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THE ELECTRIC SIREN.

WHAT promises to be an instance of the practical adaptation of a long neglected possibility is the development of the principle of an electrically vibrated diaphragm, as found in apparatus recently elaborated in the hands of Mr. A. G. Trudeau, of Ottawa. The subject is one of such interest from an engineering point of view that some pains have been taken to obtain the information concerning it that is now here presented. The massive apparatus to be seen in Mr. Trudeau's workshops is the outcome of a long line of patient and persevering experimentation, and bears on the face of it and in its hugeness strong evidence of the inventor's confidence in the utility of what he had in view.

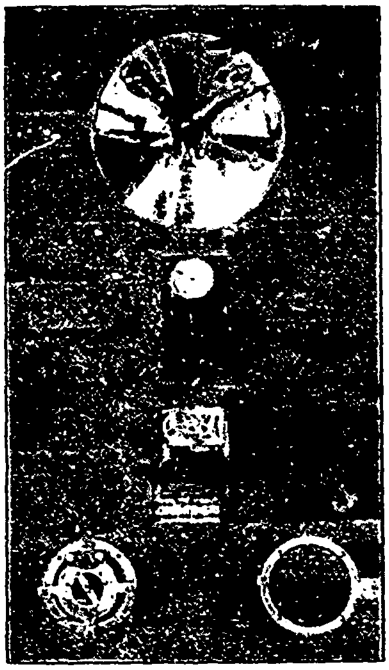

FIG. 1.—CLOCK MECHANISM AND SWITCHES, WITH GROUP OF INCANDESCENT LAMPS AND REFLECTOR.

FIG. 2.—ELECTRIC COAST SIREN.

PRINCIPLE OF THE CONTRIVANCE.

Every user of the telephone is familiar with the behaviour of the 'phone if it happens to be "off the hook" and the distant ringer is put in motion. The diaphragm of the 'phone is subjected to a series of alternating current impulses, and manifests the effect of these by giving out a clattering noise not unlike the automatic electric buzzers sometimes used in place of the ordinary vibratory call bell. This observed behaviour of the 'phone under such conditions has been obviously enough suggestive of the construction of a call system comprising just such parts, but in practice the idea has not taken hold hitherto, perhaps because of the different elements going to make up the system not having been given proper shape to fill the requirements.

Mr. Trudeau conceived at the outset that the vibratory alternate current of the electric light might be adapted for the purpose in place of the magneto ringer, and this conception led to the construction of instruments actuable in a commensurate way by any such extraordinarily heavy currents as might be had from such a source. Going further in the same direction, he supplied the sound products with current from a special alternating dynamo, the number of whose current pulsations per second can be altered at will by an increase or decrease of its speed, or otherwise, and thus achieved a variable action in the sound producer, corresponding to the variation of note in a complex steam whistle or siren—whence the descriptive name for it with which this article is headed.

DETAILS OF CONSTRUCTION.

In furtherance of the foregoing comprehensive explanation of the character of the invention, the following details of the apparatus as now elaborated are given for the benefit of those of the readers of the ELECTRICAL NEWS interested in any new and unlooked for development of this kind. The outfit shown in the accompanying illustrations comprises what is needful for a lighthouse, with electric light and siren combined. In Fig. 1 a group of three powerful incandescent lamps, with reflector, is shown above the clock-work and switches. The number of these lamps is obviously referable to the volume of current supplied, and may be replaced by an arc for the operation of a search-light if desired. Immediately beneath is shown an automatic time-switch, by which the lights and the siren (the latter shown in Fig. 2) may be operated alternately or simultaneously at given periods as arranged for. The clock-work may be an eight-day movement, requiring winding but once a week, and therewith the lights and siren might be operated automatically between, say, 5 p.m. and 8 a.m. daily, or at any other hours as predetermined. This clock-work, by which the signalling devices are operated, has two baths of mercury and two contact makers that dip into them and so close the respective circuits. As now arranged in the workshop, the siren is sounded for 20 seconds, and then the light is turned on for the remaining 40 seconds of each minute; the contact wheel makes but one revolution per minute, and so renders the wear and tear inappreciable and the movement durable and reliable. A rotating brush commutator might, of course, be used instead of this mercury contact but that the make and break spark would in time eat away the commutator segments and prove troublesome.

Beneath the lamps and switches there are shown front and back views of the vibrator or sound producer. It is very substantially constructed, having a steel frame, which is first coppered and then nickel plated so as to avoid rust and corrosion. The diaphragm is said to be of a specially prepared material and of magnetizable character, a suggested modification being one of bell metal or other non-magnetic material provided with small projections of iron to serve as armatures for the actuating electro-magnets, and it is secured in the frame by an annular clamp, somewhat after the fashion of a drum head. A screw device by which the amplitude of the vibrations of this diaphragm or drum head is to a certain extent regulated, is mounted opposite the centre in a cross piece at the back. A group of electro-magnets, made up of laminated iron cores wound in the ordinary way, is fixed in the frame and hidden by the broad and smaller annular ring shown in the left-hand (back) view, and thoroughly covered with insulating compound, and covered with rubber to shut out all moisture.

In Fig. 2 is shown the fog-horn proper, in one of the many forms that is being given to the device, and to be designated the "coast siren." It comprises two huge funnels made of ¼ inch copper and finished at each end in brass. Each of the funnels project 6 feet 6 inches from the stand, at right angles to each other. In each of these funnels or horns a vibrator or sound producer is placed, the object being to use them alternately or simultaneously as may be desired. The stand is of cast-iron and of very substantial form, 6 feet high, surmounted by a large hollow cast iron sphere, from which the horns project. This sphere is divided into two, the back portion opening on a strong hinge, enabling the light keeper to clean the instruments or make any necessary adjustments or repairs. The vibrator is self-contained and may be taken out and replaced by another in a moment, so there need be no time lost in event of a vibrator becoming broken or otherwise disordered.

Below the siren the source of the operating and lighting current is shown. This part of the plant comprises two alternating current dynamos with separate and interchangeable field exciters. Only one of these alternators is to be used at a time, however, the second being provided as a precaution against an accidental break-down. They have a capacity of 3½ h.p., are of the multipolar type, and were specially designed by Mr. Trudeau for the purpose, and they occupy each a floor space of 18 inches square and are 18 inches high. The field exciters were also specially designed, and occupy a floor space of but 6 x 8 inches, and are 8 inches high. All the work done on the different parts of the outfit is of the highest order and everything in its make-up has been designed and manufactured by Mr. Trudeau or under his immediate supervision in his shop.

The engines to be associated with the electrical plant are not shown in the illustrations. It is proposed to use a Gasoline type that can be set to work in one or two minutes. The power required to operate the siren and the light alternately is put down as 1 h.p. and is estimated to cost 15 cents; or, in cases where the maximum capacity of the plant (3½ horse power) is to be utilized — as for instance when a search-light is used—3½ x 15 = about 50 cents for a ten hours' run.

The complete installation, including the spare set of apparatus and dual engines, may be placed in a light-house room less than 8 feet square, and there being no cumbersome boilers, air compressors, etc., understood to be indispensable to other systems for a like purpose, the whole is calculated to be placed in position at a comparatively trifling cost.

OTHER APPLICATIONS.

Obviously, the apparatus in the form described in the foregoing has been designed to demonstrate the practicability of operating fog-alarms in places ordinarily inaccessible for steam plants, and where bell-buoys and hydraulic whistling-buoys are inadequate because of their comparatively feeble sounds being drowned in the noise of waters on neighboring shoals and wave-beaten head-lands. For the development of his invention, with this important object in view, too much credit cannot be given Mr. Trudeau, and it is to be hoped his undertaking will meet with a well-merited success.

Since it is immaterial how far the source of the actuating current is from the signalling instrument, or whereabouts in the circuit the controlling devices are located, the whole contrivance affords an ideal flexibility that can be approached by no other known means that has been devised for marine signalling purposes, and its adaptation to harbor-buoys connected by cable is only a matter of detail.

The minor applications for the device in its smaller forms, whether in combination with electric lighting currents or independent sources of current, are manifold and various—fire and burglar alarms for instance, or hotel and railway station gongs, police and cab calls, etc., all too patent to call for more than passing mention. Upon the whole, this interesting development of a neglected feature of every-day electrical operation seems well worth the extended notice that has herein to it been accorded.

D. H. KEELEY, M.I.E.E.

OTTAWA, 8th March, 1899.

At Tilbury, Ont., there is a municipal electric plant, which is in charge of Mr. J. H. Ward. We are advised that 400 lights are now wired up, while the capacity of the machines is only 500 lights. It is probable that the system will be changed to alternating, and a new 750-light machine installed. Some of the customers wanting lights are not within economical reach of the direct current system. One of the dynamos now doing service will likely be used for furnishing power for small motors, fans, etc., for which there is some demand.

THE LACHINE RAPIDS HYDRAULIC AND LAND COMPANY.

The annual meeting of the Lachine Rapids Hydraulic and Land Company, Limited, was held in Montreal on February 17th last. After the reading of the report explanations were made by the managing director as to the cause of the trouble during the past winter in connection with the lighting. He stated that it was owing to various causes, such as the extreme severity of the weather, which caused a block of ice below the tail-race—a phenomenon which had not occurred for forty-five years previously. He suggested remedies which he said would unquestionably overcome any such difficulties in future. It is understood that the tail-race dam will be extended and that other slight alterations will be made at the head race for the purpose of preventing interference from ice. Additional dynamos will likely be installed at once.

The report of the directors stated that, notwithstanding the difficulties incidental to the inauguration of all new enterprises, the business of the company during 1898 had been very satisfactory, and the general outlook for the future was bright.

The financial statement presented was as follows:

Gross earnings for the year ending December 31st, 1898		$118,121 23
Discounts allowed		19,824 53
Net earnings		98,296 70
Add interest on bank account and stock calls, and discounts on cash purchases		3,991 12
Gross revenue for the year		102,287 82
Operating expenses, including general expense, lamp renewals, commissions, pole rent, placing meters, testing meters, painting poles	$45,098 33	
Rent, insurance and taxes	3,897 73	49,996 06
Leaving a gross profit of		$52,291 76
From which has been charged for interest on bonds		19,530 47
Leaving a net profit of		$32,761 29

equivalent to almost 3 p. c. on the paid up capital.

From the report the following particulars are obtained: During the year additions to the plant were made which cost $206,866. The company have constructed in Montreal and vicinity 175 miles of wire, and have also placed 4,700 cross arms. This work consists of three phase lines for power and light on the principal streets of Montreal, and a large number of single phase circuits in localities where lighting only is used. An arc system was constructed for the C.P.R. at Outremont, and a permanent switch-board at the power house.

The total number of incandescent lamps on the company's circuit is 40,135. Of the above 35,335 incandescent lamps or their equivalent are on meter, and 4,800 on flat rate. This is exclusive of lights furnished by the Imperial Electric Company, who receive the necessary current from the Lachine Company. The total number of alternating arc lamps not on meter is 309. The company have 36 motors installed, with a total capacity of 924 h.p. Last year there were added over 15,000 incandescent lamps, while the number of arc lights increased from 54 to 109. The increase in flat rate customers for incandescent lighting was from 227 to 343, and their power service increased from nothing to 924 h.p..

Attention is drawn to the fact that the principal profit from the plant already installed is derived chiefly from the output of a few hours' lighting out of the twenty-four, that although lamps are connected and current is on, the customers only use the power during a short space of time, while the operating expenses of the company remain the same as though their power were being used and paid for during the whole period. They could afford to dispose of power at a very low rate if customers could be found who would be prepared to use it at other times than the hours above referred to.

The directors point out with much satisfaction that the company has been able during its first year of operation to pay not only the interest on its bonds, but all its operating expenses, and earn the handsome profits of nearly $33,000.

NERNST'S ELECTRIC LIGHT.

Prof. Walter Nernst, of the University of Gottingen, Germany, is the inventor of a new method of lighting by electricity, which is briefly described in the following abstract from a paper read by Mr. James Swinborne before the Society of Arts, London, England, on February 8th last:

Nernst's, like most great inventions, is exceedingly simple as soon as it is understood. The efficiency of an incandescent body, as far as radiation goes, depends simply on the temperature. The efficiency of an incandescent lamp, for instance, depends on the temperature of the filament only, providing there is no loss by convection. The carbon will not stand a sufficiently high temperature, especially as, in addition to its low specific resistance, the filament has to be long and slender, and thus weak. Nernst, therefore, chose a material that would stand higher temperatures than carbon, and his material has the incidental advantage that its specific resistance is so high that strong rods can be used for high pressures instead of thin filaments. The most refractory materials so far used in lighting are zirconia, which has been used to replace lime in the limelight, and the oxides or so-called rare earths in the Welsbach mantles. I am aware, of course, that many people suppose that the Welsbach mantle is not very hot, treating it as if it were at a temperature, for instance, below the melting point of platinum. The light emitted is supposed to be due to some special power of selective emission due to the oxides employed. I have had a good deal to do with incandescent gas mantles, and I find no reason to suppose there is any magic effect of this sort going on. The part of the flame where the mantles hang fuses platinum wire easily, and very few materials can stand the temperature without fusing or volatilizing. Lime and many other oxides volatilize slowly from the mantles. I do not mean that the mantles are above the boiling point of lime; I have some idea of its melting point, as I have made a few pounds of melted lime, and run it out on the floor to look at it. The Welsbach mantles, which are now chiefly thoria, are at a temperature near their softening point, and in the making are raised to a temperature at which they begin to soften.

Nernst takes highly refractory oxides as his material. It does not seem promising, because such oxides are notoriously good insulators. But such insulators are electrolytes when hot; Nernst, therefore, heats the rods to make them conduct, and then heats them electrically, preserving a temperature which is within the limits that the material can bear without softening. This means that he can take the most refractory bodies supplied by the whole range of chemical research, and can heat them to a temperature short of their softening point, and can thus get an efficiency unknown to workers on the incandescent lamp. Such efficiency also means whiteness of light, so long as the efficiency is not too high. Thus the crater of the arc being at a temperature of boiling carbon, gives a light that is unpleasantly blue. The material is worked up into little white rods. Each rod is mounted on two platinum wires, a little paste made of refractory oxides being applied to the joints. The little rod, with its two wires, is then mounted in a holder which fits ordinary electric light fittings. As the rods fall in resistance as the temperature increases, after the manner of electrolytes, an increase of current produces a decrease of resistance. This tends to give some instability in running in parallel on supply circuits. This instability is corrected, as in an arc lamp which has analogous properties due to a different cause, by a series resistance. The Nernst rod has therefore a resistance in series. This is made up of exceedingly fine wire, and for ordinary circuits amounts to 10 or 12 per cent. of the whole resistance of the lamp. The consumption, including the resistance, is 1.5 watts per candle for large lamps, and 1.6 for small lights or low pressures. In small or low pressure lamps the loss of heat at the ends is larger in proportion.

In all probability an electric light plant will be installed in the new city hall in Toronto, for the purpose of lighting the building.

