is high time, we think, that more attention was given to this subject than has hitherto been devoted to it by users of steam machinery. The chief causes of excessive oil consumption are, says our contemporary, firstly, that engineers or drivers in charge of engines care nothing about oil waste, secondly, badly designed or badly kept engines, thirdly, unsuitable oil, fourthly, running in dusty places, fifthly, defective lubricating apparatus.



Toronto Electric Light Company—View of Engine Room.

The G.T.R. Co. have recently commenced to heat their Lachine train with steam from the locomotive.

Messrs Phippen & Graham, Belleville, intend compounding the engine of the steam barge Saxon and putting it into a new hull, to be built at Pictou at a cost of 22,000.

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*EDITOR'S ANNOUNCEMENTS.*

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

## SALUTATORY.

THE general character of this journal, as well as the objects which it will seek to promote, will to a large extent be revealed by an examination of this first number. We are consequently under obligations to say but little by way of preface. The electrical industry is one of great importance in Canada, the installations at present numbering between four and five hundred, and electric lighting and power plants being daily installed in every part of the country. They may shortly be found in almost every manufactory, and in every large building. Side by side with them will be the steam engine and boiler, from which must come the power to generate the electricity, and furnish steam for heating. Upon the steam engineer will devolve the duty of operating the electric as well as the steam apparatus. It is because electricity and steam are destined thus in future to be so closely allied, that we are led to hope for the complete success of the paper in its new form. We are strengthened in this opinion by the hearty assurances of support which have already come to us from the various electrical companies, and from officers and members of the Canadian Association of Stationary Engineers.

Arrangements have been made whereby gentlemen recognized in Canada as authorities on the subjects of electrical and steam engineering will contribute liberally to the pages of each number.

Recognizing how many persons there are in charge of electric plants at the present time who have had little opportunity of gaining a proper knowledge of the principles of the science and their application, a special effort will be made to supply such information. It will be seen that in the present number has been commenced a series of articles giving the primary data with which the student needs to be thoroughly familiar before he attempts to acquire the higher standards of knowledge. To those who may happily have got beyond the rudimentary stages, it may seem like beginning too low down the scale to print information of this character, but we believe that to the majority of persons operating electric plants in Canada to-day it will prove welcome and helpful. It was thought well to begin thus at the very foundation, and after having placed the student in possession of a knowledge of the underlying principles, to lead him from thence onward to higher attainment. In view of this purpose, the persons into whose hands this paper may come, and who may be in need of this class of information would do well to become subscribers at once and thus secure possession of the entire series of articles.

In endeavoring to educate those charged with the operation of electric apparatus, we shall be conferring benefit also on the owners, inasmuch as upon the knowledge and consequent efficiency of the operator depends to a large extent the dividend which an electric plant may be made to render. It is safe to say that some of the plants in Canada to day are not yielding a fair profit to the owners because the persons in charge are unable through lack of knowledge to obtain from them the highest efficiency of which they are capable at the least cost

A Canadian Electrical Association, where owners and operators of electric apparatus might meet and consider the many questions affecting their interests, is a present necessity, and no effort will be spared on the part of this journal to bring about its early formation.

The Canadian Association of Stationary Engineers we believe to have been founded on right lines, and to be doing a grand work in the direction of raising the standard of efficiency not only of its members, but of engineers generally It must be acknowledged that there is great necessity for a higher average qualification than that which at present exists. With the increasing number of steam plants coming into use in connection with the heating and lighting of large buildings, the danger to life from improper management is vastly greater than ever before, hence the greater necessity for fully competent engineers

Many persons operating steam engines have as yet refrained from connecting themselves with the Association. We hope to see the number speedily grow less, as we believe such persons would best promote their own interests by joining the Association and assisting to bring about the objects sought to be attained.

In conclusion, the columns of this journal will be at all times open for the expression of opinions of its readers on any subject relating to electricity and steam engineering. Correspondents will be expected to observe brevity of expression, and avoid personalities. As far as we are able, we shall be pleased to answer questions on any subject which may legitimately come within the scope of this journal.

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A NOTEWORTHY result of the rapid introduction of electricity in its various forms of light and power is the high standard of knowledge and intelligence required of the mechanical engineer. Formerly any man or boy who knew enough to throw on coal and sling a pot of hot tallow was considered abundantly competent to "run the engine," and as long as the engine "ran" with tolerable punctuality he was doing about all that could be reasonably expected of him. The evolution from this state of things has been almost as rapid as the introduction of electricity itself. Hand in hand with the progress of electrical development has gone the improvement of the steam engine, and machines are placed in the hands of the engineer of to-day comprising a complexity of mechanism and employing a pressure of steam such as his predecessor of the tallow pot could have had no conception of. This alone would call for a higher intelligence and greater skill on the part of the manipulator, but the fact that the forces of steam and electricity have become so allied and interwoven—one depending so much on the other—would indicate that something even more than this will be required of the modern engineer. Every factory in which steam power is employed to any extent now has, or will have, its electrical plant for lighting and for the transmission of power, so that it has become necessary that he should understand at least some of the principles of dynamo-electric construction and operation, and have some knowledge of the laws which govern the production and distribution of electric currents. The introduction of high-pressure steam with the principle of expansion carried to its utmost limit requires an amount of theroetical and practical knowledge heretofore not considered essential, so that for the thoroughly capable and aspiring engineer who is able to grasp all this, and besides has a sound practical knowledge of electricity, there is a constantly widening field. In isolated plants there is a demand for him. Central stations for the distribution of power and light are increasing in number and extending their operations, and the extension of electric railway systems will in the near future offer unexampled opportunities. In this, as in other walks of life, the best men, will rise to the top, and the painstaking, intelligent and careful engineer will rank amongst society's most useful and respected members.

THE cost of electric apparatus to-day is very much below what it was five, three, or even two years ago. This is due in part to the growth of competition amongst manufacturers, and in part also to the discovery of improved methods of manufacture. Whether or not cheapness has in any measure been attained at the expense of quality, we are not in a position to say. The purpose is simply to point out the disadvantagous position in which the owners of plants purchased a few years ago now find themselves as the result of the fall in values. It is demanded of them that their prices shall correspond with those prevailing in neighboring towns, where the plant was bought for a much less sum, and where, consequently, a smaller revenue will suffice to meet interest charges and return a fair dividend. To this cause is attributable the fact that so large a proportion of central station plants are being operated with little profit. Another important facter in the way of dividend earning, is the absence of economy in operation of electrical circuits, due to lack of properly qualified superintendents. The ELECTRICAL NEWS will do what it can to place in the hands of those in charge of electrical plants, information which will assist them to obtain the highest degree of efficiency at the smallest cost.

THE year just closed has been a busy one for the electrical industries of Canada. It has been marked by a large increase in the introduction of isolated installations in private factories and steamships, and extension in the plant of every central station of any size in the Dominion. The city of Montreal led the way in the exclusive adoption of electric lighting for its streets and squares. The Royal Electric Company there have built extra stations of immense power, and have kept their factory busy on plant for these extensions for a year past, besides a large amount of construction work in isolated installations, notable among these being the passenger steamships of the Allan Line. Quebec has extended its service by the introduction of large incandescent machines on the alternating principle, driven like their predecessors by the power of Montmorency Falls fourteen miles away. In Toronto the progress has been most marked, the city having closed a contract for five years for an additional illuminating capacity of 400 lights. The shops of the Toronto Electric Light Company have been in full operation, night and day, for months past, constructing the necessary machinery for this extra work, and the engine and boiler industry in the city has received an immense impetus in satisfying the demands for more power. A new station has been started in the city for the supplying of incandescent light on the Edison system by means af underground wires, and the local construction companies have been busy keeping up with the demands of their stations in all parts of the city, besides installing a considerable number of new ones in public institutions and for private customers. The present year promises to eclipse all previous records in electrical construction. Many public institutions have under contemplation the introduction of electric plant. Central stations must try to get ahead of the demand for light which they are now unable to satisfactorily meet, and the distribution of electric power is as yet almost untouched. The contemplated introduction on a large scale of electricity for street railway purposes and a large amount of underground work by telephone and telegraph companies will combine to make the year as busy a one as any we have known. The industry of carbon making, though an infant one, is giving promise of a sturdy growth, and the manufacture of insulators and globes is becoming a well established and profitable branch of the glass making industry. Altogether we look for a prosperous year. That it may prove so is our earnest wish, and to make it a matter of record we hope may be the agreeable province of the ELECTRICAL NEWS.

THAT the schoolmaster is abroad is evident from an article which appeared in a Toronto evening paper under the heading of "A feasible scheme." It is there suggested that the proposed gravitation plan for supplying the city with water should also include its utilization on its way down from Lake Simcoe to produce power for the generation of electricity and other purposes. So far this is perfectly "feasible," but when the promoters gravely propose as a result of using this power "to put an electric light on top of every lamp post, to run all the street cars in the city, and supply power to an unlimited extent for manufacturing purposes" they are letting their brilliant imaginations get a long way ahead of their knowledge. A few figures will demonstrate this. The estimated consumption of water in Toronto is now about fifteen million gallons per day. Sixty millions per day is figured as the amount that can be made available, and as sufficient for the city's needs for many years to come. The utmost fall that could be obtained even in sections all along the line of conduit would not exceed 250 feet. Sixty millions per day would be 42,000 gallons per minute. This multiplied by 10, the number of pounds per gallon, and by 250, the height in feet, and divided by 33,000, the number of foot pounds representing one horse power, would give a sum total of 3,100 h.p. The loss in transmitting this at a tension suitable for electric power and railroad work would be at least 50 per cent., while the interest on the expense of copper conductors would amount to nearly as much as fuel for a steam engine on the spot. There is over 1,500 horse power now used in the city for the electric lights alone at present in use, to say nothing of "the top of every gas post." To the mind of the practical man the scheme is utopian in the last degree, but its promulgation and unquestioned acceptance in many quarters goes to show the need there is of a popular educator for the masses in the first rudiments of electrical and mechanical principles. Of course we cannot expect every one to be learned in the precise sciences, but now that electricity is rapidly becoming a household word, and is being utilized in so many of the operations of everyday life, it becomes a necessity that every man who desires to keep himself informed on current events should be acquainted with at least some of its first principles and economic values. Its rudiments should be taught in our schools, and periodicals bearing upon its progress should be allowed to claim at least an equal share of attention with the best on any subject from those of our mechanics, business men and citizens who aspire to become acquainted with every factor of our modern civilization.

IF ever there was a crying need for an underground conduit for electric railways that need is felt to-day. Improvement upon improvement has been made in the cars, the track, and especially in the motor and electrical outfit. Their success is a tangible and solid reality. The electric method of propulsion is practicable beyond a doubt, but the full and complete fruition of its success will not be realized until the unsightly and cumbrous overhead construction can be done away with. It would seem to the tyro a simple matter to lay a trench to contain the wires with a slot on top to enable the car to make a wiring contact with it at any point in its progress, but the fact remains that the more it is tried the more frequently and emphatically are its difficulties demonstrated. Wet, or even dampness—the arch enemy of the electrician—are fatal in the case of the open conductor such as must be employed to admit of contact with the moving motor. A perfectly insulated conductor in a closed conduit and carrying an alternating current intended to work the motor by induction has been proposed—something similar in principle to the telegraph employed on moving trains—but it is evidently a case of "the wish being the father of the thought" and we should not feel disposed to squander much wealth on the patent of the scheme. Another proposition to overcome the difficulties of a conduit and to reduce the leakage to a minimum is to employ a sectional conductor, a short length only being automatically placed in communication with the main insulated conductor while the car is upon it, and disconnected as the car leaves it and enters upon the next one ahead. The chief objection to this plan would seem to be its complexity and liability to derangement at most critical times. The storage battery is at present a forlorn hope, yet it would be idle to say it will never be made commercially available. It must, however, be radically improved before it can be. Though at present it may be a somewhat forlorn one yet we *do* hope that the storage battery will be the coming solution of the problem. The advantage of having the car carry its motive power along entirely independent of connection with anything else and able to run on any track at present constructed would be a consummation devoutly to be wished. Its success would place the electric car upon the tracks of every street railroad in the Dominion, and our larger cities which now hesitate on account of the objectionable overhead construction, would rejoice in the fulfilment of their desires. The next best method not open to so much objection would be the conduit, providing it can be successfully accomplished. Some of the foremost of the construction companies are working at the problem with all the skill at their command. Let us hope that every success may crown the efforts of some enterprising inventor, and then the electric railroad on our busy streets would become a thing of beauty and a joy forever.

## ON ERRORS IN BOILER TRIALS.

MANY engineers and experts, in making boiler trials, measure the weight of fuel, the weight of water, and the other quantities, without paying the slightest attention to the relative accuracy with which these quantities should be determined. The object of this article, from the *Locomotive*, is to show that such considerations may be of importance when a very accurate result is required.

As an illustration of the point we wish to make, let us take the following example · At a certain boiler trial the amount of coal actually burned was 2,354 pounds, and the amount of water evaporated was 20,640 pounds. These figures give us an evaporative efficiency of 8.77 pounds of water per pound of coal.

Now let us assume that an error of 50 pounds was made in weighing the water, so that the apparent amount of water evaporated was 20,690 pounds, instead of 20,640 pounds, the actual amount. $20,690 \div 2,354 = 8.79$. so that the apparent evaporative performance of the boiler is 8.79 pounds of water per pound of coal, instead of 8.77 pounds, which is the correct result. The difference introduced by an error of fifty pounds in weighing the water, it will be seen, is only .02.

Now let us make a different supposition. Let us assume that the water was weighed correctly, but that an error of fifty pounds was made in weighing the coal, the apparent weight of coal being 2,304 pounds. Then $20,640 - 2,304 = 8.96$, so that the apparent evaporative performance of the boiler is 8.96 pounds of water per pound of coal, instead of the true result, 8.77 pounds. The difference in this case is quite appreciable, and the example shows that it makes quite a difference whether a given error is made in weighing the coal or in weighing the water.

The moral of this is, we suppose, that we should pay particular attention to the weighing of the coal. The scales should be very accurately balanced for the weight of the barrow, and the readings should be taken closely. The value of the kindlings, expressed in pounds of coal, should also be carefully ascertained. Furthermore, if we wish an accurate estimate of the evaporation per pound of *combustible*, we should be very careful about wetting down the fire after it is hauled; for the error introduced by the weight of the moisture in the ash produces as great an effect on the result as an equal error in weighing the coal.

The ideal way of carrying out a test is to make all the measurements in such a manner that the error committed in making any one of them shall have the same effect on the result as the error committed in making any other one. The principle is the same, to use an excellent but threadbare illustration, as in making a chain. Don't make one link any stronger than any other one, for if you do you are wasting labor. This can be achieved in evaporative tests by weighing the coal with 8 or 9 times the accuracy used in weighing the water, the ordinary evaporation per pound of coal being from 8 to 9 pounds. Of course we do not mean that this should be done with any very great degree of precision, but what we do mean is that the water should be weighed with ordinary care, and the coal with ordinary care.