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EDITOR'S ANNOUNCEMENTS.

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

The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

The Overcrowding of Street Cars.

THE bill which was recently introduced in the Ontario Legislature by Mr. Crawford, M.P.P., to regulate the overcrowding of street cars is, to our mind, one of the most unreasonable measures which has yet been compiled. Applying only to cities with a population exceeding one hundred thousand, it is applicable exclusively to Toronto. Clause one provides that every passenger on a street car shall be entitled to a seat, while the third clause states that no person shall be refused the right to admission in any car provided there is reasonable standing room for such passenger. A passenger unable to secure a seat is to demand and receive from the conductor a ticket entitling him to a seat in any car on the same route during the same hours of any other day, or at his option he may tear his ticket into two parts and use one part for that trip, the other part to be good for a standing trip at any future time when the cars shall be so overcrowded that he shall be unable to obtain a seat. Such a law would be unworkable, and unfair to the companies operating street railways, who are given no protection from unscrupulous persons, who would seize every opportunity of boarding a car whose seating accommodation was already exhausted, notwithstanding that other cars in which seats could be had might be available. In large cities, upon the occasion of the holding of exhibitions, public meetings, and other events to which the public are attracted, the people gather in such numbers that no reasonable street car service could provide the necessary accommodation to the satisfaction of all. Another illustration will show the absurdity of the bill. A passenger might board a car the seats of which were occupied, pay his half fare to the conductor, and at the next stopping point—perhaps not two hundred yards distant—one of the passengers might alight, thus giving him a seat for almost his entire journey. In these instances, Mr. Crawford's bill, if passed by the Legislature, would be the cause of a serious injustice to the railway companies.

The Nernst Method of Electric Lighting.

THE information to hand respecting the new departure in incandescent lighting (Nernst's invention) is scarcely complete enough to warrant a definite opinion. It looks as though it would create a new departure in incandescent lighting on similar lines to the Welsbach improvement in gas business. The Welsbach was considered one of the greatest advances in gas illumination ever brought forward. Experience of its continued use, however, has not quite justified the sanguine expectations of its promoters. The Nernst lamp may be a new departure that may practically revolutionize electric lighting, or it may develop defects and unforeseen drawbacks that may keep it from becoming a serious competitor with the present system of vacuum lamps. An automatic arrangement to heat the rod must be, to a certain extent, complicated and liable to get out of order and unsuitable for small lamps. It may be that for store lighting, such places as factories, railroad stations and so on, the system would be eminently suitable, while for high class lighting, such as for residence purposes and decorative effects, the vacuum lamp would lend itself with much greater adaptability. The cost of this lighting is not so excessive at the present time that convenience and appearance may be sacrificed for the sake of extreme economy. At present something must be allowed for the enthusiastic optimism with which a new departure like this is apt to be received, but notwithstanding, later developments may show that a distinct advance has been made in the commercial adaptability of the electric light.

Municipalities and Lighting Companies.

THE treatment accorded to electric lighting companies in Germany appears to closely correspond to that which Canadian private lighting companies in many instances receive at the hands of the municipal councils. The City Council of Berlin proposed to give a contract to the electrical companies for the supply of electricity for a period of fifteen years, provision being made that the municipality should participate in the profits. Strong pressure was brought to bear by the social democrats to compel the Council to assume entire control of the electric lighting. This demand would probably have been acceded to but for the fact that the authorities feared that new discoveries might take place in the near future which would depreciate the value of the existing works. In view of this, it was finally deemed advisable to approve the contract with the electric companies. The policy of many municipalities in Canada, as in Germany, is to saddle the private lighting companies with all the responsibility and expense incident to placing the electric lighting business on an established basis, and when that point shall have been reached, step in and assume control without even offering to buy out the existing works at a fair valuation. This has the appearance of base ingratitude and injustice to the enterprising men who were the pioneers in electric lighting, and who in many instances were induced to embark their means in an untried and doubtful enterprise by the promises of support made to them by the municipalities. It is to be hoped that the Provincial Government wil step in and see justice done—that millions of dollars' worth of valuable property shall not be rendered valueless, but that where it is the desire of the municipality to own and operate an electric lighting plant, it must, as in the case of water companies, purchase at a *fair valuation*, to be fixed by arbitration, the works of the existing private lighting company.

Relations of Lighting Companies to Municipalities. A BILL has been introduced in the Ontario Legislature by Mr. Conmee to amend the Municipal Act in respect to municipal lighting. The object of this bill is two-fold. 1. To place *gas and electric light companies*, in cases where a *municipality* desires to go into the manufacture of gas or electric light, in the same position as water companies now are where the municipality desires to go into water supply. The present law regarding water companies provides that before the council shall levy any water rate, they shall *make an offer* for the works or stock of an *existing* water company, and the water company then can either accept the offer, or may give notice of an arbitration to determine the price to be paid by the municipality for the works. 2. The second proposal in the bill is, to enable municipalities to secure street lighting and lighting for public uses from an existing *light company, on fair terms*. At present the Municipal Act permits a contract by mutual agreement to be made between a municipality and a company for street lighting and lighting for public uses for a term not exceeding ten years, but a municipality, as the law now stands, has not power to require a company, against its consent, to supply *such lighting* upon what it may consider *to be fair terms*. It is therefore proposed by this bill to permit a municipality to make an offer to a lighting company of terms of contract for such lighting, and in the event of the company refusing the offer of the municipality, the municipality will have power to secure an arbitration to determine the price and terms of the contract.

It will be observed that the first of these provisions will not prevent municipalities entering upon the supply of light. It simply provides that if they do enter upon such undertaking, they are first to try to buy, at a fair price, or at a price to be fixed by arbitration, existing works. No valid reason can be advanced why the law, now applicable in case of water-works, should not be extended to light companies as well. Such a purchase will put the municipality in the possession of the very plant and material which they would have to purchase from other sources, if they are going into the business. Gas and electric light companies, as well as water companies, have always *come into existence* with the consent, encouragement and approval of municipalities, who have granted the use of streets, and in many cases, exemption from taxation for these works. They have thereby induced enterprising citizens to embark their capital in these undertakings. It is unfair and unjust that municipalities themselves should afterwards have power to *destroy* the *value* of the very property they have encouraged citizens to purchase and pay for, when that property can be utilized by the municipalities themselves if they so desire. Such a law also benefits municipalities, because it tends to extinguish rivalry to themselves, which rivalry might render municipal operation of these works unprofitable. It is also in the public interest, because it will further encourage private citizens to invest their capital in new enterprises, and in extending and improving existing lighting works. At present, private capital is in danger of being lost through municipal competition, if invested in such works, or in extending and improving existing works, and all private enterprise in these directions is paralyzed and discouraged.

The equitable character of this bill was admitted last year by leading members of the Legislature on both sides of politics, including the Hon. Mr. Hardy and Mr. Whitney. The principle was long since recognized in Great Britain, where the law provides that the municipality cannot interfere with an electric light company until the expiration of twenty-one years, or such shorter period as is specified in the application by the company for the original order. At the end of twenty-one years the municipal authorities may, by notice in writing, require the electric light company to sell their undertaking upon certain terms adjusted by independent authority. If they do not so require, then the company goes on for seven years further; at the end of that seven years the municipal authorities have again a right to purchase, and so on at the end of every term of seven years.

Municipal ownership in rivalry with an existing company is a case of a whole community going into competition with private individuals who are the shareholders of the existing gas and electric light company. These people are taxpayers, and a part of their money contributed to the municipality would be used in competition to themselves and to confiscate their own property. On economic grounds, it is evident that the purchase of the plant of an existing company would be more profitable both to the company and the municipality than the duplication of plants for competitive service. Duplicating plants involves a waste of capital. The second proposal in this bill, which is just and proper in itself, will remove a grievance which municipalities complain of under the present law—viz., that they have been charged with high rates for street lighting by existing companies, and have been unable to compel companies to furnish such lighting at reasonable rates. By the proposed amendment they will be enabled to secure street lighting either upon their own terms, if accepted by the company, or upon terms to be fixed by fair arbitration. While, on careful consideration, it may be thought desirable to make some slight amendments, the measure as it stands gives evidence of having been carefully framed so as to safeguard all the interests involved. It is therefore highly desirable that it should meet with the approval of the legislators on both sides of the House.

QUESTIONS AND ANSWERS.

"R," LINDSAY, Ont., asks: "When was electric light first used on the streets of Toronto? When was incandescent light first used as an article of commerce in Ontario? When was the telephone first used commercially in Ontario?"

ANSWER.—Electric lights were first used on the streets of Toronto in the fall of 1883. Incandescent lights in series on arc circuits were used in several places in the province of Ontario the following year. The first telephone line in Ontario was built in the city of Hamilton in October, 1877.

TELEGRAPH and TELEPHONE

NEW TELEPHONE REPEATER.

INVENTORS have tried to devise means whereby telephonic messages might be repeated from one circuit into another in order to permit conversation over unusually long distances. Little success has hitherto been attained in this regard. All telephone repeaters, except that about to be described, have the diaphragm of a Bell receiver, or its equivalent, to vary the pressure on the carbon of a microphone transmitter at the end of the first circuit, and so cause a repetition of the message in this circuit. Nearly all repeaters can be used only in repeating messages from the first into the second circuit. None but the new repeater can repeat into an indefinite number of circuits in a manner similar to repeating into an indefinite number of telegraphic circuits.

Telephone repeaters have usually been unsuccessful, because although the amplitude of the diaphragm's vibration in the transmitter is considerable, yet that of the diaphragm in the receiver is very small. Hence, the variation in pressure on the carbon transmitter of a repeater is small, and consequently the telephonic message at the end of the second circuit is very weak, if indeed it can be heard even on short circuits.

In the new repeater a telephone receiver which can speak more loudly than a person is used. This motograph receiver was invented more than twenty years ago by Mr. Edison. It has a cylinder of plaster of Paris moistened with a solution. Pressed against the face of this cylinder is a strip of platinum, the other end of which is fastened to a diaphragm. One line wire is connected with the platinum, and the other with the cylinder. When this is steadily turned by hand or other motor, the strip is drawn forward by friction on the cylinder or released, according as a weaker or a stronger current of electricity passes through the film of chemical solution between the platinum and the cylinder. The platinum, being fastened to the diaphragm, imparts its motions to the same. The diaphragm throws the air into accoustic vibrations, reproducing the sender's voice. The sound of the receiver is dynamically caused by the motor which turns the cylinder. This is turned with more difficulty during the reception of a message than when the line is idle. The electric current which flows on the line merely controls the vibrations o the diaphragm. The motograph has been little used, because Bell's simpler receiver speaks in a sufficiently loud tone for common service.

It recently occurred to the inventor of the new telephone repeater that by using Edison's loud speaking receiver or motograph near the carbon or other suitable transmitter of a second circuit, a message spoken into the first circuit would be repeated with undiminished force into the second circuit. At the end of the second circuit a repeater may be used to forward the message into a third circuit, and so on throughout an indefinite number of circuits. At the end of the last circuit a Bell receiver may be used, if desirable, instead of the motograph. A small electric motor may be used for driving the cylinder of each repeater during business hours. By means of a duplication of transmitting and receiving parts in each repeater, messages may be automatically sent in either direction.

All parts of one or more continents could be brought within speaking distance of one another. The reproduction of a speaker's voice would be louder than the voice itself, because the sounds at each repeater are dynamically due to the motor which rotates the cylinder. The reproduction of the voice at the end of a dozen circuits would be as loud as that at the end of the first circuit.

The inventor has devised a practical telephonograph. At the end of the last circuit a phonograph may be set before a motograph receiver. This will speak as loudly as the person sending the message, hence this may be as deeply impressed on the wax cylinder as if the speaker were present. The phonogram may be detached from the phonograph and sent to the person addressed. He may at leisure place this on his phonograph and listen to the message. The phonogram may be saved, and caused to reproduce the voice of the correspondent at any future time.

JAMES ASHER.

Dunnville, Ont., Canada, March 3, 1899.

LAYING ATLANTIC CABLES.

MR. F. A. Hamilton, E.E., of Halifax, N. S., recently delivered before the Dartmouth Literary Society an interesting talk about the North Atlantic cables, with the laying of many of which he was personally associated. The many difficulties and disappointments which were met in endeavoring to connect the two hemispheres by cable were interestingly and sometimes thrillingly described.

In 1857 the first attempt was made by a United States ship. A start was made and 350 miles of cable payed out, but just when there seemed to be hope of success something caused the cable to part, the end was lost overboard and sank in a hundred fathoms of water, and the 350 miles was lost. In the next attempt two steamers started in mid-ocean one proceeding toward Ireland and the other toward Newfoundland. The end was again lost overboard and 290 miles more of cable were left on the bottom of the sea.

On July 28th, 1858, another attempt was made, this time with better success, for in August both ships arrived simultaneously at Newfoundland and Ireland, having accomplished the work of connecting Europe and America by cable. About 400 messages were transmitted by this cable, some of which were given by the speaker. One of the first was from the directors of the company in England, and occupied about twenty minutes in transmitting. It was, "Europe and America are at last united. Glory to God in the highest and on earth peace and good will toward men." The second message transmitted was from Queen Victoria to the President of the United States. On September 3rd, 1858, this cable had breathed its last, but the feasibility of the work had been demonstrated, and it was not long before it was again taken up.

In 1865 the next attempt was made, with cable of superior quality and with better steamers and appliances. The ships engaged in the work were the Terrible, Sphink and Great Eastern. After the start was made, as the cable was being payed out, the speaker described the intense anxiety on board for fear of losing the connection. When being passed from bow to stern the cable caught in something, and before the ship's way could be checked it had chafed and broken and sank to the bottom in 2,000 fathoms of water. Then commenced a series of drags, but all to no avail; it could not be recovered, and the work was abandoned in 1865.

But the hopes of the men who had undertaken the work never wavered, and in 1866 they were realized. The Great Eastern accomplished the work and established the ties that have never since been severed. The bones of the Great Eastern, on which the speaker had served, had been since distributed among dealers in old iron.

From that time forward great strides had been made. In a short time over 1,600 tons of copper wire had been laid in the North Atlantic. In 1873 and 1874 great work was done, which was continued until nearly every place of any importance whatever has cable connection. In 1874 the Faraday had commenced the work she is still carrying on.

To-day repairing in deep water was no longer the difficult task that it had been. The automatic grapnel was a great aid in the work. As soon as the cable was hooked connection was established and those on board were aware that the cable had been picked up. The ringing of the bell was a welcome sound after long and tedious dragging.

A case of repairing in 1,500 fathoms was described, and the delicate work of raising the cable to the surface without breaking it was shown. It had to be picked up a couple of miles from the break, so that the end would not slip off the grapnel. Then the connection was made and the other end was picked up in like manner. To raise the bight from about two miles of water required about four miles of the cable, so that the two ends thus raised would be ten, twelve or fifteen miles apart. Breaks were accurately located by calculating from the resistance. The break described occurred 1,442 miles from St. Pierre.