Another very necessary operation in testing evaporative efficiencies, is the determination of the dryness of the steam generated. The ordinary method of conducting this part of the work is described in *The Locomotive* for March, 1890, on page 35, and to this description we would refer the reader. In the place of the steelyards there shown, a spring balance of some sort is often used. This should never be done unless the spring balance is of special construction, so as to weigh very accurately. The ordinary spring balance will not weigh closer than an ounce—or, at the outside, half an ounce. The total weight of *steam admitted being 16 ounces, half an ounce is one thirty*-second of the whole amount, and an error of one thirty-second in the amount of steam admitted will produce approximately the same effect as an equal error in noting the rise in temperature of the water in the pail. For instance, let us suppose that a given sample of steam actually contains 3 per cent. of moisture, but that we *have* admitted 16½ ounces of steam, when we think we have admitted only 19 ounces. The error, half an ounce, is one thirty-second of the whole amount. The rise in temperature would have 102° Fah. if we had really introduced only 16 pounds; but the real rise in temperature will be one thirty-second greater than this, since we have introduced one thirty-second more steam than we think we have. A thirty-second of 102° is 3°, which added to 102° gives 105°; and this is the *actual* rise in the temperature of the water in the pail. Thus we see that although the steam really contained 3 per cent. of moisture, the error of half an ounce in the weight of the pail would make us conclude that it was absolutely dry. The moral of this is, that there is no use in measuring the rise in the temperature of the water to within one per cent., if we are going to commit an error of at least three per cent., and perhaps six per cent., in weighing the water.

We may call attention here to another error that one is liable to, in determining the dryness of steam by the ordinary method —an error that at first sight seems quite insignificant. When the steam is still entering the pail, and the steelyards are approaching equilibrium, the easiest way to secure an accurate balance is to leave the pail in position, with the steam pipe still dipping below the surface of the water, and close the valve just at the right instant. The final weighing is thus performed with *the steam-pipe submerged; while ordinarily the ten pounds of* water originally put in are weighed without the steam-pipe. For the sake of investigating the effect of this let us assume that the pipe dips 5 inches below the surface of the water, and that the area of its cross section is half a square inch. When in position, therefore, it displaces 2½ cubic inches of water, and therefore increases the weight of the pail and contents by nearly an ounce and a half. It will be seen from this, and from the previous calculation of the effect of an error of half an ounce, that it is a highly important matter to have the steam-pipe dipping into the pail when the original ten pounds of water are weighed out. The most satisfactory way is to make a suitable mark on the pipe, and bring this mark to the level of the water in the pipe whenever a weighing is made.

## VARIATIONS IN THE E. M. F. OF CELLS.*

THE description of the apparatus, the capillary electro-meter, and method of working are given fully in the paper. The following conclusions are drawn from the results of the experiments:

I. When the metals, copper, silver, bismuth and mercury, are introduced into purified nitric acid of different degrees of concentration, and a couple made with platinum, the E. M. F. of such a cell increases considerably from an initial point until it reaches a constant and in most cases a maximum value. The rise of E. M. F. is attributed to the production of nitrous acid by the decomposition of the nitric acid, and the final value is considered to be due to the former acid only, while the initial value is due for the most part to the latter acid, though it is affected to a remarkable degree by the amount of impurity of nitrous acid, either initially present or produced by minute and unavoidable uncleanliness of the metallic strip and the containing vessel.

II. If nitrous acid has been previously added to the nitric acid, then the maximum E. M. F. is reached at once.

III. If the conditions—namely, increase of temperature, of impurity, and of concentration of acid—are such as would favor a more rapid solution of the metal, and consequently a more rapid production of nitrous acid, then the rise of E. M. F. is concomitantly more rapid.

IV. Conversely, if the conditions are unfavorable to the production of nitrous acid, the rise of E. M. F. is less rapid.

V. If any substance, such as urea, be added which would tend to destroy the nitrous acid as fast as it may be formed, then the rise of E. M. F. is extremely slow, being dependent upon the number of molecular impacts of the nitrous acid upon the surface of the metal. Thus, the results obtained by the electrometer are confirmatory of those obtained by the latter author with the chemical balance.

The authors propose to carry on further investigations on kindred problems.

*Abstract of a paper on "The Variations of E. M. F. of Cells, consisting of certain Metals, Platinum and Nitric Acid," read by Messrs. G. J. Burch and V. H. Veley, University Museum, Oxford, before the Royal Society, Nov. 27th, 1890.

## NOTES.

Mr. John Thomson has been appointed inspector of boilers and machinery for the province of British Columbia.

When wood is to be the fuel employed under a boiler, the grate area should be from 25 to 40 per cent larger than if coal is to be used.

The Steam Boiler and Plate Glass Insurance Co., recently organized at London, Ont., has made application to Parliament for incorporation.

Mr. Frank Doty, of the Doty Engine Co., and Mr. Reid, of the firm of Reid & Currie, Toronto, recently paid a visit to the Northwest and British Columbia.

At a recent meeting of the executive committee of the Stationary Engineers of Montreal it was decided to amalgamate with the Canadian Association of Stationary Engineers.

Much regret is felt throughout western Ontario at the recent death of Mr. Geo. Marks, of London, who for thirty-five years was a locomotive engineer on the Great Western division of the G.T.R.

The Canadian Locomotive and Engine Co., of Kingston, are building two locomotives for the Chignecto Marine Transit railway which will weigh 100 tons each, and will probably be the largest locomotives in the world.

Aluminum wire is being used for calking steam pipes in New York with good success. A wire of ⅛ inch diameter is used, one turn of aluminum wire being first inserted, followed by four or five turns of a lead wire of slightly larger diameter, these last being calked in the usual manner. It is found that aluminum does not cut, and is not acted upon by the steam as the lead is, so that joints remain tight much better.

Recently experiments have been made with high pressure steam to determine its dryness, in which a match is held in the issuing jet. Where the steam is dry the match will ignite, but any moisture will, of course, prevent it. It is an indication merely of the state of the steam issuing, which may be dry through wire drawing, while in reality wet when it leaves the boiler. Whether or not steam is wet is a matter of importance to the engineer when testing his plant. We note a number of boiler tests reported recently showing exceptionally good work in which no account was made of the moisture. It makes a great difference whether you evaporate all the water put into a boiler or send a portion of it through the engine without ever being made into steam.

Steam gauges are often placed in queer places, and, in many instances, without regard to the necessity of following certain directions in setting them up. *The Locomotive* reports finding steam gauges so arranged that their indications are necessarily a number of pounds in error, owing to the static pressure of water of condensation in the connection. While the error does not ordinarily exceed two or three pounds, it sometimes is far greater than this, and becomes of grave importance, especially in low-pressure systems. We met with a case recently in which an ordinary heating boiler was in the basement, and the gauge was in the owner's room on the third floor, fully twenty-five feet above. The piping was so arranged that it was an easy matter for it to fill up with water condensed from steam, so that the indication of the gauge might be as much as ten pounds less than the actual pressure in the boiler. Such a gauge, it need hardly be said, is no better than none at all. In fact, it becomes a positive source of danger.

A paper was recently read before the Halifax, N.S., Institute of Science, by D. W. Robb, M.E., of Amherst, on "Steam Boiler Tests as a Means of Determining the Calorific Value of Fuels." The author said there are three methods of determining their calorific value—(1), by chemical analysis, (2), by the use of the calorimeter, (3), by direct measurement of the water, evaporated by a definite amount of fuel in a steam generator. He pointed out the difficulties and sources of error in the first two. The third is generally regarded as a test of the efficiency of the generator, but experience shows that it is quite as valuable for determining the calorific value of a fuel. In using it there are two sources of error—(1), through imperfect combustion of the fuel, (2), through escape of gases at a high temperature. Practically these errors may be largely excluded, experience showing that almost perfect combustion may be secured by careful stoking, and that the gases may be reduced to a known minimum temperature before escaping and may be made to register their volume on escaping. It is not of much consequence what kind of generator is used, a water-lined furnace being quite as good for the purpose as a brick furnace. Steam boiler tests are quite within the reach of ordinary consumers and should be more generally used. Owing to the deterioration of boilers they should be made frequently. They may be made by ordinary assistants, but an occasional test should be made by a professional engineer. The author suggested as good practice in the use of steam engines, the recording of the amount of water used by a water meter and the regular weighing of the coals consumed. Such practice would indicate constantly the condition of the boiler, would form a check on the working of the engine and would furnish a constant incentive to the men in charge to improve the working of the engine and reduce the consumption of fuel to its lowest limit. Detailed statements were given of the way in which such tests should be made and of the manner in which the results should be registered.

## PERSONAL.

Mr. Rosebrugh, B.A., an honor graduate of Toronto University, and also a graduate of the School of Practical Science, Toronto, has been engaged by the management of the latter institution to give a portion of the instruction in mechanical engineering and take general charge of the testing machines, experimental engines and other testing apparatus. Mr. Rosebrugh is said to have devoted much attention to the subject of electricity.

## RECENT CANADIAN PATENTS.

No. 35323. Jas. F. McElroy, Pressure regulator.
No. 35335. J. Blair, Connecting carbon pencil.
No. 35337. M. Burt, Galvanic battery.
No. 35349. T Stetson, Insulating conductor
No. 35358. J P. Hebendalt, Elevating and lowering electric light
No. 35372. W. Blakely, Engine lever and handle.
No. 35391-10. G. Weems, Moving goods by electricity.
No. 35400. G. Pfaukuche, Dynamo.
No. 35406. A. Woodbury, Air current.
No. 35438. J. Van Depoele, Pulsating electric generator.
No. 35449-20. R. Earle, Air and steam injector.
No. 35455. Jos. Van Depoele, Pulsating current system.
No. 35456. " " Conv't'g cont. into pul.
No. 35457. " " Multiple cur. pul. gen.
No. 35458. " " Alternate cu. pul. gen.
No. 35459. " " Alternating cur. elec. recip'g engine.
No. 35460. " " Recip'g cur. elec. engine system.
No. 35475. H. Dow, Rotary steam engine.
No. 35478-22. F. Leadbeater, Low water alarm.

## STORAGE BATTERY STREET CARS AS A BUSINESS ENTERPRISE.

We learn from the New York *Electrical Review* that the Metropolitan Street Railroad Co., Washington, has decided to change the entire equipment of its main line from horse cars to storage battery cars. It is now building the first installment of cars and preparing to commence the erection of an extensive power station. This will be located on Rock Creek, between Washington and Georgetown, where the company some time ago purchased a large block of land adjoining its present stables. About 40 cars will be required on this line, and they will be put in operation, probably in lots of five, as fast as they can be got ready and as soon as the station is started. Engineer Mailloux's motors and gearing will be used. This part of the equipment is to be manufactured at Baltimore by Mr. G. W. S. Baker, president of the Baltimore Car Wheel Co., who has established a factory for the business. It is expected the first cars will be running in the course of three or four months. This undertaking has been decided upon after the most thorough and exhaustive investigation of the whole subject of street car propulsion and nearly a year's experimenting with Mr. Mailloux's invention and the Accumulator Co.s batteries. President Pearson is one of the most experienced and successful street railway managers in the country, and he has satisfied himself and his stockholders that they have caught up with the "motor of the future.

## TEMPERED COPPER FOR ELECTRICAL PURPOSES.

In the construction of electrical apparatus copper enters largely, and thus far nothing has been found which could, with any degree of success, be substituted for it. And not only in the construction of machines and appliances is it used, it is the material of which is composed the millions of miles of conductors for electric currents all over the world. For some purposes the ordinary, common, commercial copper is too soft, and wears away too rapidly, so to avoid this tempered copper has found its way into the market. Some recent tests of this material, made by the sub-committee on Science and the Arts, of the Franklin Institute, contain some points of interest to central station managers who are quite willing to have the best material for the commutators of their dynamos, and those who are engaged in the manufacture of electrical appliances. In this examination chemical tests were made showing the article in question to be commercially pure copper, and various tests were made—tensile, transverse, torsion, and compression of both tempered and untempered copper as well—the results generally being in favor of the former, though in some respects there is little to choose between them. Some interesting facts were brought out by letters sent by the committee to various users of tempered copper, about sixty-five per cent. of the answers being of a favorable nature: the greater part of these, too, basing their answers upon their experience with tempered copper for commutator segments and brushes. This point is of most interest to those using dynamo electric machines, and while tempered copper is no new thing it certainly possesses excellent qualities. Anything which will render the operation of dynamo machines and motors more economical is certainly of value, and will, in time, as has been the case with other new things, come into general use.—*Modern Light and Heat.*

## FACTS CONCERNING DYNAMO ELECTRIC MACHINES AND THEIR MANAGEMENT.*

A dynamo consists of the field and the armature. The field consists of the magnets, which are solidly connected with the iron frame. The magnet are iron cores, on which layers of insulated wire are wound. These magnets belong to the class of electro-magnets, as they become magnetic only when the current is passing through their coils. Between the poles of the magnet the armature rotates. The armature consists of an iron or steel shaft, to which a number of coils of insulated wire are affixed.

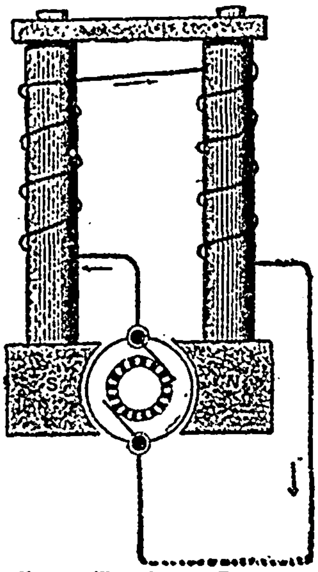


FIG. 1—THE SERIES DYNAMO.

Metal plates or bundles of wire called brushes conduct the current generated in the armature to the lamp circuit.

The two main types of dynamos are :

*A*, *The continuous current dynamo.* The current generated in this dynamo always flows in the same direction. The armature of this dynamo has a commutator from which the current is taken off by the brushes.

*B*, *The alternating current dynamo.* The current generated in this machine flows at rapid intervals first in one and then in the other direction. This dynamo has no commutator but simply a collector consisting of two metal rings on which the brushes rest. The magnets of the alternating current machine require, however, a continuous current for excitation. This current is

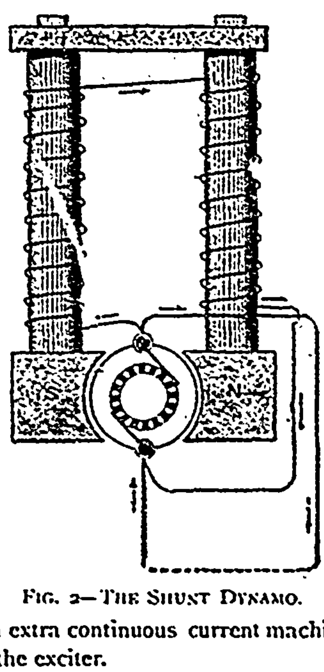


FIG. 2—THE SHUNT DYNAMO.

generated by an extra continuous current machine of small size, which is called the exciter.

*A*, The series dynamo, Fig. 1. Magnet, armature and lamp circuit are connected one behind the other, that is, in series; that is to say, the current generated in the armature passes in equal strength through field magnets and lamp circuit. These machines are mostly used for arc lighting.

*B*, The shunt dynamo, also called derived circuit dynamo. The coils of wire wound around the field magnets in Fig. 2, are connected in shunt or parallel to the brushes. Only a comparatively small part of the current generated in the armature is used for excitation of the field coils, while the greater part of the current is conducted from the brushes to the lamp circuit. These machines generally have a resistance box, rheostat or regulator which is connected in the shunt winding of the field. By putting

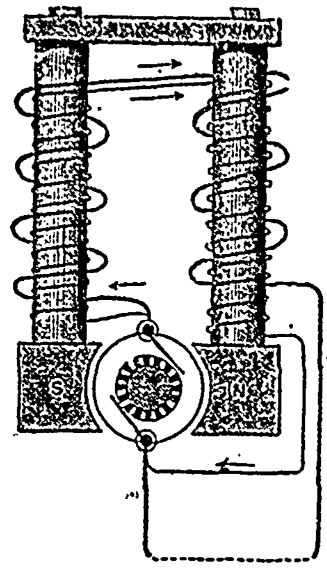


FIG. 3—THE COMPOUND DYNAMO.

more or less resistance in the field of these machines the e. m. f at the binding post of the machine can be decreased or increased. Shunt dynamos are mostly used for incandescent lighting. In some systems, however, they are used for arc lighting also.