SHORT-CIRCUITS.

Mr. Chas. Hosmer, manager of C. P. R. Telegraphs, has returned from the European continent, his daughter in Paris having recovered from her recent illness.

Mr. K. G. Holland, of the Mica Manufacturing Company, of Ottawa, reports that the mining business in the Lake Gerard district, near Wakefield, is brisk this season. The company intend carrying on extensive operations, and will employ upwards of one hundred hands.

The announcement has been made by the Financial Secretary of the Treasury, Mr. R. W. Hanbury, in the British House of Commons, that the government has decided to introduce competition in the telephone service in the country. He asked for a credit of $10,000,000 as a starter in order to enable the Post-office Department to develop the telephonic communication of London.

Mr. Frank Richardson, assistant electrician of the C.P.R., with a staff of assistants, is about to leave Ottawa for the Pacific coast. Acting under instructions from the Minister of Public Works, he will construct a telegraph line from Skaguay to Dawson. The distance is 600 miles, and the cost (on the basis of $250 per mile) will be $150,000. It is expected that the line will be in operation by the 15th of November, 1899.

The annual meeting of the Bell Telephone Company was held in Montreal last month. The directors' report stated: 1,637 subscribers have been added during the year, the total number of sets of instruments now earning rental being 32,082. The company now owns and operates 343 exchanges and 340 agencies, 666 miles of wire have been added to the long distance system in 1898; of these 326 miles are in the Ontario Department and 340 miles are in the Eastern Department. The long distance lines now owned and operated by the company comprise 17,233 miles of wire on 6,096 miles of poles. The receipts for the year 1898 were $1,302,994.04, made up as follows: Exchanges, $935,705.52; long distance lines, $264,455.49; private lines, $12,743.32; miscellaneous, $90,041.71. The expenses were $971,792.30, divided as below: Operating, $897,138.73; legal, $9,582.22; insurance, $13,740.20; bond interest, $47,042.16; miscellaneous, $4,288.99. This left a net revenue of $331,151.74.

MODERN SYSTEMS OF INTERIOR WIRING.*

By L. B. Chubbuck.

When the incandescent electric light was introduced commercially about 1881, in order to supplant its rival gas, it was claimed that the new illuminant required merely the cheapest and simplest kind of wiring. Paraffin covered wire (i.e., copper insulated with two cotton layers soaked in paraffin) had been used before this time for electric bell and telegraph work, and was at once adopted for electric light wiring. This covering was found to be totally useless, however, as often an overheated wire would ignite the inflammable covering, the flame following the wire for long stretches, especially where concealed under the floors or between the walls.

When the underwriters discovered this, they demanded a covering that was non-inflammable. So-called "Underwriters" wire was then introduced, the covering of which consisted of a cotton fibre braid, with a coating of zinc paint on the outside. This wire, while being non-combustible, was not water proof, and where moisture was present, electrolysis was set up, which soon destroyed the wire.

After the short stay of the "Underwriters" wire, a wire insulated with bitumen was brought forward to be used in moist

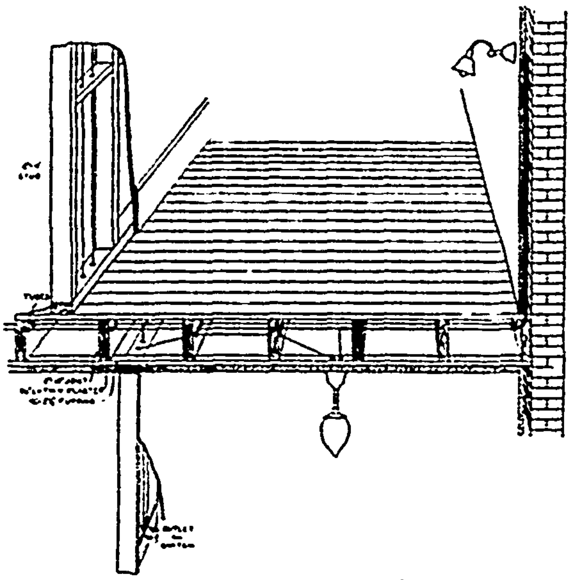


Fig. 1.—Porcelain Tube Work.

places. This, under the name of "Paragon wire," gave good results for a time, but eventually its insulation was found to crack, and its manufacture was discontinued. Since then various grades of composite and rubber covered wires have been introduced which are water-proof and of high insulation. These have survived to date.

A little of the earliest work was done by tacking the wires in place with small metal staples. This soon proved so objectionable, especially with poor grade of insulation then used, on account of grounds, short-circuits, etc., that it has been condemned ever since. A great deal of wiring after this was done with wooden cleats to support the wires in position. The wires were carefully run in respect to being kept away from gas or water pipes, and though no attempt was made to keep them from touching wood or plaster, they have given good satisfaction in nearly all cases where the buildings were perfectly dry. But natural dampness in the atmosphere, a leaky roof or the accidental spilling of water, is most liable to impair the insulation to such an extent that considerable leakage might take place. Fortunately, in this climate the small amount of moisture in the atmosphere has practically no effect on inside wiring, though in foggy districts near the sea coast, and especially in England, a great deal of trouble is experienced from grounds caused by a film of moisture forming over the surface of the fittings. In regard to wires imbedded in plaster, the effect on the insulation is uncertain, depending on the composition of the plaster and the covering on the wire. In some cases the alkalies in the plaster soon break down all insulation on the wire, while there are many instances of specimens of wire testing well after being imbedded in plaster for many years.

To prevent any liability of leakage or chemical action on the wire, it is now supported throughout on porcelain knobs or cleats, and where passing through timber or plaster is surrounded by a porcelain tube. In Fig. 1 is shown a sketch of this method of wiring as installed in the ordinary style of building. As may be seen from the figure, there is considerable open space in the partition walls, under the floors, and in many cases on the outer brick walls, in which the wiring may be concealed. The joists, studding, etc., are bored to receive the porcelain tubes, and the wires run through these tubes, which are made in different sizes and lengths, depending on the size of the wire and the thickness of the timber they are to pass through. The wiring of such a building is most readily done while the building is under construction and before the lathing and plastering is commenced. In finished buildings, where the wiring is to be concealed, the problem is more complicated, and to avoid breaking the plaster, a number of devices are used by different contractors. In passing down the partition walls the best work is done by using bits with shanks that can be lengthened to twelve feet or more, and boring through all obstructions in the partition from top to bottom. In passing down the narrow space between the lathing and brick work on outer walls, what is technically termed a "mouse" is used, consisting of a short chain fastened to the end of a cord. This is dropped down the wall and fished out from below; the wires are then drawn up to the outlet in flexible conduit. In order to conceal the wiring under the floors, some of the flooring is taken up, preferably by carpenters, although in small jobs this work is generally done by the electrican himself. Where thick gummy flooring is encountered, this is a most laborious operation with a hand saw, and a small circular saw is often used to much advantage. The writer has seen a combination of one of these saws geared to a small iron clad motor used for this work, which answered the purpose perfectly. Both saw and motor were mounted on a light wooden frame, by which the saw was moved ahead as the cutting proceeded. The connection to the motor was made by a long twin wire to the mains in the basement.

When it is considered too troublesome or expensive to conceal the wiring in a finished building by lifting floors, etc., the wires are often run in wooden moulding to diminish the unsightliness of open wires across the ceilings or walls. This class of work is much used on steam boats and is especially adapted in wiring panelled rooms, as the moulding may be made to match the woodwork of the room. Considered from an electrical rather than the decorative standpoint, wiring imbedded in moulding is inferior to wiring supported on porcelain and freely surrounded by air. The dissipation of heat is much easier effected in the latter case than in the former, and in a damp place the moulding will cause leakage, as wet wood is a conductor rather than an insulator. A case was met with recently where a No. 8 wire under the action of electrolysis had been entirely wasted away to a green trace of copper salts, by being imbedded in

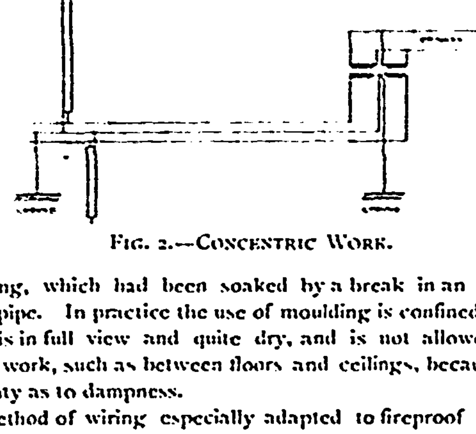


Fig. 2.—Concentric Work.

moulding, which had been soaked by a break in an adjoining water pipe. In practice the use of moulding is confined to work which is in full view and quite dry, and is not allowed in concealed work, such as between floors and ceilings, because of uncertainty as to dampness.

A method of wiring especially adapted to fireproof buildings, and known as the concentric system, is used to a great extent in England and Germany, though not yet in America. In this system, as illustrated in Fig. 2, instead of using two separate wires, one conductor is enclosed inside of an outer armor, which is

* Paper read before the Engineering Society of the School of Practical Science, Toronto, and published by permission.

used as the other conductor. The inner conductor is a tinned copper wire, which is surrounded with vulcanized rubber, taped and bedded with jute. Over all is bound a layer of galvanized iron wires twisted spirally, forming a complete tube about the inner conductor, and having a conductivity equal to it. For three-wire work, there are two inner conductors, insulated from each other, and from the outer covering, which in this case is used as the middle wire of the system. In both the two and three wire work this outer armor is grounded where the mains enter the building, and at different points along the wiring, if the stretches are long. A case may occur where the terminals of two separate concentrics which are on long circuits come a short distance apart. If one of these cables is fully loaded while the other is idle, there may be a "drop" of 2% on the loaded cable to no "drop" at all on the other, which will cause a difference of potential of 1% between the outers at the ends of the two cables. This under certain conditions is sufficient to set up electrolysis, which in time would destroy the covering of one or both cables unless they are both well grounded at these ends. For alternating current work, unless for short runs, both conductors must be run in the outer covering, as in the case of a single conductor in an outer iron armor, the drop along the line will be increased by impedence due to the alternating current.

The advantages of the concentric system are, that there is practically only one wire to run, and this may be buried in plaster or run over iron work with impunity. The cable itself also is quite small, being for a No. 12 wire only 5/16 in. in diameter, and as no insulators are required it is very easily concealed. Since it is armored, it is unaffected by nails, etc., and in case of any rough usage, such as the rupture of the cable by a chisel, a dead short-circuit is formed, which blows the fuse immediately, without any arc being formed external to the cable. The adherents of this system claim, like Mark Twain, that it is best to put all your eggs in one basket and then "watch that basket." They argue that it is better to put all the insulation on one conductor, and to see that this insulation is well protected, than to have two conductors, each liable to a breakdown. The disadvantages of this system are, first, the obvious difficulty in making the joints, and, second, having the outer grounded, which is a disputed question. This system is used chiefly in isolated plants or in buildings using alternating current and supplied from separate transformers, as there would probably be considerable electrolysis of gas and water mains where there was a network of bare outer conductors all over a city.

The concentric system is not used in America, and in the modern type of fireproof buildings, having brick partitions and floors of brick arches across the steel floor beams, the frail system of wiring on porcelain knobs is unsuitable. There is usually no free space along the floors or in the walls for running the wires, and even if there were such a space, the chances are great that falling mortar or brick would either break the wires or ground them on the steel frame work. To provide protection and accessibility to the wiring in such buildings, the conduit systems have been evolved. As far back as 1885 there are instances of wiring on some steamers being run in small brass pipes. The inside of the pipes was smooth, and as the runs were not long, the flexible cord used was easily threaded through the pipe from one opening to the next. Speaking tubes were tried about this time to act as a channel for the wires, but it was found that the conductors could not be inserted or withdrawn freely, and speaking tubes for this purpose were discarded. Since that time there has been very largely used a tube of papier mache, impregnated with a bituminous compound, to render it impervious to moisture and also to increase its insulation. It was found, however, that when this "plain conduit" was concealed in plaster, it was ultimately destroyed by chemical action. Another form of conduit, called circular loom or flexible conduit, is now used extensively. The inner portion consists of a tube formed by a strip of treated paper wound in a spiral; over this is a braided covering coated on the outside with flakes of mica. Though the inner tube is rather inflammable, the outer tube will withstand quite a flame for some time.

The next step was to cover the plain papier mache tube with a thin brass sheath having a longitudinal seam. This brass armored conduit was thought at one time to be near perfection, but even it was found to have its faults. It withstands chemical action to some extent, but is not completely waterproof, and, like all the preceding forms of conduit, it is very susceptible to mechanical injury. Much of the trouble with brass armored conduit has been due to the poor manner in which it was installed, as moisture entering at the outlets or at poor joints is absorbed by the inner lining, which in time will ground the wires on the outer covering.

Several tests were made in the school laboratories on both the circular loom and brass armored conduit, to determine their insulation under the presence of moisture. These tests were made by the condenser method in connection with an electrostatic voltmeter. It was found that in the case of the circular loom, though of fairly high insulation when dry, the insulation resistance fell off very rapidly under the presence of much moisture. The brass armored conduit tested well when dry, and also with moisture for a short time. When exposed, however, to damp for some time, especially if the armor was defective, the insulation fell off, the effect of grounding being more noticeable in the case of the brass armored conduit than with the circular loom, on account of the metal covering.

For absolute mechanical and moisture protection, the iron armored conduit is now used. It has been made with insulating linings of paper, wood, rubber, cement, enamel and asphaltic compound. The metal tube should be the minimum of metal for strength and rigidity, and the lining, besides being capable of bending with the pipe without cracking or splitting, must be impervious to heat and moisture. There has been much discussion as to whether an insulating lining is necessary in a metal pipe which is perfectly waterproof and the wires it contains are insulated up to many megohms per mile. At the World's Fair (1892) all forms of pipe tubing and conduit then manufactured were rejected, and plain iron pipe was finally adopted, in which the distribution wires were run. Although some of these wires were carrying a 2,000-volt alternating current, no faults whatever were developed. There are also thousands of miles of plain iron pipe now used for underground service for high potential mains in cities, which have given perfect satisfaction.

In spite of these facts, a thin insulating lining is always used for interior conduit work, for several reasons. All the iron pipe as now manufactured on a large scale is very rough on its interior, due to burrs, fins and splinters, and in pulling a wire through a long stretch of this pipe the insulation is very liable to be torn, especially in rounding corners, elbows, etc., in the smaller sizes of pipe. A plain iron pipe is also liable to sweat internally, and any rust due to moisture in the conduit is a menace to the insulation on the wire. Thus a thin lining is useful as tending to preserve both the pipe and the insulation.

There are two styles of iron armored conduit very extensively used, one having a lining of treated paper and the other a thin coating of enamel both inside and outside. The lining in the latter conduit is very hard and as smooth as glass, which is an advantage in inserting the wires. These iron armored conduits are manufactured in the regular gas pipe sizes externally, and in coupling the standard gas pipe threads are also used.