*C*, *The Compound Dynamo.* This dynamo, Fig. 3, combines in its fields the winding of both the series and the shunt dynamo. The magnets are wound with thick wire, which is in series with the armature and the lamp circuit. In addition they have a winding of fine wire, which is in shunt with the brushes. This dynamo generally has a resistance box put in the shunt winding of the fields, for the same purpose as explained under *B*. Compound dynamos are mostly used for incandescent lighting.

The field wire coils of an alternating current dynamo, Fig. 4, have no connection with the brushes of the dynamo at all. The fields are separately excited, as mentioned in the foregoing, by a little continuous current dynamo, called an exciter. The alternating current machines were used formerly for arc lighting mainly—very little, however, in the United States—but recently have been introduced for long distance incandescent lighting by means of transformers or converters.

In the preparation of a new dynamo for operating, iron parts which have to be fitted to each other must be carefully cleaned

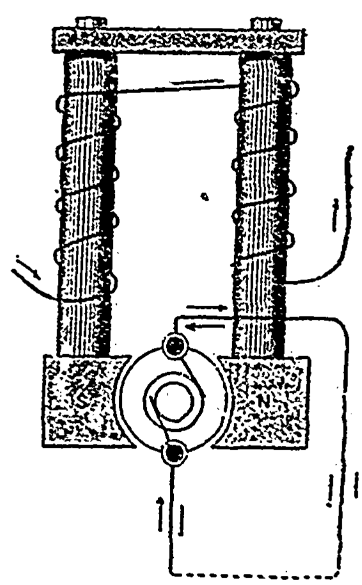


FIG. 4—THE ALTERNATING CURRENT DYNAMO.

with fine emery cloth. When the armature is put into the dynamo, extra precaution is necessary in order to avoid any injuries to the insulation of the wire and to the commutator. The armature should be carried by a man on each end of the shaft. Heavy armatures should be supported by a board put underneath the armature, and each end carried by an additional man.

* From the "Dynamo Tender's Hand-Book.

Armatures weighing over 500 pounds should be handled by means of a differential block and tackle.

An armature should not be lifted by its commutator.

Some soft material, such as cotton waste or felting, should be put between the armature and the support.

When put in place in the dynamo the armature must not touch the pole pieces and must turn easily. There should be at least from 1-16 to ⅛ inch play between its bearings. This play or lengthways motion can generally be regulated by adjusting the collar on the shaft.

It must be borne in mind that the armature will warm and expand not only diametrically but also lengthways. If there should be no play, the armature might get wedged between its two bearings and cause hot boxes and stoppage of the dynamo. A swinging motion of the armature will cause the bearing to wear evenly, distribute the oil from end to end of the bearings, and prevent heating of the boxes. An armature can be caused to play only when the dynamo is in proper alignment and the belt not too tight.

All connections through which the current has to pass should be cleaned with fine emery cloth and should not touch any part of the iron frame or field-coils of the dynamo.

It is advisable to run a new dynamo a few hours or even a day, without any load, in order to test the lubrication, etc., not only of the dynamo, but of the engine, if it should be a new one. If everything is in good condition the load should be put on gradually. This can be done, either by running the dynamo below normal speed and gradually increasing the speed, or by using the resistance boxes and starting with very little current and gradually increasing it.

The latter is especially advisable for incandescent lamp installations. The testing should be made during the day. It will require for small plants a few hours; for plants of greater importance a few days; only when everything operates in good order should the regular running of the installation commence.

Every day before starting the dynamo, the dynamo tender should examine the binding posts, commutator and brushes. If the brushes are allowed to rest against the commutator, the engineer should be careful not to reverse the motion of his engine when starting, as he would spoil the brushes.

Iron nails, bolts and small tools should be kept away from the dynamo, as they may be attracted to the machine and damage it.

Oil cans for filling the oil cups of the dynamo should be of non-magnetic material (brass or zinc).

The dynamo must be kept scrupulously clean, like any other expensive machine. Any good engineer or dynamo tender will do that without being told.

Copper dust, which will be caused by the friction of the copper brushes against the commutator, should never show; it should be cleaned off the armature and fields by means of a paint brush and a pair of bellows every day. Shafts and pulleys running near the dynamo must be prevented, by means of shields, from throwing oil on the dynamo, especially on the commutator.

A brush should never be lifted off the commutator while the dynamo is running.

Binding posts and other contacts should always be tight. A slight vibration of the dynamo, which will occur even when it is properly set, will loosen these connections in time. Every binding screw should be examined, and, if necessary, tightened every day.

The setting of the brushes is one of the most important duties of the dynamo tender. The brushes should rest against the commutator with a slight pressure. They should not be rigid, but the brush holder springs should allow a certain amount of spring; this will prevent excessive sparking of the brushes, even if the commutator should be a little uneven.

The contact points for the brushes in the commutator are in most dynamos diametrically opposite each other. In order to find these points quickly it is advisable to cut a little strip of tin, the length of which is just one-half the circumference of the commutator, and use this strip as a gauge when setting the brushes. The brush holders should be carefully kept clean, and should be wiped off every time before the brushes are put in. The brushes must extend from each brush holder at equal lengths. The insulation between the brush holder pins and the quadrant must be in good condition; oil and dirt must be kept out.

Fig. 5 shows the proper position of the brushes. The point where the brushes are resting on the commutator when the greatest current strength is obtained are called the maximum

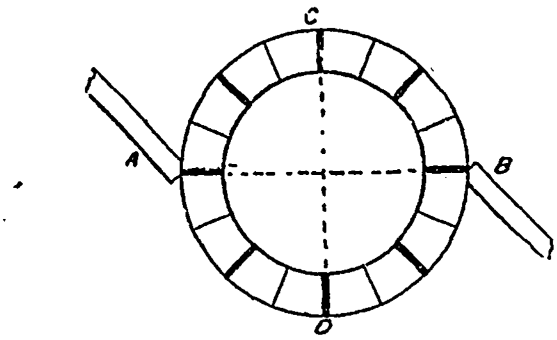



FIG. 5—PROPER POSITION OF BRUSHES.

points, *A*, *B*. When the brushes touch the points *C*, *D*, at right angles to *A*, *B*, called the neutral points, no current is obtained.

If the brush is nearly worn through to the middle of its thickness, it should be turned over and the other side used on the commutator. When both sides are worn off, as shown in the upper part of Fig. 6, the brushes should be trimmed. In larger stations, little brush cutting machines are used for this purpose; in smaller installations, two blocks of hard wood, lower part of Fig. 6, are used. The brush is put between the two blocks and the whole put in a vise. The end of the brush projecting beyond the wooden blocks is then removed by means of a file.

The brushes should also be in such a position on the commutator that the least sparking will be set up. In some dynamos it is necessary to move the brushes in proportion to the load in order to get little sparking. In other systems, the brushes need not be removed at all, no matter how many lights are turned on or off. In some dynamos, the moving of the quadrant, or, in other words, the moving of the contact points of the brushes on the commutator, is used for increasing or decreasing the strength of the current.

The commutator is the most sensitive part of the dynamo, and

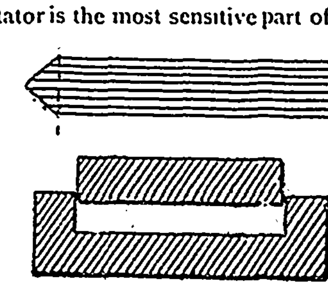


FIG. 6—WORN BRUSH AND BLOCKS FOR TRIMMING.

should be especially cared for. It must always be kept smooth. If it should get rough from the electric spark, it is necessary to smooth it by pressing a block of wood covered with fine emery cloth against it, after having set the dynamo in motion with the brushes lifted off. If the commutator is so rough that a smooth surface cannot be obtained by the use of emery cloth, it should be filed. In order to do that, it is necessary to take out the brush holders, pins and brushes. After a straight surface has been obtained, the commutator should be smoothed with fine emery cloth.