DISTRIBUTION.

The system of distribution to be used in a building depends to a large extent on the character of the building, whether the lights are scattered, as in the case of a business block, or arranged in groups in a large electrolier, around the stage, etc., as in the case of a theatre. One of the most general methods of distribution is shown in Fig. 3, which gives an isometric sketch of the feeder system in one wing of a modern office building. In this system of wiring all the branch circuits (not shown) on each floor are run from one or more distribution boxes or cabinets on that floor. The panel boards in these cabinets are supplied from the switchboard in the basement by a system of risers or feeders running up one of the side walls to the cabinets. In conduit work a two-wire system is usually employed throughout the building, and a separate pair of feeders run up from the switch-board to each distribution box. Or where the load is light, and separate control for each floor from the basement is not required, the panel boards on two or three adjacent floors are supplied from one pair of feeders. In order that the public lights along the halls, staircases and elevators may be independent of the other lights in the building, it is customary to run a pair of feeders from the base-

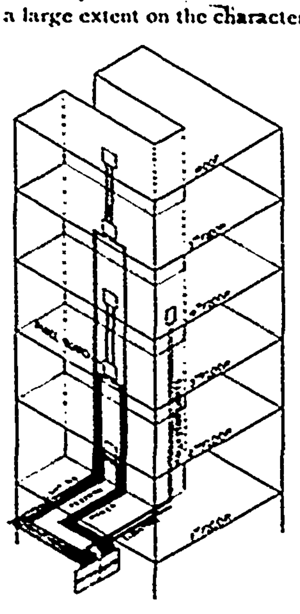


FIG. 3.—FEEDER SYSTEM.

ment to one or more separate panel-boards on certain floors from which these lights are wired. In case current is required for running motors for printing presses, etc., on some of the floors, the main panel boards on these floors are divided into two sections, one part for the lighting and the other for power service. This power section of the panel board is supplied by separate feeders from the power panel of the switch-board, from which are also run the mains for the elevator motors.

Where ventilating motors are used in a building, they are usually placed immediately under the roof and wired from the power panel in the top floor. To start or reverse these from the basement, a magnetic switch is often placed in the branch circuit to the motor, and the four small controlling wires from this switch run to the basement in one conduit. By the use of these automatic switches, motors, lights, etc., may be controlled from distant points without the expense of diverting the heavy main wires. They can be used in controlling dummy waiters from different floors, and also as the ordinary three and four point switches in lighting an electrolier from several different places. Where the building is to be wired for electric bell, telephone or ticker service, weatherproof wire is generally used throughout for this purpose, and all the wires from each floor run in a single conduit to a distribution box in the basement.

INSTALLATION.

In Figs. 4 to 11 are shown details of different parts of conduit electric wiring as installed in a fireproof office building. The

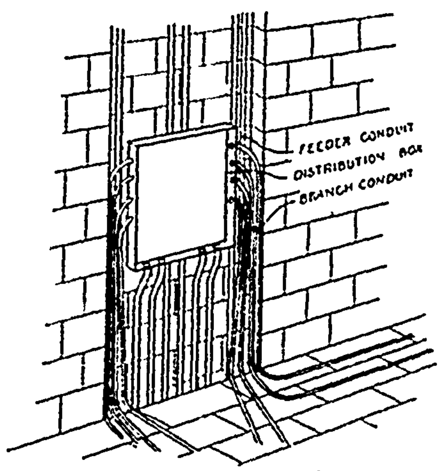


FIG. 4.—WIRE WAY.

conduit is installed at that stage in the construction of the building after the brickwork in the flooring and walls is finished, but before any plastering is started. Since even the smallest size of conduit (⅝") is generally too large to be covered by the layer of plaster on the brick walls, it is necessary to cut shallow channels in the brickwork wherever the conduit is to run on these walls. This is a tedious job, and is usually done by a gang of men with hammers and cold chisels before the regular conduit work is started. Where there are a number of vertical feeders requiring large conduit to be run, arrangements are made with the architect to have a recess left in the brickwork of sufficient width and one brick deep from the basement right up to the roof. A good place to run this channel for the feeders is up the elevator enclosure. This is generally in a central location, which is convenient for the panel boards, and besides this there are no windows, partitions, walls, etc., to dodge around in running the feeders to the basement. Fig. 4 shows the manner in which the feeder conduits are run in the wire way and their connection to the distribution box, also the smaller branch conduits leading from the box to the different circuits.

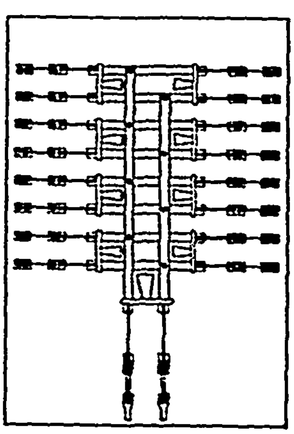


FIG. 4a.—PANEL BOARD.

On account of the large size of wire used for the feeders, a separate conduit is generally run for each wire. If, however, an alternating current is to be used in the building, this arrangement of one conductor in an iron tube will cause a loss of energy by induced currents set up in the iron. It is thus necessary to use brass armored conduit or to neutralize this effect by running both wires in the one tube.

In the branch circuits two wires or a twin wire are almost always run to a single conduit, and the wiring differs in some respects

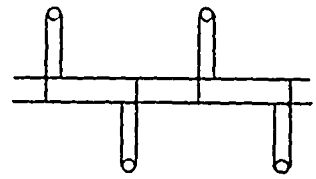


FIG. 5.—ORDINARY WIRING.

from ordinary methods. In ordinary work, where a number o lights are installed in a room, the mains are run down the length of the room and branches tapped off to each lamp, as shown in Fig. 5. In conduit work, however, no tee's are placed on the conduit, and a zig-zag path is taken from one outlet to the next. In afterwards inserting the wires they are run to the furthest outlet, and, working back, a loop is left at each of the other outlets, to

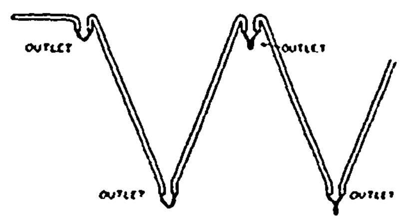


FIG. 6.—LOOP SYSTEM.

which the wires from the fixture are connected. Thus in this "loop system" (Fig. 6) the branch wires are not cut at any place between the panel board and the furthest outlet, so that if larger wires are afterwards required, the different fixtures may be disconnected, the old wires pulled out from end to end, and the larger wires inserted.

Some details of the conduit work on branch circuits are shown in Figs. 7 and 8. It will be noticed that the conduit is run on the

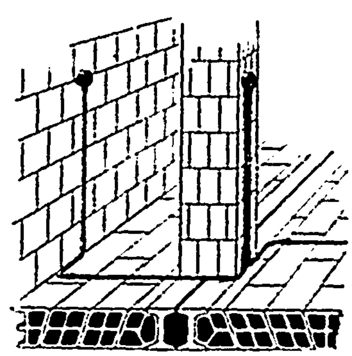


FIG. 7.—DETAILS OF BRANCH CIRCUITS.

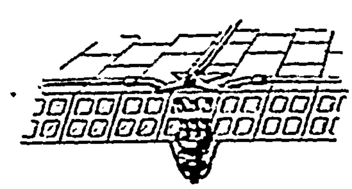
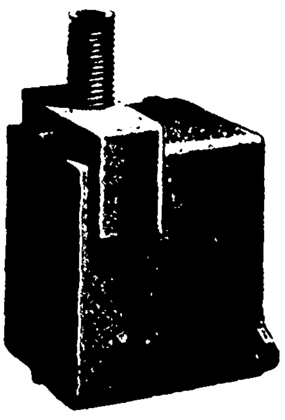


FIG. 8.—DETAILS OF BRANCH CIRCUITS.

brick flooring and not across the ceilings. This is because the plaster on the ceilings is not thick enough to cover the iron armored conduit, and since the brick flooring is afterwards covered by two to four inches of cinders, over which asphalt or the floor boards are laid, the tubes are completely concealed. In both these figures outlet boxes are used, into which the ends of the conduit at the outlet are sealed. These outlet boxes are made of iron, with a lining of the same material as that used in the conduit. Two common forms are shown in Figs. 9 and 10, the first of which is an outlet box shaped to act as a receptacle for a flush switch. Fig. 10 gives a form used at a bracket outlet, showing the nipple on the cover by which the bracket is supported. In many buildings, however, outlet boxes are not used, especially for bracket and ceiling lights, the conduit being trimmed off nearly flush with the plaster and the fixture connected up in the usual manner. When one or more branches are to be tapped off the mains for an electrolier, etc., a "junction box" is used. These are very similar to outlet boxes and often contain a branch cut out, making them practically a distribution box on a small scale.

The wiring in the basement is usually run open, i.e., not concealed in the plaster, and is often run in flexible conduit or on porcelain knobs, though for fireproof work the iron armored con-



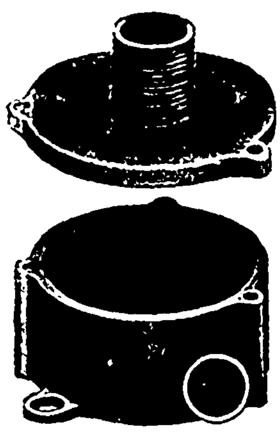


FIG. 9. OUTLET BOX. FIG. 10.—OUTLET BOX.

duit is continued to the switchboard. A very useful support, made from gas pipe, for carrying the conduit in the basement is shown in the upper portion of Fig. 11. This figure also shows a form of switchboard suited to the feeder system in Fig. 3, each pair of feeders being controlled by a double pole switch.

It is not permitted when installing the conduit to run cords in the stretches as they are put up, to facilitate pulling the conductors through afterwards, as this might make poor construction possible; that is, it would be an easy matter to pull even large wire through a conduit having rough, poorly made joints, which would abrade the insulation on the wire. When the wire is run through the conduit properly, it is practically a gaurantee that the conduit has been well installed or the conductors could not be inserted. For this same reason, it is important to have all necessary curves as gradual as possible or difficulty will be had in running the wires afterwards. In making a correct joint in iron armored couduit, a wheel pipe cutter is used to cut merely through the outer iron armor, a hack-saw being used to saw through the lining. A reamer is then used to trim up the end of the conduit before it is threaded. A jack-knife is often used in-

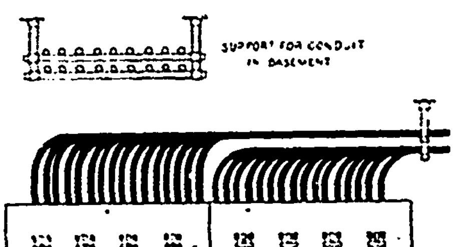


FIG. 11.—SWITCHBOARD.

stead of the reamer, but a poor job is generally the result. Care should also be taken that the white lead used in sealing the joint does not get between the ends of the conduit. This can be prevented by giving the coupling a turn or two on the conduit, and then applying the lead to the thread on the outside of the conduit.

The actual wiring of the building by running the conductors through the conduit is not done till all the plastering, flooring, etc., is over and the building is nearly finished—in fact, the wires are often run and the fixture work done at the same time.

There is not much difficulty in running the risers or feeders, as the conduit is large, and the wire, where larger than No. 6, is generally a stranded conductor. On the horizontal branch circuits, however, with many turns and using twin wire, the problem is not so simple. The inside surface of the conduit is first rendered smooth by blowing some powdered soapstone out of a horn through a section of the conduit. A steel tape about 3/8" wide and as thick as a clock spring is then passed through the conduit, after which the wires may be run. The tape is always run downwards if possible from a higher to a lower outlet. An ordinary stretch for a run is from fifty to eighty feet with three or four turns, though it is sometimes possible to thread the steel tape nearly two hundred feet on a horizontal run.

In conclusion, it may be stated, that on account of the high standard of insulation now used on wire, any system of wiring is practically perfect where the insulation is protected from mechanical and chemical injury. The system to be employed in any special case depends on the circumstances. In some cases one system may be perfect, while in others it is expensive and unnecessary. In the best practice iron armored conduit is used in fireproof buildings or where the wiring is embedded in plaster or brick work. For the ordinary class of buildings with wooden joists, etc., where there is no liability of mechanical abuse, porcelain work is perhaps as good a system as can be used. In any case, where the wiring is properly done, the incandescent electric light—in contrast to the explosive and poisonous character of ordinary lighting gas—is probably the safest method of illumination yet devised by man.

THE BURSTING OF SMALL CAST IRON FLY-WHEELS.

MR. Chas. H. Benjamin, of Cleveland, Ohio, in a paper presented recently to the American Society of Mechanical Engineers on the above subject, states the following as his conclusions on the subject, based upon careful experiments:

1. Fly-wheels with solid rims, of the proportions usual among engine builders and having the usual number of arms, have a sufficient factor of safety at a rim speed of 100 feet per second if the iron is of good quality and there are no serious cooling strains. In such wheels the bending due to centrifugal force is slight, and may safely be disregarded.

2. Rim joints mid-way between the arms are a serious defect and reduce the factor of safety very materially. Such joints are as serious mistakes in design as would be a joint in the middle of a girder under a heavy load.

3. Joints made in the ordinary manner, with internal flanges and bolts, are probably the worst that could be devised for this purpose. Under the most favorable circumstances they have only about one-fourth of the strength of the solid rim, and are particularly weak against bending. In several joints of this character, on large fly-wheels, calculation has shown a strength less than one-fifth that of the rim.

4. The type of joint exemplified in Nos. 16 and 17 is probably the best that could be devised for narrow-rimmed wheels not intended to carry belts, and possesses, when properly designed, a strength about two-thirds that of the solid rim.

It is gratifying to notice the fact that since the subject of joints in fly-wheel rims has been so thoroughly ventilated during the discussions before this society, several of our prominent engine builders have changed the designs of their wheels by bringing the rim joints opposite the ends of the arms. The experiments which have just been described, although at times a trifle too exciting, were interesting from first to last. The writer hopes to supplement them by others on models of the more recent rim-joints, and would be glad to receive any suggestions. The more this subject is agitated, the less shall we have occasion to mourn the destruction of life and property on account of faults in the design of this most necessary element of the steam engine.

Mr. C. H. Meredith, of Ottawa, is working on an invention to prevent anchor ice.

PROPOSED WATER POWER DEVELOPMENT AT SHAWINIGAN FALLS, QUE.

A WATER power development of rather unusual interest, the construction of which will soon be commenced, is that of the Shawinigan Falls, on the St. Maurice River, P.Q. This power and over 800 acres of land adjacent thereto are owned and will be developed by the Shawinigan Water and Power Company, of Montreal.