The disadvantages of using a file on a commutator are the liability of pressing small chips of copper into the insulation between the coppe. segments, and the impossibility of getting the commutator true. The best way is to turn the commutator off by means of a little lathe, which can be attached to the dynamo, or by taking the armature out of the dynamo and having the commutator turned off in a lathe in a machine shop. This will not only make the commutator smooth but perfectly true. In filing or turning off the commutator while the armature is rotating in the dynamo, it is necessary to reduce the normal speed of the dynamo considerably, as too high a speed would spoil commutator and turning tools.

In new commutators for which fibre is used as insulation between the copper segments it is very often found that the thin sheets of fibre have absorbed moisture, and extend above the surface of the commutator. If a few days exposure in a dry warm room does not cause the fibre to shrink and go back to its place, the surface of the commutator must be smoothed first with coarse and then with fine emery cloth.

In most systems it is advisable to put a little oil on the commutator just after starting the dynamo. Very little oil, however, must be used. Dip the point of one finger in one drop of oil, distribute it by rubbing it on the inner surface of the hand and apply what oil remains on the finger tip to the commutator, and take it off with another finger. This will do for at least three hours run.

If it should become necessary at any time to replace the commutator by a new one, it should be done in the following manner: Take the armature out of the dynamo and put the two ends of the shaft on two wooden horses. Mark the wires leading from the armature to the commutator by attaching little tags with numbers, to make sure of the proper place of each wire after taking off the commutator. Then disconnect these wires from the corresponding copper bars of the commutator, either by unscrewing the set screw, or in commutators which have solid connections, by unsoldering them by means of a hot soldering iron. Take the commutator off, clean the shaft and connections and put the new commutator carefully in its proper position and connect the wires in proper turn to the corresponding copper bars of the commutator by means of set screws, or soldering with hard solder. The greatest care must be observed not to short-circuit any parts of the commutator with drops of molten solder.

In most cases repairs to the armature are necessitated by injuries to the insulation of the wire from external mechanical sources or by excessive heat generated in the armature. The first is very often caused by little particles of material dropping in the spaces between armature and pole pieces for instance, little balls of cotton waste being caught from the end of the dynamo and pressed between armature and pole pieces, thus scaling off the insulation of the wires in some places, or bursting the metal bands. Such injuries can have two different results, either short circuiting some of the coils or bringing different parts of the wire coils in contact with the iron core. These injuries hardly ever extend below the first layer of wire. In most cases it will be possible to carefully lift one wire at a time just high enough to wrap it with silk tape, and thus insulate it. After having wrapped and insulated all the injured parts, drive the wires back into their position by means of a small hard wood block and hammer, and give them two or three good coatings of shellac varnish. If the injuries are below the first layer of the armature, it will be necessary in most cases to have it sent to the factory to have it re-wound.

Excessive heat in the armature will very often char the insulation of one or more coils of wire entirely. These coils, of course, must be taken out and replaced with new wire. In most armatures of the so-called Gramme pattern this can be easily done. In armatures of the Siemens drum pattern it will necessitate a re-winding of the whole armature. The over-heating of one or more coils of an armature is very often caused by the short-circuiting of two or more segments of the commutator by means of copper dust which has been allowed to settle back of the commutator, or by excessive sparking of the brushes, forming little bridges of metal across to adjacent commutator segments.

The faults which mostly occur in field magnets consist in short-circuiting coils, or in getting parts of the field wire in contact with the iron core. The field wire should be unwound until the damaged part is reached, and after insulating it properly as described before, it should be wound back on the core. If it should be necessary to take a considerable amount of wire off the field in this way it will be advisable to put the damaged field magnet in a lathe and do the unwinding and re-winding by means of the lathe.

The iron frame of each dynamo must be well insulated from the wire coils of the field, the armature and also from any connection with the earth. If one of these wire coils should get in contact with the iron frame of the dynamo and the latter should be in connection with the earth by means of foundation bolts, etc., it would cause what is called a ground. The ground must be considered the worst enemy of electric light apparatus, and should never be allowed to exist. In testing for contact between field wire coils or armature coils and the iron, any wires leading to the circuits or other apparatus should be disconnected from the dynamo in order to make sure that the fault really lies in the dynamo itself. Another fault sometimes found in the field of the armature is called a short circuit.

A short circuit is a shunt of little resistance between two points of a conductor. Suppose the points *A* and *B*, in Fig. 7, are set in some way in connection. It is clear that the main part of the current will pass through *A*, *B*, and but very little of the current will pass through the coil. If this should occur in the armature, the coil thus short-circuited in itself will generate currents of great strength, which will destroy the insulation of this coil in a very

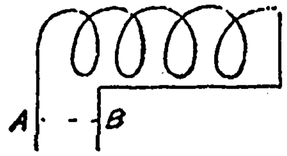



FIG. 7—A SHORT CIRCUIT.

short time. Generally the dynamo tender will be warned by a smell of burnt cotton and shellac. If this fault should occur in a field magnet it would decrease its power, and thus cause the different magnets of the field to be of unequal strength. It may cause heating of the field in shunt and compound dynamos, while in series dynamos it will simply decrease the current strength generated by the dynamo. In order to test for a short circuit in an armature coil, or a field magnet, it is necessary to disconnect each field coil, or each armature coil, and measure by proper instruments the resistance of each coil. If any magnet coil shows a resistance below the others, it is short circuited. The use of the necessary testing apparatus can not be described here, as it would go beyond the limits of our space.

The short circuits in field coils, however, can very often be found without the use of finer testing instruments, simply by the use of the dector galvanometer and the cell. By connecting each field coil in series with galvanometer and cell, and marking the deflection of the galvanometer, the coil which will show the least deflection is the one which is short circuited. A short-circuited field magnet will heat less than a sound magnet when the dynamo is generating current. A break of the fire can very easily be found by means of the galvanometer, as no deflection would be obtained at all through the broken coil. A break in a wire coil of the armature could only be found by disconnecting all wire coils from the commutator and from each other, and