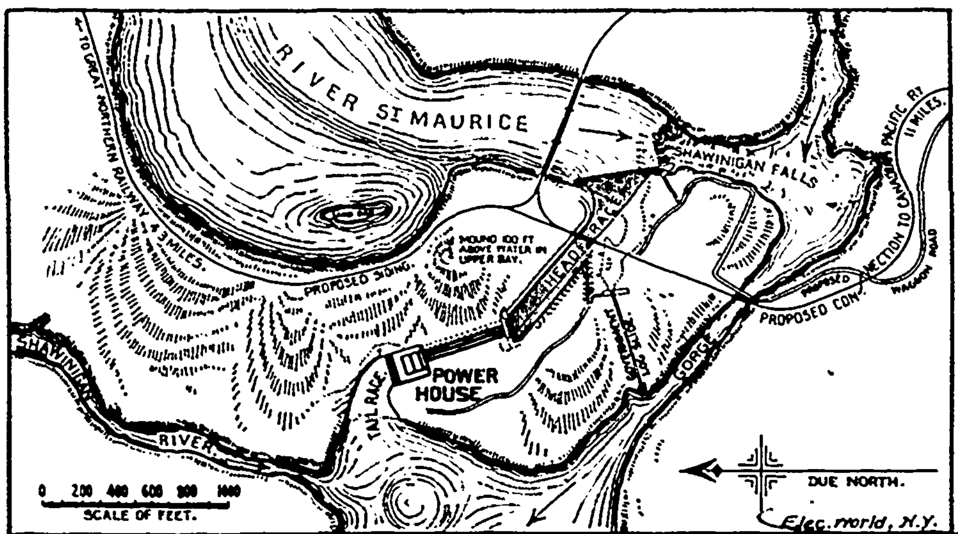
At these falls the river, which is one of the largest in Canada, draining some 18,000 square miles of territory, drops over 140 feet in a very short distance. The extraordinary formation of the peninsula of land lying between the upper and lower levels of the river above and below the falls, and the way in which the river turns at more than a right angle to its course after hurling itself down the main cascade, here affords what is undoubtedly one of the most favorable natural locations for a water power development in the world.

Owing to the nature of the country drained, which is densely wooded throughout, the flow of water in this stream is very steady throughout the year. At lowest water it is calculated that sufficient water passes over the falls to develop 190,000 horse-power, under the working head of 120 feet, on the shafts of turbines having 80 per cent. efficiency. Of this amount 150,000 horse-power could safely be used.

The falls are favorably situated as regard saccess to rail and water shipping facilities. The Great Northern Railway, which is a link in the short line route from Chicago and Parry Sound to Quebec by way of Ottawa, passes close to the falls, and the construction of a siding 4½ miles long to this road will be commenced in the early spring. This will give communication with Quebec, 90 miles distant in one direction, and with the great west by the shortest known route, in the other direction. The Canadian Pacific Railway, Canada's transcontinental line, passes within 10 miles of the falls on the opposite side of the river, and a siding from this road has been located by the engineers. The operation of the Montreal and Quebec division of the Canadian Pacific Railway and a considerable section of the Great Northern Railway by electricity, using either the trolley or the third-rail system, is claimed by the engineers to be well within the commercial possibilities of this development.

Three Rivers, a town of 9,000 inhabitants, at the junction of the St. Maurice river with the St. Lawrence river, and 17 miles distant from the falls, is a seaport with excellent shipping faciiities, which afford means of water communication with the ocean and the great lakes for eight months in the year. The Canadian Pacific Railway passes through this town, and the Grand Trunk railway is reached by means of a ferry to the opposite shore of the River St. Lawrence. It is intended to transmit power under 20,000 volts pressure to this town for manufactures of various kinds on an extensive scale.

The present development, for which contracts have been let, and on which construction will be commenced shortly, will consist of the installation of turbines and generators for 30,000 horse-power, with provision for extension up to 150,000 horse power. Twenty thousand horse-power of this will be in the form of alternating current for transmission to Three Rivers, and 10,000 horse-power in low-voltage direct current, to be used in various electro-chemical industries in the vicinity of the falls. The water is to be taken in from the side of the river just at the head of the falls, and carried back in a head-race 1,200 feet long, 100 feet wide and 16 feet deep. The arrangement of the head-race entrance will naturally tend to allow the draft over the falls to carry off the frazil and anchor ice which is such a bugbear to all engineers who have to deal with water powers in Canada.



MAP SHOWING PROPOSED WATER POWER DEVELOPMENT AT SHAWINIGAN FALLS.

The bulkhead is to be of concrete, with steel grates operated by pneumatic pressure, in front of feeder-pipe inlets, and from here the water will be carried down in steel feeder pipes 13 feet in diameter and about 550 feet long. Each of these pipes will carry sufficient water to develop 10,000 horse-power net, under the working head of 120 feet. Two of the pipes will be connected to two pairs of twin turbines, each of 5,000 h.p. capacity, running at 300 revolutions per minute, each direct connected to an alternating-current 5,000 h.p. generator. These generators will be among the largest horizontal shaft generators yet built, and will weigh in the neighborhood of 100 tons. A pair of gate valves 78 inches in diameter, with pneumatic lift, will control each unit of 5,000 horse-power, so that should one unit require to be stopped, the opposite one on the same pipe can be kept running. The turbines operating the direct-current generators will consist of four pairs of twin turbines, each of 2,500 h.p. capacity, having two direct-connected generators, one on each end of the driving shaft. Each of these 2,500 h.p. units will also be controlled by separate gate valves.

A special feeder pipe 4 feet in diameter will run the exciters and the air compressor, supplying air for the operation of gate valves, switches, etc. All the feeder pipes are to be coned down and provided with numerous pop valves and large air cushion cylinders to relieve water hammer. The governors will be operated by compressed air, and in operating the cylinder gates of turbines a novel arrangement has been devised, so that no moving part of the mechanism will operate under water. Roomy tunnels well above back-water level will run between the generators and switchboards and transformers. The switches will be operated by compressed air, and the switchboard is so located as to overlook all the generators and exciters.

The transmission lines to Three Rivers, operating under a pressure of 20,000 volts, will be two in number, one on each side of the river, so as to avoid the risk of total loss of line from forest fires which might occur in the wooded country through which the lines will pass. These lines will be 17 miles long, of which 15 miles will be dead straight. Wire will be bare copper, on triple petticoated insulators set on suitable cross arms on heavy cedar poles set 6 feet into ground, 100 feet apart.

A triple line of lightning arrestor wires, grounded at every fourth pole, will be carried over the transmission lines. The transformers at both ends will be oil-filled self-cooling.

Messrs. T. Pringle & Son, of Montreal, are the company's engineers for both the hydraulic and electrical development, W. C. Johnson, engineer of the Niagara Falls Hydraulic Power & Manufacturing Company, being consulting engineer. Wm. Israel Bishop will be engineer in charge, and F. H. Leonard will have charge of the designing and installation of electrical apparatus.

For the above particulars we are indebted to the Electrical World.

INSPECTION OF STEAM BOILERS IN BRITISH COLUMBIA.

The Legislature of the province of British Columbia has passed a bill, which received its third reading on February 13th last, to provide for the inspection of steam boilers. It is entitled "An Act respecting the Inspection of Steam Boilers," and is as follows:

ACT RESPECTING THE INSPECTION OF STEAM BOILERS.

Her Majesty, by and with the advice and consent of the Legislative Assembly of the Province of British Columbia, enacts as follows:

1. This Act may be cited as the "Steam Boiler Inspection Act, 1899."

2. The expression "boiler" wherever the same occurs in this Act includes the steam engine or engines, and every part thereof, and all apparatus and things attached to and connected therewith, or used with reference to any such boiler or engine.

3. This Act shall not apply to railway locomotives on railways under the supervision of the Dominion of Canada, nor to any boiler subject to inspection under the laws of the Parliament of Canada, nor to any boiler with a capacity of two horse power or under.

4. The Lieutenant-Governor in Council may constitute such portions of the Province as he may think proper into Steam Boiler Inspection Districts, and may, from time to time, alter such districts.

5. For each of such districts the Lieutenant-Governor in Council shall appoint an Inspector, to be called Inspector of Steam Boilers.

6. It shall be the duty of each Inspector to inspect the steam boilers within his district before the same shall be used, and once at least in each year to inspect and thoroughly test all steam boilers within his district.

7. Nothing in this Act shall be construed to prevent the use of any boiler or steam generator which may not be constructed of riveted iron or steel plates, when the Inspector has satisfactory evidence that such boiler or steam generator is equal in strength and as safe from explosion as boilers of the best quality constructed of riveted iron or steel plates.

8. (1.) Every steam boiler shall be provided with a fusible plug, approved by the Inspector, inserted in the flues, crown sheet or other part of the boiler most exposed to the heat of the furnace when the water falls below the prescribed limits, so that the plug will fuse and put out the fire.

(a.) Each boiler shall have a safety valve of approved pattern of not less than one square inch of area to three square feet of grate surface; if it be a water tube boiler, it shall have one square inch of area to six square feet of grate surface. This safety valve shall be set by the Inspector to the pressure of steam allowed by him.

(b.) No person shall alter in any way the weight, or if a spring loaded safety valve is used, no one shall alter the spring so as to carry a greater pressure than allowed by certificate of Inspector, under a penalty of not exceeding one hundred dollars.

9. Every steam boiler shall also be provided with one or more steam gauges, tricocks, gauge glass and safety valve, tested annually, unless the Inspector shall specially certify the same to be unnecessary.

10. The certificate of inspection to be granted under this Act shall be in the form set out in Schedule A.

11. The said certificate, together with a copy of sections 21 and 22 of this Act, shall be posted up, and be kept posted up in a conspicuous place on the steam boiler, or in the engine room where such steam boiler is being operated, in such place as the Inspector shall direct, and no person operating such steam boiler shall operate the same at a higher pressure than that authorised in the certificate.

12. (a) An appeal shall lie from any ruling or decision of an Inspector, to the Chief Commissioner of Lands and Works, whose decision shall be final, and the said Chief Commissioner shall have power to order the payment of a reasonable sum for costs, and in case of default in payment pursuant to such order, the same may be recovered in any Court of competent jurisdiction by the party or parties to whom awarded.

(b) In any appeal it shall be lawful for the Chief Commissioner of Lands and Works, if he think fit, to summon to his assistance an expert engineer who shall attend and assist accordingly.

13. In addition to the annual inspection, it shall be the duty of each Inspector to examine at any time, when in his opinion such examination shall become necessary, all such steam boilers within his district as shall become unsafe from any cause, and to notify the owner or person using such steam boilers of any defect, and what repairs are necessary in order to render them safe.

14. The Inspector shall have the right, at all reasonable hours, to examine steam boilers in course of construction or repair, and to refuse to grant a certificate for any steam boiler found to be defective according to the provisions of this Act, or of which such examination has been refused.

15. Each Inspector shall keep a register of the inspections and certificates made and granted by him, of all repairs ordered by him, of all steam boilers condemned by him as unsafe, of all accidents to steam boilers whether by explosion or otherwise, and of all casualties that may happen or occur in connection with steam boilers within his district.

16. The Chief Commissioner of Lands and Works may order an investigation to be made, by any person or persons, into the cause of any accident to any steam boiler, attended or not attended with loss of life, and the person or persons so appointed may summon witnesses and compel their attendance before him or them, by the same process as Courts of Justice, and may administer oaths and examine witnesses touching the cause of such accident, and shall report thereon to the Chief Commissioner.

17. Each Inspector shall annually, on or before the first day January, send to the Chief Commissioner of Lands and Works a concise report of all inspections and transactions connected with the performance of his duties, and of all accidents and

casualties to steam boilers, whether by explosion or otherwise, that have happened or occurred within his district during the year.

18. The fees to be paid for inspection and the salary of the Inspectors shall be fixed by the Lieutenant-Governor in Council.

19. Every person who constructs steam boilers known to be imperfect, or who drifts any rivet hole to make it come fair, shall be liable to a fine of two hundred dollars.

20. It shall be the duty of owners or managers of steam boilers to allow the Inspector free access to the same, and to furnish water and fill the boiler and remove the jacket or covering when directed by the Inspector, to enable the Inspector to make a proper test, and all engineers operating such steam boilers shall assist the Inspector in his examination, and shall point out to him any defect that they may know or believe to exist in the steam boiler in their charge, subject to a penalty of not less than twenty dollars nor more than three hundred dollars.

21. Any person operating a steam boiler, as well as the lessee or owner thereof, in case the same is being operated with his consent, without there being an unexpired certificate of inspection thereof, shall be liable to a penalty of five dollars a day for each day that he shall operate such uncertificated steam boiler; provided, however, that the penalties herein enacted shall not take effect until after the expiration of four months after this Act shall have come into force, nor in cases where there is no such certificate owing to the neglect or default of an Inspector.

22. It shall be the duty of the person operating or owning any boiler pronounced by the Inspector unsafe, to cease to use the same until such repairs as are indicated by the Inspector are made, and in case of failure to comply with the requirements of the Inspector, the person owning, as well as the person operating, any such boiler shall be liable to a fine not exceeding one hundred dollars, and shall also be liable for any damage to person and property resulting therefrom.

23. Any Inspector who shall wilfully certify falsely regarding any steam boiler shall, on conviction, be liable to a fine of not less than fifty dollars and not exceeding five hundred dollars.

24. Any person violating the provisions of section 11 of this Act shall be liable to a penalty of not less than ten dollars and not more than fifty dollars.

25. No Inspector shall act as agent for the sale of boilers under a penalty of removal by the Lieutenant-Governor in Council.

26. Any penalty recovered under this Act shall form part of the Consolidated Revenue Fund.

27. All penalties imposed under this Act shall be recoverable before a Justice of the Peace, a Police Magistrate, or a Stipendiary Magistrate. Such Justice of the Peace, Police Magistrate, or Stipendiary Magistrate, in case the penalty awarded by him be not forthwith paid upon conviction, with such costs as shall be awarded, shall levy the same by distress and sale of the goods and chattels of the offender, by warrant under his hand and seal.

28. In default of the payment of the penalty and costs, or of sufficient distress, the offender may, by warrant under the hand and seal of the convicting Justice of the Peace, Police Magistrate, or Stipendiary Magistrate, be imprisoned in the nearest goal or lock-up for a period of not less than fourteen days, and not more than six months, at the discretion of such Justice of the Peace, Police Magistrate, or Stipendiary Magistrate.

29. No conviction or warrant of commitment under this Act shall be vacated, quashed or set aside for want of form, or be removed by writ of certiorari or other process into the Supreme Court.

30. (a) The Lieutenant-Governor in Council may make rules and regulations for the testing of steam boilers, and all matters connected with the construction and working thereof, including the examination of persons in charge of same.

(b.) Any rules and regulations made under the authority of this section, shall, after publication in the British Columbia Gazette, have like force and effect as if herein enacted.

SCHEDULE "A."

CERTIFICATE OF INSPECTION OF STEAM BOILER.

PROVINCE OF BRITISH COLUMBIA. } This certificate expires 18 .