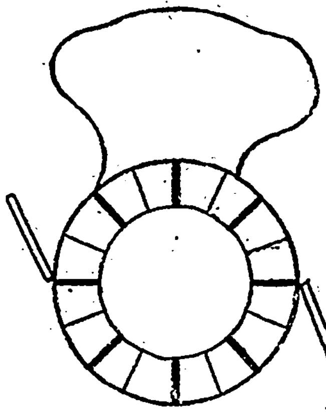


*FIG 8. – TESTING FOR A BREAK IN AN ARMATURE COIL.*

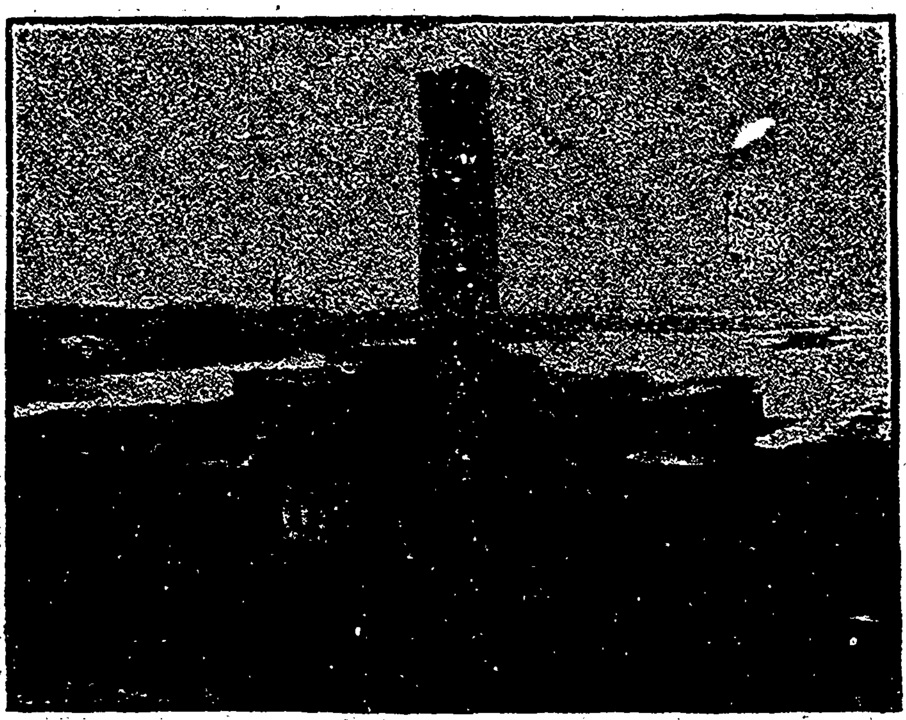
then testing each coil separately in the manner described. This, however, would involve considerable work and delay, and a quicker method may be employed: Set the dynamo in operation; then take a short piece of wire and touch the commutator with the two ends of this wire at a distance of three or four segments apart, Fig. 8. If the machine should commence to generate current, an electric arc will be formed on the commutator between the two ends of this wire, and indicate there is a break in the armature wire. The machine must be shut down quickly, as otherwise it would cause damage in the commutator and armature. The coil of the armature in which the fault lies can be easily recognized by the burns on the corresponding segments of the commutator. Faults of this kind are very often found in poor contacts between two coils, or between a coil and the corresponding copper bar of the commutator. Poor contacts will cause more trouble than actual breakage of the wire. Such faults will often destroy certain commutator segments, caused by increased sparking of the brushes when passing these points. Hence, if only one or two commutator segments should show rapid destruction from the electric spark, all the connections between these segments to the corresponding armature coils should be well examined, and, if necessary, cleaned and well tightened, or made solid with solder. The poor contact between parts of the field wire coils can be very often discovered by holding a piece of iron, for instance a machine wrench, near the pole piece without touching it. If the contacts are good the wrench will be attracted with a uniform force, if poor, these forces will vary and cause a single vibratory motion of the wrench in the hand.

## BOILER EXPLOSION AT ST. JOHN, N. B.

ON November 30th two steam boilers in a saw mill at South Bay, near Saint John, N. B., exploded with great violence, causing the death of eight persons and injuring a large number. Considerable damage was done to the property, and about three days after the explosion fire broke out in the portion damaged and the mill was completely destroyed.

There were six steam boilers in one battery in the boiler house. The boilers were of the style commonly used in saw mills in the Maritime Provinces, and sometimes called "Log Boilers." They were cylindrical, egg ended boilers about 33 inches diameter and 35 feet long. There was an equalizing pipe crossing the boilers in such manner that the water was free to flow from one boiler to another, and as all were connected to same steam pipe and were subjected to the same pressure, under ordinary circumstances the water level would be uniform in all the boilers, and if low in one would be low in all. Such at least was the design of the arrangement, and there is no reason to suppose that in actual work the equalizing pipe did not answer its purpose.

A coroner's inquest was held and a large number of witnesses examined. The explosion occurred about nine o'clock in the morning, at a time when the engineer was at his home for breakfast. The assistant engineer stated that the feed pumps was working at full speed, and had been so for some time; that the engines were running as usual and the safety valves blowing off. The steam gauge showed a pressure of 60 lbs. per sq. inch, and the water gauges showed that the water was high in the boilers. He went to the pump to shut off the water and was in the act of doing so when the explosion occurred.



SCENE OF BOILER EXPLOSION AT ST. JOHN, N. B.

Other witnesses who had been working in the mill spoke of water having been thrown around them and the mill at the time of the explosion. Parts of two of the boilers were thrown out into the water about 1,000 feet from the boiler room, and the explosion was a violent one. From the evidence, there did not appear to have been two distinct explosions heard or seen by any one. The boilers which exploded were not next to each other, but were said to be Nos. 2 and 5 of the battery. It has frequently happened that where a number of boilers are worked in one battery, the explosion of one has led to the others going off as well. Sometimes witnesses have described these explosions as following one after the other, like shots from a revolver.

No doubt, in this case, one part of one boiler commenced to give way, and led to such disturbances within the other boilers as caused the other to explode. Why did not all the others go up to? The evidence shows that the boilers were not all of the same age. They had been in their present position for about six years, but some of them had done service in other mills before being fitted up at South Bay. They were not all of equal quality, and there seems no reasonable doubt that the weakest exploded. A critical examination and test of the ruptured plates would doubtless show the reason why they ruptured and the others did not.

The jury brought in a peculiar verdict. They found that the boilers were short of water, and that from overheating they exploded. They add a recommendation that the Dominion Government be urged to make boiler inspection compulsory, and that persons running steam boilers in mills be required to hold a certificate of competency. They did not blame any one, yet the verdict intimates that the boilers were not what they should have been and that the men in charge of them could not have passed the necessary examination for certificate of competency.

The evidence of those most likely to know showed that there was plenty of water in the boilers, and some of the dead and injured were severely scalded, yet the water was low! It is the common idea of many that low water is the necessary cause of a boiler explosion.

It seems to be too much to expect from an ordinary jury that they should be able to understand the various technical points involved in a boiler explosion investigation. In Britain, when any accident of the nature of an explosion occurs to a steam boiler, an enquiry into the matter is made by a competent engineer acting for the Board of Trade. If the accident has been a serious one or produced serious results, after the preliminary investigation the owner of the boiler is liable to be tried before a court composed of engineers and a lawyer appointed to try the case for the Government. The object of this trial is to discover the cause of the explosion and to fix the blame on the proper person. Reports are published of these cases and much valuable information is given to the public and warnings issued to boiler owners and attendants. The punishments inflicted are fines or imprisonments. This method is a great improvement on the plan of leaving it to a coroner's jury to say whether or not the explosion was caused by any culpable negligence.

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The statement is made that a movement is on foot for compelling periodical inspection of boilers in Canadian saw mills and licensed engineers for saw mills. If such a law were to prevail in this country there would be a great demand for competent engineers, for there are thousands of them now running mill engines who could not obtain the proper certificate of ability. —*Woodworker.*

Before the Street Railway Committee of the Toronto City Council, recently, Mr. Cargill, of the Thomson-Houston Electric Company gave statistics of the relative cost of electric and horse power, saying that in some cases the reduction had been from seventeen to nine cents per mile, or eight cents per mile in favor of electricity in one case, and from seventeen to thirteen in another. In Toronto the difficulties of electricity would probably be increased by the severity of the winters, the high price of coal and other considerations.

## SHRINKING CRANKS ON SHAFTS.

A WRITER in a foreign journal gives the following method of shrinking a crank on a shaft: "When the crank has sufficiently expanded remove it smartly from the fire, and clear the hole from cinders, etc., by means of a wire brush (a piece of waste is not a good thing to use, as portions adhere to the metal and carbonize, remaining in the hole). Have tackle ready to immediately sling the crank upon its bearing, driving it on with a lead or copper hammer, or a sledge driving upon wood blocks, so as not to damage crank face. As soon as sufficiently driven home, drive a key in the keyway, a slack fit top and bottom, and a sliding fit sideways, thereby adjusting the crank accurately upon its seat. Try a square upon the crank neck and the boss to see that the crank is put on square with its shaft. Allow to slowly cool, and fit the keys."

## THE SMOKE PROBLEM IN ENGLAND.

ACCORDING to *Iron* of London, a Mr. Elliott, of that city, proposes to solve the smoke problem by condensing the smoke in water and recovering the by-products. To this end he has a tank of water in which are revolving stirrers driven by a small engine or by spare power. By means of a fan he draws the smoke from the chimney and forces it into the water at a point near the bottom of the tank. The smoke and products of combustion are then churned up together in the tank, the solid particles of the smoke and the sulphurous vapors and noxious fumes being arrested in the water. In time the heat of combustion warms up the water, and the steam is allowed to escape through a chimney into the air. When the water has become fully charged with the condensed smoke and other matters, it is drawn off and the tank is refilled with water. The charged liquor is to be afterwards treated, and the by-products due to the combustion of the coal are to be recovered. By this means it is claimed that not only will the smoke nuisance be abated but that a profit will be derived from the operation.