I hereby certify that I have this day inspected the steam boiler owned by of in the Province of British Columbia [GIVE DISCRIPTION OF STEAM BOILER BY WHICH IT MAY BE READILY IDENTIFIED], and having carefully examined said steam boiler, have found the same in condition, and therefore authorize a steam pressure of pounds to the square inch and no more.

Dated this day of 18

INSPECTOR.

MUNICIPAL LIGHTING PLANT AT ACTON.

THE village of Acton, Ont., is now supplied with arc and incandescent electric lights by a municipal plant, which was started up for the first time on January 28th, just two months and one week after the contracts were signed.

The power house is a stone structure, 24 × 50 feet, floored with maple, with walls and trimmings of dressed red birch. The engine and dynamo room is 24 × 37 feet, and the boiler room 24 × 13 feet. The engine is of the Wheelock type, capacity 75 h.p. nominal; and the boiler 90 h.p. These were supplied by the Goldie & McCulloch Co., Galt, and uphold the reputation of that well-known firm. The dynamo is a fifty kilowatt alternating current machine, with a capacity of 1,000 incandescent lights. There is a fine two-panel marble switchboard, with full complement of controlling instruments, and 56 32 c.p. incandescent street lamps, arranged in two circuits independent of each other, and a third circuit for domestic and commercial service, also independent. The electrical machinery, wiring, etc., was contracted for by the W. A. Johnson Electric Company, of Toronto. The main driving belt is 16 inches, 65 feet long, and the dynamo belt is a 10 inch, double, endless. Both were supplied by the belting department of the Acton Tanning Company.

Mr. Reynolds, the electrician, had the general oversight of plans and arrangements; Messrs. Forbes and Graham of the erection of the power house; Mr. W. Cowan, of the Goldie & McCulloch Co., of the placing of the boiler and engine; and Mr. H. J. Hurd superintended the construction of the electrical work for the W. A. Johnson Electric Co.

MOONLIGHT SCHEDULE FOR MARCH.

Day of Month.	Light.	Extinguish.	No. of Hours.
	H.M.	H.M.	H.M.
1....	P.M. 6.10	P.M. 11.30	5.20
2....	" 6.10	A.M. 1.00	6.50
3....	" 6.10	" 1.30	7.20
4....	" 6.10	" 2.40	8.30
5....	" 6.20	" 3.30	9.10
6....	" 6.20	" 4.20	10.00
7....	" 6.20	" 5.10	10.50
8....	" 6.20	" 5.20	11.00
9....	" 6.30	" 5.20	10.50
10....	" 6.30	" 5.20	10.50
11....	" 6.30	" 5.20	10.50
12....	" 6.30	" 5.10	10.40
13....	" 7.40	" 5.10	9.30
14....	" 8.40	" 5.10	8.30
15....	" 9.40	" 5.10	7.30
16....	" 10.50	" 5.10	6.20
17 ...	" 11.00	" 5.10	6.10
18....	" 11.50	" 5.10	5.20
19....	....	" 5.10 }	4.30
20....	A.M. 12.40	..... }	
21....	" 1.20	" 5.00	3.40
22....	" 2.00	" 5.00	3.00
23....	" 2.30	" 5.00	2.30
24....	No Light.	No Light.	.....
25....	No Light.	No Light.	.....
26....	No Light.	No Light.	.....
27....	No Light.	No Light.	.....
28....	P.M. 6.50	P.M. 9.20	2.30
29....	" 6.50	" 10.20	3.30
30....	" 6.50	" 11.30	4.40
31....	" 6.50	A.M. 12.30	5.40
		Total.........	185.30

THE PITTING OF BOILERS.—Investigations have been made by M. Olory, a French engineer, in regard to the pitting of boilers, the result showing that the powder thus formed contains 86.29 per cent. peroxide of iron, 6.29 per cent. of grease and other organic matter, and 4.25 per cent. of lime salts. In one of the tests resorted to a polished iron bar was first immersed in a natural water containing much oxygen and no lime salts; the bar gradually rusted, the corrosion ceasing when the oxygen was used up – the bar being now removed, repolished, and put back, it remained perfectly bright. Repeating the experiment, with water containing lime, the rusting was much less complete, the lime salts forming a protective layer on the iron, but on polishing this off corrosion recommenced. In distilled water the bar remained quite bright. The corrosion is much more rapid if the water contains carbonic acid gas as well as oxygen.

MONTREAL

(Correspondence of THE CANADIAN ELECTRICAL NEWS.)

MCGILL UNIVERSITY LECTURE "ELECTRICITY AS A FACTOR IN MODERN DEVELOPMENT."

The annual university lecture of McGill was delivered on February 17th before a large and representative audience, the lecturer being Prof. R. B. Owens, chief of the electrical department. Prof. Owens chose as his subject "Electricity as a Factor in Modern Development. At the outset he referred briefly to the relation of the world's material and social progress to the work of the engineer the man who economically converts the materials and forces of nature to useful and social ends. A single invention the steam engine had made more history in its short life than half the world's rulers. By the introduction of electric traction, not only had the sanitary conditions of our cities been improved, but healthy country homes had been substituted for the overcrowded tenement. Electric traction was not dangerous at higher speeds than is possible with horses, and the small cost of electric operation permitted of low fares being charged. The effect of rapid transit on urban architecture was also plainly seen.

In regard to electric power for industrial purposes, Prof. Owens said that he thought the change from older methods of factory driving to the present one of using electric motors had a distinct and elevating influence upon the character of the men employed. So scrupulously clean, cheerful and healthy had many modern shops become, that positions in them are eagerly sought by persons of both sexes of genuine culture and refinement. For example, the Weston Electrical Instrument Company, of New Jersey, were erecting a new shop for the manufacture of their famous instruments, in which not only are manual operations reduced to a minimum, and a pure sunlight effect maintained by skilful coloring and the intelligent use of electric lights, but the very air the employees breathe is first mechanically cleansed of every germ and dust particle it contains.

The question of the place of engineering in the coming university was dealt with. The speaker said that just as a general knowledge of science had become to be considered an essential in every course intended to afford a liberal education, so a general knowledge of the applications of the science would likewise be regarded. In other words, the broad principles of engineering would be included in every university course, and the special branches would be taught in graduate technical schools. But this would not come immediately--not until the supply of engineers more nearly equalled the demand for them, for only then could they be expected to spend more than four years in preparation for their work. For the present, then, electrical as well as other special branches of engineering must be conducted as undergraduate work, but so rapid have been the advances in the development of electricity, and so vast are the facilities for experiment possessed by the larger manufacturing companies, that the school is in general behind the factory. Consequently, every effort must be made to keep in close touch with best current practice. This it would be sought to accomplish in two ways—first, by equipping the electrical laboratories with the best facilities for investigation that could be obtained, most of the machines upon which tests are to be made being supplied by the manufacturing companies, as different new types are developed; and, secondly, by having practical engineers, engineers of the better electrical manufacturing companies, and others engaged in special work, deliver lectures on special subjects from time to time.

Prof. Owens said that few, if any, schools of electrical engineering were more happily situated than McGill. With the splendidly equipped factories of the Canadian General Electric Company at Peterborough, the Royal Electric Company at Montreal, and the magnificent water power developments at Lachine and Chambly, all within easy reach, the student would quickly learn the bearing of his subject upon the commercial and industrial interest of the Dominion, and it was the speaker's highest ambition that the splendid water powers of Canada should be guided into useful channels largely by graduates of McGill University.

Prof. Owens then returned to his original subject, and traced in more detail the developments in the several branches of electrical work. His remarks in this connection are given below in full:

ELECTRIC LIGHTING.

Sir Humphery Davy, with a battery of copper zinc elements, gave us the electric arc in 1810, by passing a current of electricity between the ends of carbon pencils held a small distance apart in air, but the generation of electricity by chemical means was then, and still is, too expensive for commercial use. It was not until after the discovery of the principle of the dynamo by Henry in 1830, and Faraday in 1831, that the way was opened for the general application of the most beautiful and easily managed of all forms of physical energy.

Coupled with the steam engine and water wheel, the dynamo converts the solar energy of our coal fields and waterfalls into a subtle and powerful force, whose applications are literally without number.

Unaffected by gravity or temperature, capable of indefinite subdivision and highly efficient conversion, and requiring the simplest of all means of conveyance—a stationary metal conductor—no limit can be put upon the use of electric power.

By 1870 the dynamo machine might be said to have reached a commercial form, but the problem of electric lighting was not solved until 10 years later. On February 5th, 1880, Mr. Edison filed an application for a patent on a system of electric lighting involving the use of high resistance electric lamps, arranged in multiple circuit across the terminals of a low resistance dynamo, solving by this combination the then serious problem of the subdivision, as it was called, of the electric light.

In September, 1882, the Edison Electric Illuminating Company of New York, started their Pearl street central station, to supply current on a commercial scale to the down-town or business districts of the city, and within the next few years about this old station were worked out many of the problems of central station practice.

So rapidly were the advantages of the incandescent lamp appreciated for interior lighting, and the electric arc for street illumination, that in less than a single generation from fifteen to twenty million incandescents and nearly half a million arcs are now in use in a single country—the United States.

In the early days of the industry when the problems of insulation and distribution were imperfectly understood, it was necessary to use low electric pressures and to place the central station close to the district to be supplied, but now that we have become familiar with pressures of ten, twenty, thirty and forty thousand volts, and the possibilities of alternating currents for transmission and distribution are better known, the station may be located well outside the limits of the average city, feeding into suitable substations wherever current is required. This means both a great economy in the cost of generation and the absence of the familiar smoke nuisance.

The most notable example of this practice of concentrating all generating machines in a single plant at a distance from the districts to be supplied, is that of the Third Avenue Railway Company, of New York. They are now installing the largest steam electric plant in existence, consisting of sixteen 6000 horse power dynamos, having a combined capacity of nearly 100,000 horse power, the equivalent of more than a million 16 candle power incandescent lamps. The station will be situated on the upper end of Manhattan Island, by the East River, and will distribute current by underground conductors, at a pressure of 10,000 volts, to sub-stations in all parts of the city. From the sub-stations current will be supplied for surface and elevated railways, electric lighting, motors, etc. Aside from the economy affected, this arrangement will have a tremendous effect in purifying the atmosphere of New York. But no such scheme is necessary here.

Happy, and thrice happy, should the people of this city be, because of the magnificent water power that is being developed at her very gates. Within easy reach of Montreal there is more hydraulic power than in the whole of Switzerland, and when fully developed and electrically applied we should have here the electric city of the Dominion. But as brilliant as have been the advances in electric science, we are still far short of what we hope the future holds.

CONVERSION OF ENERGY.

The two engineering problems that excite most interest to-day, are the efficient conversion of the energy of fuel into electric energy, and the conversion of electric energy into light, without accompanying heat. The steam engine converts only from five to ten per cent. of the chemical energy of coal into mechanical power, while the dynamo converts from ninety to ninety-five per cent. of the mechanical power it receives into electric power. In point of efficiency the dynamo is practically perfect, but all thermal engines are subject to laws which under working conditions sadly limit their efficiency. Therefore, the effort is being constantly made to convert the chemical energy of carbon directly into electric energy without passing through the form of heat, a process essentially similar to the conversion in the ordinary zinc-copper battery, but, so far, no practical carbon battery has been produced. Indeed, it is doubtful if the art of government is sufficiently far advanced to withstand the social strain that such a revolutionary invention would produce. It would mean unlimited power at practically no cost, and would occasion industrial and social changes beside which those produced by the steam engine would dwindle to a vanishing point.

The efficiency of the incandescent lamp, though somewhat improved in late years, is still extremely small—only some three per cent.—the major portion of the electric power supplied being dissipated as radiant energy of a wave length too great to be appreciated by the eye.

Vacuum tube lighting, at high frequencies and high potentials, promises something, but the results so far obtained have not been all that was anticipated.

If our modern lighting apparatus could be brought to the efficiency of that of the glow worm and fire fly, the consumption of a few tons of coal per hour would light the world.

ELECTRIC POWER.

If a coil of wire is made to revolve between the poles of a magnet, a current of electricity will be generated in the wire, and conversely, if a current of electricity is sent through the coil from an external source, it will tend to move. In the one case we have a dynamo, in the other a motor. By different arrangements of magnets and different groupings of conductors, all the many types of electric machinery now in use have been evolved, but an inspection will show that modern dynamos and motors consist esentially of but two parts ; a stationary element, and an element having a pure rotary motion. This is the acme of mechanical simplicity, and when other features of the electric motor are considered, its small weight for a given output, the absence of noise, heat and odor, its ability to operate in any position, and under any atmospheric conditions, we are justified in thinking that a more perfect source of power could hardly be conceived.

Power distribution by electric motors, though first developed in conjunction with electric lighting, not only now exceeds many times the electrical interests, but has become one of the largest commercial enterprises of the globe. In 1898 more than a milion horse power in electric motors was employed in America in street railway transportation alone, conveying, by a recent estimate, more than three billion passengers, and earning something like $125,000,000. These same railroads employ an army of 200,000 men, and represent an invested capital of from one to one and one-half billion dollars.

When we further consider the aggregate capacity of the thousands of motors employed in the distribution of power for other than traction purposes—in machine shops, cotton mills and sugar houses, in printing, pumping, hoisting, and ventilating, on modern warships for steering, handling ordnance, etc., to say nothing of the apparatus used in the transmission of power, as distinct from power distribution—we begin to form some adequate idea of the influence of this new agent.

Before the invention of the steam engine, waterfalls were of first importance as sources of power, and usually attracted settlements about them, but after Watt's discovery and Stephenson's application to the locomotive, it was found more convenient to transport the new source of power—fuel—to different established centres of population, instead of moving the centres of population to the sources of power. With the advent of electricity, however, not only have water powers acquired a vastly increased value by reason of the ease with which their energy can be economically transmitted over great distances, but electrical methods of distribution have in some cases actually superseded the railway for fuel energy transference, a case in point being the recently established plant of the Colorado Springs Power Company, for the transfer of the energy of coal from a low geographical level to a higher one without the necessity of overcoming gravitational forces.

The first experiment to reveal the astonishing possibilities of electric power transmission was made in 1891. In that year some 200 horse power was transmitted over a wire, roughly one-tenth of an inch in diameter, from Lauffen to Frankfort-on-the-Main, a distance of 108 miles, with a total loss in transmission and conversion of less than 30%, and this with an electric pressure not so great as will be used between Chambly and this city.

About the same time, plans were in preparation for harnessing the mightiest of all Nature's water powers—Niagara Falls—and a commission appointed to consider methods, including, among other distinguished scientists and engineers, Lord Kelvin, of Glasgow, and Professor Unwin, of London, after carefully considering all known means of power transmission, unanimously adopted electricity. To-day, about a mile above the falls, some 50,000 horse power is continuoulsy flowing from half a score of huge electric spinning tops. No feat of modern engineering has been watched with greater interest than this, and none more successfully conducted.

Though time does not permit me, nor would you find it of interest to go into details, I may mention that the power of Niagara has been estimated at about 7,000,000 horse power—greater probably than the physical force the whole human race is capable of continuously exerting. At present some 250,000 horse power is to be developed on the American and Canadian sides, or about 5 per cent. of the total power available—not enough to perceptibly diminish the flow over the falls. However, should the whole be utilized, leaving the rocky river bed dry and bare, we should but be substituting a wonderful cataract of etheric energy for the splendid flow of gravitational matter so justly famed. Which spectacle would present greater beauty would depend upon the individual.

To those who trace in imagination the course of a beam of sunlight, as it buries itself in the ocean, rises in cloud, and falls again in grateful shower over grain field and vineyard, filling brook and swelling river, and finally tumbling through mighty turbines and silently streaming from the polished slip rings of stately dynamos, bursting again into wholesome sunlight, to brighten the homes of hundreds, the substitution would but be the completion of a full cycle of usefulness and beauty. From either standpoint, however, Canada is fortunate, for she has water power enough and to spare. Some of this is already being splendidly developed, but much will not be needed for many years.

Among the best examples of electric transmission in the world are the plants at Lachine, Chambly and Hamilton. The latter plant started in September last, and is now transmitting some 2,500 horse power thirty-five miles, at the enormous pressure of 22,500 volts. The two former I suppose most persons in Montreal have had the pleasure of seeing.

The question is often asked, will electricity eventually supersede the locomotive on the present steam railroads? I may reply that careful estimates show no economy of electricity over steam for the handling of heavy freight traffic where the number of trains operated per day is small, but for passenger service, where trains must be operated at frequent intervals on small headway, the advantage is with electricity, and it is probable that because of the smaller cost, as well as increased speed, such cities as New York, Baltimore and Washington will be connected by through lines in the near future.

It is also of interest to inquire as to the probable limit of economical power transmission by electrical means. In reply to this I may say that Lord Kelvin, after an inspection of the Niagara plant in 1897, is quoted as placing the limit at about 300 miles.

At Snoqualmie Falls, Washington, there is now being installed a 6,000 horse power plant, to supply power to the cities of Seattle and Tacoma—one 31 and the other 45 miles distant. The pressure used is 25,000 volts. This voltage, though perhaps the highest in commercial use for so large an amount of power, is by no means the limit of practicable electric pressures, small amounts of power being transmitted commercially at pressures as high as 40,000 volts, and to distances of 85 miles. Recent experiments show that the leakage losses in a well constructed transmission line are practically negligible up to pressures of from 50,000 to 60,000 volts. Beyond this, however, such losses seem to increase rather rapidly.

It is estimated that about 200,000 horse power of electrical machinery is now in use on the American continent for transmitting the power of falling water.

TELEPHONE AND TELEGRAPH.

The principle of the telegraph was discovered by Prof. Joseph Henry, in 1829, and first practically applied by Morse in America and Wheatstone and Cook in England. The first telegraph line in America was erected between Baltimore and Washington in 1844, and the first message—"What hath God wrought"—is ever recalled with increasing force, as we contemplate the vast network of wire and cable that now forms the nervous system of the commercial and political world. For a long time the simple Morse system of telegraphy was the only one in general use in America, and similarly the single needle system in England, but as these became inadequate to the volume of business requiring to be done, other and more rapid systems were developed.

The "duplex" system, by which two messages can be sent in opposite directions at the same time over the same wire, appeared in 1858, but did not come into general use until in the early seventies. Later, in 1878, Edison brought out his "quadruplex," by which four messages can be simultaneously transmitted over the same wire without interference. Of late, the Delaney "synchronous multiplex" has taken a prominent place, but without doubt the greatest advance that has been made for many years in land telegraphy has occurred in the past year, and is due to Prof. Henry A. Rowland, of Baltimore. He has brought out a "multiplex printing telegraph," by which sixteen messages per minute, of twenty words each, may be sent over a single wire by operators skilled only in the use of the typewriter, the messages being automatically recorded, not in cipher, but in ordinary type, at each end of the line. I had the pleasure of seeing his apparatus, which is a marvel of mechanical beauty, in successful operation a few weeks ago, over artificial lines varying from 500 to 1,000 miles in length. A modification of his system, adapted to automatic sending, will transmit from 3,000 to 4,000 words per minute. What this means may be seen by remembering that at this rate the contents of a New York daily might be transmitted to Montreal in less than an hour.

But, notwithstanding these devices, by which the carrying capacity of a single wire is multiplied many times, efforts are continually being made to do away with wires altogether, and to transmit messages by setting up electro-magnetic waves at different sending points, and using suitable detectors as receivers. At the transmitting station, by means of a key and suitable sending mechanism, a series of electro-magnetic waves are projected into space and travel in all directions with the speed of light. Falling upon a metallic collector connected to a tube containing fine conducting particles in loose contact, the particles are found to cohere and to have an increased electric conductivity. This change in their conductivity is readily used to register a signal. Other forms of detectors or receivers have also been devised, and some of you probably remember the beautiful magnetic detector invented by Prof. Rutherford, shown by him in the McDonald Physics Building some months ago.

Wireless, or space telegraphy, as it is sometimes called, though partially successful up to distances of about twenty miles, will not, in its present form, supersede the older methods. It is, however, finding a limited application in England, particularly in their coast signalling system, and Mr. W. H. Preece, in a recent address before the Institution of Civil Engineers, states that a system of his own is now in use by the Post Office and War Departments of the British Government.

The extent to which the telegraph in its ordinary form is used may be roughly gathered by recalling that in the United States there are more than a million miles of telegraph wire, strung on over 200,000 poles, and connected to about 25,000 offices. The number of messages annually transmitted by a single company has already reached some 70,000,000, resulting in a gross income of over $25,000,000.

The telegraph and cable systems of the British Empire employ, according to recent statistics, about the same length of wire, 1,111,000 miles, and transact a proportional business.

No great advance has been made in cable working since Lord Kelvin devised his mirror galvanometer and siphon recorder, except the application of duplex working, by which the capacity of cables has been practically doubled, but a great number of improvements in detail have been effected and many new cables laid, until now some 150,000 miles of ocean cable are in use, costing roughly about $150,000,000, and requiring a fleet of over twenty ocean-going vessels to keep them in repair.

Bell obtained his fundamental telephone patent in 1876, and a number of important improvements were made shortly after. The first Bell instrument was used both as a receiver and transmitter, but the carbon transmitter and induction coil made their appearance within the next year. Since then a vast amount of work has been done in perfecting details, and now telephonic communication is daily carried on between points from 1,000 to 1,800 miles apart with perfect clearness.

In the United States there are considerably over a million telephone instruments in daily use, and each day more than three million connections are made. In England about 150,000 miles of telephone wire are in use, and the number of messages per year has reached something over eighty million.

OTHER APPLICATIONS.

The most marked feature of electrical development in the past year has been the astonishing growth of the electric vehicle business. Within a few months, orders amounting to $15,000,000 have been received by American manufacturing companies from Europe, and it is expected that the entire cab system of Paris will substitute electricity as a motive power before the end of the present year. Cleanliness, increased speed, and the easing of the congested traffic conditions in our crowded business districts are obvious results, but I also look for the betterment of our country roads, even to a greater extent, from the use of the automobile than the bicycle. The old days of post roads and country inns will be revived, but electricity instead of horses will be the motive power. Indeed, a company has recently been organized in Paris to carry out this very idea.

The applications of electricity in electro-chemical processes and in the refining of metals is also most marked. In 1897 the output of German electrolytic alkali works alone was 20,000 tons, and in the past year it is estimated that more than 300,000,000 pounds of copper were electrolitically refined. Some 8,000,000 pounds of aluminum are also annually produced in the same manner, to say nothing of the various products of the electric furnace.

In hundreds of other ways electricity is playing a similar part. In agriculture, electrical methods of stimulating plant growth have passed the experimental stage. In medical practice it has become indispensable. In domestic life the electric call-bell, chafing dish and fan motor bring a measure of comfort even to bachelor quarters. Indeed, no bounds can be placed upon this spirit of the 19th century, that comes

"To answer our best pleasure ; be't to fly
To swim, to dive into the fire, to ride
On the curl'd clouds."

NOTES.

Last month it was stated that "things would soon quiet down with construction men, and supply dealers would be correspondingly affected." This is exactly the status of business at present in Montreal, with, however, every indication of a brisk spring trade at the opening of navigation.

The Laurie Engine Co., of this city, have just completed a new 500 h.p. engine for the Winnipeg Electric Street Railway. This engine is of the vertical cross-compound Corliss type, provided with tail rods and a shaft governor. The cylinders are respectively high pressure 18 inches, and low pressure 36 inches in diameter, with a common stroke of two feet. The fly wheel is ten feet in diameter and weighs about fifteen tons. The working steam pressure is to be 125 lbs. per square inch, and the speed 120 revolutions per minute.

The Lachine Rapids Hydraulic & Land Co., of Montreal, having suffered interruptions to their lines, engaged detectives to discover the miscreants. As a result a charge was laid against Alexander Daoust, under article 492 of the Criminal Code, for attempting to damage wires used for electric lighting. The manner in which the interruption was caused was by throwing iron hoops so that they would rest on both wires, thus producing a short-circuit. Daoust was tried before Judge Desnoyers, who imposed a fine of $5.00 and costs, serving to show that the law punishes any interference with electric wires.

The death is announced of Mr. F. H. Badger, jr., son of Mr. F. H. Badger, city electrician of Montreal, at 35 years of age, from pneumonia, brought on by an attack of la grippe. Deceased was for some time in charge of the contruction department of the Royal Electric Company, of this city, later taking charge of the lighting department as superintendent. He left the Royal Company some years ago to take charge of the Montmorency Power Company's plant at Quebec, succeeding the late Mr. Mohr. Lately Mr. Badger resigned his position with the Montmorency Power Company to accept a position in Washington, U.S.A.

Motor-vehicles as sold in the United States will be about as useful in the city of Montreal as a wheel-barrow. It would appear that the cities in the United States must be fairly level, judging by the grades which the auto-vehicles are guaranteed to ascend. As Canadians are beginning the manufacture of these popular articles, they will not be likely to forget Montreal, more especially if any of the members of their company have had occasion to walk up-town on a hot summer's day. If they have driven in Montreal, they will also remember that the rule of the road is 'to the right,' hence the controller handle would be of more use arranged 'right'-handed.

The upper pumping station of the Montreal waterworks is situated in rear of the McGill College grounds, near the main reservoir. The McGill authorities claim that smoke from the stack of the station damages their instruments. They also contend that leaks from the reservoir percolate down into their grounds and undermine the foundations of certain buildings, which seems quite probable, as it has been known for some time that the reservoir was defective. As a means of overcoming the smoke nuisance, the authorities of McGill have suggested that electricity be utilized for pumping purposes, the power to be obtained from the Lachine Company or the Royal Electric Company. They have offered to submit a scheme if remunerated for their work by the council. That any change will be made is extremely improbable, as the contract for a new boiler has recently been given to Mr. John McDougall.

SERIES ARC LIGHTING.*

By Wm. A. Turbayne, E.E.

Although the arc light first made its appearance about the beginning of the present century, it is only within the last quarter of a century that it has become generally adopted as an illuminant. About the year 1802, an Englishman, Sir Humphrey Davy, conceived the idea of opening an active electric circuit between two points of carbon. He had at his disposal some 2,000 cells of a simple primary battery, which he connected in series, and from the extreme terminals he brought wires to the ends of which were connected small pieces of charcoal. These he touched together and afterwards *drew apart, and in so doing the current bridged the gap* which was made, appearing as a flame having powerful heating properties and causing the charcoal tips to glow to an intense whiteness. Thus appeared the first true arc light.

The charcoal points were evidently held in a horizontal position, as the stream of vaporized carbon appeared in the form of an "arch," being impelled upwards in the centre by the ascending currents of air; from this phenomenon we derive the name "arc" light. About thirty years after this discovery of Davy's, one Michael Faraday discovered and promulgated the principle of electro-magnetic induction. He found that when a steel bar magnet was passed through a coil of wire properly arranged, a current of electricity was momentarily induced in the coil, which manifested itself similarly as the current from a primary battery, and this important discovery soon led to the development of the dynamo machine for producing powerful currents.

Previous to the introduction of these dynamos the arc light was seldom seen outside the laboratory, the expense and annoyance, coupled with the use of acid batteries, prohibiting its more extended adoption. With the advent of the dynamo, however, renewed interest was taken in the development of the arc light; mechanisms called lamps were devised for feeding the carbons together as they wasted away, and improvements were introduced into the current generators so that an uninterrupted light could be maintained for considerable periods. Even at this time, however, the usefulness of the new light was limited, as it was found that the feeding of the lamp so affected the current in the line that only one lamp could be operated on a single circuit, and it was only in certain isolated cases, such as in lighthouses, that the light became of value.

This was the condition of affairs until some forty years later, when in 1875 Chas. F. Brush, of Cleveland, and others, discovered the principle of differential regulation, which made the operation of several lamps on one circuit and machine possible, and made each lamp an independent unit as regards its feeding properties.

It is not our intention in this paper to follow the art of arc lighting from the date of its inception and to successively note the advances which have been made in bringing this method of illumination up to its present state, but to offer a brief exposition of the cardinal principles involved, and to shortly describe the functions of the mechanisms employed in a modern system of series arc lighting, in which a direct current of constant value is employed, a system which has been developed since the introduction of the differential lamp of 1875.

Such a system virtually comprises a current generator or dynamo, a number of arc lamps and an arrangement of conductors interconnecting the whole in such manner that the current on leaving the dynamo enters the first lamp and thence passes to the next, and after having successively traversed all the lamps in like order, returns to the dynamo, the path of the current therefore being in one continuous circuit, within which the total electrical energy produced by the generator is expended.

If we take a pair of carbon rods and introduce them into an active electric circuit, as above, no light will be emitted until a separation of the carbons takes place, and we find that, with the current strengths adopted in practice, a separation of approximately one-eighth of an inch gives the best results, as being free from objectionable hissing or flaming. Such an arc requires for its maintenance an electro-motive force or pressure of about 45 volts, which represents an energy of something over ½ horse power. This energy is expended, in part, in overcoming the resistance of the arc gap, but the greater part appears in the form of heat, and the resulting temperature is so concentrated and intense as to cause a vaporization at the surface of the positive carbon, which in the process is brought up to a highly incandescent state, this being in reality the source of light. This vaporization and a combustion of the carbons is accompanied by a gradual *wasting away and consequent* shortening of same, and in order, therefore, to maintain an uninterrupted light, means must be found for feeding the carbons together at a rate proportional to this consumption.

An arc lamp, therefore, is substantially a mechanism for initially separating the carbons a predetermined distance, and for further maintaining them at this distance during continued operation. In studying the arc lamp we will not touch on the innumerable mechanical devices, such as racks and pinions, brake wheels, clutches and bands or chains, which are employed with the one view of gripping and releasing the carbon under the control of the actuating magnets, but we will describe the action of an ideal differential lamp, such, in fact, as may be taken as a representative of the types in extended use.