## A WIRE BOUND FLY-WHEEL.

A NOVEL fly-wheel of large dimensions, which differs materially in construction from those ordinarily in use, has been designed by Messrs. Mannesmann to guard against the terrible danger of bursting, to which accident cast iron fly-wheels are only too subject when worked at a high speed. This wheel, which is in operation at the Mannesmann Tube Company's works, in connection with their process for making seamless tubes, consists of a cast-iron hub, to which are securely bolted two discs of steel plates of about 20 feet in diameter. Round the periphery of the wheel thus formed about 70 tons of No. 5 gauge wire are wound, under a tension of about 50 pounds, thus binding the whole securely together. There can be no comparison between the resistance of a wheel so constructed to the centrifugal force, and that offered to this force by a cast-iron one. This fly-wheel, of 20 feet diameter and weighing 70 tons, revolves 240 times per minute, therefore the periphery of the wheel has a speed of 2.85 miles per minute, or nearly three times the speed of the "Flying Dutchman." It works on the main shaft from which the tube mill is driven by means of helical toothed wheels.—*Specialties.*

## TRADE PAPERS.

AS indicating the important position which trade and technical papers occupy at the present time, it may be mentioned that the managers of the advertising departments of the prominent daily papers are at present instructing their canvassers to give no attention whatever to soliciting lines of business in which the general public is not interested, and in which the services of the trade paper would be more likely to bring results than a daily paper. The rule is so closely followed by a number of the leading papers of the country that it may be accepted as the general policy of the newspapers of the day. Trade papers are constantly occupying a higher place in the estimation of the business public, and more particularly in the estimation of the manufacturers and wholesalers who use them, and upon whose patronage they depend for support. While trade papers a short time since consisted of little more than mere advertising pages, with random clippings from various sources, they are at present the result of the labor of large corps of able and experienced writers; and, taken collectively, they exhibit more originality and more enterprise than, perhaps, any other class of periodicals at present published, not excepting the leading literary magazines.—*The Office.*

## SPARKS.

The town of Palmerston, Ont., is to have twelve electric lights.

Regina, N. W. T., is now in the enjoyment of electric street lighting.

The electric light is about to be introduced in the village of Arthur, Ont.

Terrebonne, Que., was lighted by electricity for the first time a few days ago.

An effort is being made to form a local electric light company at Athens, Ont.

The Methodist Church at Essex Centre, Ont., is now lighted by electricity.

A system of incandescent electric lighting is about to go into operation at Kamloops, B. C.

The Bell Telephone Co. will supply the town of Gananoque with an electric fire alarm system.

The Ball Company's engine house at London, Ont., is being enlarged to accommodate a new 125 h. p. engine.

A joint stock company is in process of formation at Exeter, Ont., to purchase the necessary plant to light the town.

During the year just closed the Bell Telephone Company erected in Canada no less than 1,380 miles of trunk line wire.

The Bell Telephone Co. propose to establish a night service at Chatham, and supply the town with an electric fire alarm system.

The Vancouver, B. C., Electric Light Co. has suffered much annoyance by the breaking of arc light globes by mischievous boys.

The Canadian electric companies are experiencing considerable difficulty in getting poles, and owing to the scarcity the price has risen.

Messrs. Corley & Collins, of Mount Forest, Ont., have purchased a 40 light dynamo and will supply arc and incandescent lighting to the citizens.

It is said that the prospect for the construction of an electric street railway at Kingston, Ont., is almost certain to be carried out the present year.

Dr. Groves has introduced the electric light in the town of Fergus, Ont. It is the purpose to supply current to Elora and one or two other neighboring villages.

A number of converters sent into Manitoba by an American company, of St. Paul, were recently seized by the Canadian Customs authorities on account of undervaluation.

The telephone wires were recently stripped from the poles in Windsor, Ont., by a couple of enterprising theives, who were arrested while trying to dispose of them in a Detroit junk shop.

The Hamilton Electric Light Company's plant and business has been leased by the Electric Light & Power Company. Mr. W. J. Clarke, late of Trenton, is the manager of the new company.

The employees of the Brooks Mfg. Co., of Peterborough, recently presented Mr. Taylor, superintendent, and Mr. Castle, foreman, with kindly worded addresses and other tangible tokens of esteem.

The Ontario Telephone Co., of Peterborough, have recently supplied an instrument for the benefit of persons with defective hearing. The receiver has an ear trumpet attachment which has proved an entire success.

The Ontario Government has incorporated the Toronto Telephone Company with a capital stock of $250,000. The promoters are: Alex. Nelson, Abner Nelson, Toronto, W. Travers, Paris; John Ritchie, jr., and Louis Gibson Harris.

The Standard Electrical Company, of Ottawa, is the name of a new organization which is applying to the Ontario Legislature for incorporation with the object of producing, selling and supplying electricity for purposes of light, heat and power.

New buildings are being erected at New Westminster, B.C., for the electric lighting plant, which will be owned and operated by the city. The building has been planned with a view to increasing the plant and power in future as required, and is situated at a convenient distance to blow in for fuel the refuse from one of the large saw mills.

The Bell Telephone Company is said to have issued a writ against the Brantford Electric Light Company, claiming $5,000 damages for erecting its poles and wires in such a way as to endanger the property of the telephone company and its subscribers, and asks for an injunction to compel the removal of the electric light wires to a proper position.

The specifications drawn up by the Toronto City Council as the basis upon which tenders will be received for the privilege of operating the street railway system, provides that an electric, cable or other new system of motor, or a combined system recommended by the City Engineer, and approved of by the Council as suitable, is to be introduced at once and used, at least on the main lines, within two years.

Messrs. Henderson Bros., of Montreal, have applied to the Quebec Legislature to incorporate the Ries Electric Traction & Brake Company, of Canada, with a capital stock of $1,000,000, with the object of largely increasing the traction of railway locomotives, and for the operation of locomotive and train brakes, head lights, and train lighting. Very successful tests of the Ries invention have been made in the United States.

## SPARKS.

The construction of the New Westminster, B. C., electric tramway will commence immediately.

The municipality of St. Cunegonde, Que., will exchange its incandescent for arc lamps for street lighting.

The Malleable Iron Works at Walkerville, Ont., are constructing an electric light plant for their own use.

The Bell Telephone Co. will shortly commence the construction of a line from St. Thomas to Ridgetown, Ont.

The Cobourg Car Works Company will probably engage in the manufacture of cars for use on electric railways.

Messrs. Cliff & Foster, of Goderich, Ont., have installed in their furniture factory a 40 light incandescent plant.

The town of Lucknow has contracted with the ...ll Co. for eight arc lights of 1,000 c. p for 280 nights each year, at a cost of 15 cents per light.

The streets of Hespeler, Ont., will be lighted from dusk till midnight, 280 nights in the year, by ten arc lamps of 1,500 c. p. at a cost of 17 cents each per night.

Mr. Kenneth Dunstan, Manager of the Bell Telephone Co., Hamilton, recently delivered an interesting address to the young mechanics of Hamilton on " Electricity and its Uses.

The Hamilton Gas Company asks permission of the Council to lay electric wires underground, from which the inference is drawn that competition in electric lighting has been decided upon.

A difficulty having arisen between the Town Council of Oshawa and Messrs. Edmonson, owners of the electric light plant by which the town is lighted, new tenders for lighting have been invited.

The firm of Patterson & Corbin, of St. Catharines, has received a $15,000 order for ten electric cars for the Ottawa Street Railway Company. They ask the city for $10,000 to assist them in erecting a factory for the manufacture of street cars.

W. Brown, a telegraph line repairer, of Hamilton, while walking on the Northern and Northwestern track recently, discovered a bear lying between the tracks. Bruin indicated his desire to make a meal of him, but in this he was disappointed by the good use which the lineman made of his legs.