The carbons are separated by an electro-magnet in the main circuit through which the whole current passes, while the feeding is effected by another electro-magnet acting in opposition to and tending to overcome the lifting action of the first. The second magnet is provided with a high resistance winding of fine wire and is connected as a shunt across the carbons, and therefore exerts a greater or lesser influence, accordingly as the carbons are more or less widely separated; therefore, as the carbons are consumed the arc increases in length, and coincidently the second magnet opposes the action of the first, until finally it overpowers it and allows the carbons to feed forward. In practice so fine a balance is obtained between these two magnets that the carbons are continually feeding forward in imperceptible degrees.

There are, of course, numerous modifications of this principle introduced into different lamps, but, nevertheless, their electrical actions are similar, inasmuch as the separation of the carbons is brought about by the action of the main current itself, while the feeding is accomplished by the action of a circuit derived from this and having as terminals the upper and lower carbons.

We may here state that the illuminating power of an arc lamp varies with the electrical power which is expended within it. This electric power, expressed in watts, is the product of two factors—the electro-motive force or pressure and the volume of the current as expressed in the terms volts and amperes respectively.

We have seen that the function of the arc lamp is to look after one factor, viz., the pressure or volts across its terminals; consequently, in order to produce an unvarying light, we must keep the other factor of current volume constant.

The functions, therefore, of the generator or dynamo is to furnish a current of constant strength, and, as the lamps are connected in series, and as each demands some 45 volts as explained, it must operate at a pressure sufficient to maintain the number of lamps for which it was designed to operate, together with sufficient marginal pressure to overcome the resistance of the copper lines connecting same.

An arc lighting dynamo, like most other dynamos, consists essentially of an arrangement of copper conductors wound over an iron core and rotating within the influence of the poles of a powerful electro-magnet, but, as contrasted with constant pressure dynamos, which include those used in operating incandescent lamps in multiple and those used in furnishing current to stationary and street railway motors, it must possess peculiar

* Paper read before the Hamilton branch Canadian Association Stationery Engineers.

properties, which are required to adapt it to the running of arc lamps on series, and notable among which is that a fall of current below the normal strength must be accompanied instantly by a rise in voltage, and likewise with an increase of current the voltage must fall. We may here state that while the function of a constant pressure dynamo is to keep the electro-motive force or pressure factor constant while the current is variable, the constant current or arc dynamo, on the other hand, must keep the current factor constant while the pressure is variable. In such a machine the magnets are series wound, and the energizing windings are traversed by the full current passing through the circuit of lamps. The iron magnet cores are so proportioned as to be magnetically saturated, that is, are worked to such a high degree of magnetization as to be insensible to slight changes in the strength of the current which energizes them.

On the other hand, the rotating armature is wound with a great number of turns of wire, and in reality constitutes a powerful magnet, which is sensitive to current changes, and which meanwhile reacts against and partially controls the magnetic field, which induces the current within itself.

As, therefore, the switching off of a lamp, or the feeding of several lamps at once, would cause the current to rise, the armature magnetization would increase perceptibly, while that of the field magnet would not do so; the former would, therefore, so react against the latter as to reduce the effective magnetic strength, and the voltage therefore would fall; the reverse action would likewise take place should one or more lamps be switched on. In order that this inherent regulating property will be effective over the whole range of the machine, automatic current regulators are employed, which, by moving the collecting brushes around the commutator, or by adjusting the field strength, so adjust the electro-motive force, and incidentally the current strength, as to meet the conditions of the outside load, and further assures sparkless operation at the collecting brushes.

The power required to drive an arc dynamo will be in proportion to the number of lamps burning at any time, and will vary as the number of lamps in operation. As we have stated that the electric power is the product of the current volume and the electro-motive force, and as the former factor is constant, the power delivered will vary, therefore, as the latter factor, which varies only as lamps are added to or withdrawn from the circuit.

Arc dynamos, unlike constant pressure dynamos, do not necessarily demand the refinements in speed governing in the mover which drives them, as the inherent regulation of the machine itself will look after any such irregularities as are met with in practice; and in fact, with the brushes locked in a fixed position, constancy of current during change of load may be obtained by varying the running speed only.

There are other accessories, such as automatic lamp cut-outs, which ensure continuity of the circuit should a lamp be defective, lightning arresters for protecting the lines and station apparatus, and loop switches for controlling groups of lamps, which we cannot now cover in detail, and which, although essential to the satisfactory and safe operation of such a system, yet are not necessary to the production of the light itself, the generator and lamps being the indispensable adjuncts of a series arc lighting system.

MARITIME ELECTRICAL ASSOCIATION.

Arrangements are being completed for the next convention of the Maritime Electrical Association, which will be held in the city of Halifax, N.S., probably about the 18th of April. Further particulars will be given in the next issue of the ELECTRICAL NEWS.

Mr. J. F. Askwith, of Ottawa, is endeavoring to organize a company, to be called the Compressed Air Transmission Company of Ottawa, for the purpose of transmitting and supplying compressed air in the city of Ottawa and elsewhere.

SPARKS.

Mr. W. J. Fletcher, of Markham, Ont., has disposed of his electric light plant to the corporation.

It is again reported that the Galt and Hespeler Street Railway will be extended from Preston to Berlin.

The Board of Police Commissioners of Toronto have decided to test an ambulance propelled by electric power.

The Ontario Legislature has granted authority to the London Electric Company, Limited, of London, Ont., to increase its capital stock to $500,000.

Mr. C. A. Chant, B.A., lecturer on Physics at Toronto University, recently delivered a public lecture, with demonstrations, on ' Electric Waves.

The annual meeting of The Canadian General Electric Company was held in Toronto recently. All the old directors who were eligible were re-elected.

The electric light plant at Shubenacadie, N.S., has changed hands. It has been purchased from its former owner, R. C. Ervin, by John Christie, of Dartmouth.

The Ottawa Suburban Electric Company, of which Mr. Geo. E. Kidd is solicitor, is asking for a charter to build an electric railway to Shead's Mills and Windermere.

Messrs. Cunliffe & Ablett, of Rossland, B. C., have placed an order with the Canadian General Electric Company for two of their standard 50 h.p. three phase induction motors.

The Department of Railways and Canals has purchased from the Canadian General Electric Company additional generating apparatus for their improvements on the Sault canal at Sault Ste. Marie, Ont.

The Private Bills Committee of the Ontario Legislature has passed the bill authorizing the town of Goderich, Ont., to issue $25,000 of debentures to complete the water works and electric light plant.

The annual meeting of the Guelph Light & Power Company was held recently, at which Mr. D. Guthrie was re-elected president, Mr. Richard Mitchell vice-president, and Mr. John Yule general-manager.

The annual statement of the Halifax Electric Railway shows that the gross earnings in 1898 were $197,830, an increase of $4,450. The operating expenses were $113,081, against $112,570, an increase of $511.

The city council of Montreal have accepted the tender of John Macdougall, of the Caledonian Iron Works, for furnishing a boiler for the water works, at the price of $5,975. Other tenderers were: Geo. Brush, $5,680; Babcock & Wilcox Co., $6,410.

The town council of Pembroke, Ont., and the Pembroke Electric Light Company have not reached an agreement regarding electric lighting, and it is possible that a by-law may yet be submitted to the ratepayers to raise money to install a municipal plant.

The Light, Heat & Power Co., of Lindsay, Ont., is making some extensive additions to their power plant, and have purchased a large 500 volt multipolar power generator from the Canadian General Electric Company for the purpose of meeting the many demands for power.

The Richelieu & Ontario Navigation Company are equipping their new boats in the most modern manner, and have purchased from the Canadian General Electric Company two of their standard direct connected 500 light generators, with Ideal engines and marble switchboards.

The city of Sherbrooke, Que., recently invited tenders for electric lighting, and has awarded the contract for five years to the Sherbrooke Gas & Water Company. The price for arc lamps, 7½ amperes, is $60 per lamp up to 100, and $50 per lamp for all over that number, four incandescent lamps to count as one arc lamp.

The annual meeting of the Cataract Power Company of Hamilton was held last month, at which the following officers were re-elected: President, Hon. J. M. Gibson; vice-president, James Dixon; treasurer, John Moodie; secretary, John Patterson. The company is now delivering 1,000 h.p. in Hamilton, and contracts are about to be closed which will double that amount.

As examples of unsuccessful municipal plants, it is pointed out that Xenia, O., paid $35,000 for its lighting plant, and sold it for $10,060, and made a contract with a private company; Gravesend, L.I., paid $120,000 for its plant, sold it for $30,000, and made a contract with a private company also; Grenville, S. C., found it could better afford to pay a private company $100 a light than to own its own plant.

The town council of Gravenhurst, Ont., is considering a proposition to raise $20,000 for a waterworks system and $10,000 for an electric lighting plant, and in response to a request, Orillia town council has offered to supply Gravenhurst with 100 horse power for the sum of $1,000 per year, the former municipality to pay the cost of line construction to Ragged Rapids, about ten miles distant. This price is for power delivered at Ragged Rapids.

The British Columbia Electric Railways Co., Vancouver, B.C., are making vast improvements in their railway development, and for the purpose of carrying out this work have purchased from the Canadian General Electric Company three C.G.E. 1,000 two-motor equipments, and four C.G.E. four-motor equipments, complete with controllers, resistances, etc. They have also, for their lighting plant, placed an order for a large 500 kilowatt alternator of the Canadian General Electric Company's type.

SPARKS.

Joseph Knox, Esq., of Stayner, has purchased from the Canadian General Electric Company a 700 light single phase alternating current dynamo.

The railway commissioners of the town of Port Arthur, Ont., have purchased a new Goldie & McCulloch boiler, for operating the electric railway.

Mr. Thos. Tompkins, of Brockville, Ont., has had plans prepared for a new hotel to be erected in that town, and which will be equipped with an electric light plant.

The Montreal Novely Co. are lighting their factories at Louiseville, P.Q., and have just installed an electric plant for this purpose, purchased from the Canadian General Electric Company.

The city council of Winnipeg seems to be in favor of a civic electric lighting plant, and it is probable that the question will again be submitted to the ratepayers, notwithstanding that it was defeated a few months ago.

A dispatch from Buffalo states that the Niagara Falls and Lewiston railroad, otherwise known as the Gorge Road, has passed into the hands of a receiver. This is said to be due to the heavy losses from damage suits.

The town of Brockville, Ont., is considering the question of installing a municipal electric light plant. It is not expected that any definite action will be taken during the present year beyond obtaining estimates of the probable cost.

The Alberta Railway & Coal Co., of Lethbridge, N.W.T., is installing an electric outfit, and has purchased from the Canadian General Electric Company a 150 light direct current generator, with the necessary supplies, for lighting their mines.

Mr. John Mullin, formerly connected with the Ottawa Electric Railway Company, is now in Port Elizabeth, South Africa, where he is inaugurating a new road under the auspices of the British Canadian Electric Company, of London, Eng.

The Guelph Street Railway Co. have recently purchased from the Canadian General Electric Company one of their standard 110 kilowatt 6 pole railway generators. This has been installed, and is said to be much admired by all who visit the power house.

The town of Whitby, Ont., is about to make arrangements for its electric lighting. It is reported that a contract for five years with Madill Bros. will be recommended by the Fire and Light Committee.

The Canadian General Electric Company have closed a contract with the London Electric Co. for one of their standard 300 kilowatt revolving field type single phase generators, which is the second machine of this type recently purchased by the London company.

This is not the season for mosquitoes, but an inventor of Angouleme, France, is ready to welcome them with a novel thrill. He has invented a mosquito netting, which is charged with electricity, and the moment an insect touches it down the insect drops, shocked to death. Next!

The Canadian General Electric Company have received an order from the Toronto Railway Co. for a third large generator; this will be of the direct connected type, similar to the two already in operation, and will have a capacity of 850 kilowatts, operating at 85 revolutions per minute.

It is announced that a Toronto syndicate have instructed Messrs. Bond & Smith, architects, to prepare plans for a large office building to be erected on Terauley street, opposite the new city hall. The building will contain a private telephone system, and will be equipped with an electric lighting plant.

The Lake Erie and Detroit River Railway, of Walkerville, Ont., are equipping their magnificent steamer "Flora" electrically, and have contracted with the Canadian General Electric Company for a lighting generator, in connection with an Ideal engine, marble panels, and the wiring of the steamer throughout.

The various local associations of marine engineers in Canada have decided to amalgamate, under the name of the National Association of Canadian Marine Engineers. This step was decided upon at a meeting held in Toronto on March 9th. The first convention will be held in Montreal shortly after the close of navigation.

Mr. A. A. Dion recently delivered a public lecture in Ottawa on "Electricity as Applied to Arc and Incandescent Lighting." Mr. Dion showed how electricity was generated in a dynamo and how transformed in distribution by means of transformers, and explained the construction and operation of arc and incandescent lights.

The Montreal Street Railway Company are now testing a street car recorder, similar in principle to the ticker used in the brokers' offices to record the fluctuations of the stock market. By attaching the instrument to any line a record is shown at the superintendent's office, and it can then be seen how many cars pass a given point in a given time.

The Peterborongh Light & Power Company have submitted to the Council of Ashburnham, Ont., a proposition for lighting the village, in which they agree to furnish power and light for the eleven arc lights now in use for a term of five years at the price of $50 each per year, burning from half an hour before dark till midnight for at least three hundred nights a year.

A bill to incorporate the Nova Scotia Electric Light and Heat Company has passed the legislature of that province. The company propose to light by electricity the whole Annapolis valley from a power station to be situated on the Gaspereau river. The estimated expenditure is placed at $400,000. The incorporators are: Dr. F. W. Borden, Minister of Militia, Ottawa; Dr. Allen Haley, M.P., Windsor, N.S.; J. W. Beckwith, C. O. Ross, F. W. Clarke and F. B. Wade, of Bridgewater, N.S.

The Kentville Electric Light & Power Co., Kentville, N.S., find that the demands upon them for light and power have been so great during the past year that they have been compelled to increase their capacity, and for this purpose have purchased two-45 kilowatt direct current generators from the Canadian General Electric Company, of their latest multipolar type.

The Quebec District Railway, Light & Power Company will this spring build a new line of railway to connect with the old Quebec, Montmorency & Charlevois route at Montmorency Falls. When the system of this company is completed about 60 miles of electric road will be in operation. New cars for the company are now under construction by the Ottawa Car Company.

A. S. Bowen, Esq., of the Kemptville Milling Co., Kemptville, Ont., has purchased the plant of the Kemptville Electric Light Co., and is making some material changes in modernizing the apparatus. For carrying out this work, he has purchased from the Canadian General Electric Company one of their standard new type 60 kilowatt single phase alternators, with necessary switchboard and instruments.

The town council of Picton, Ont., has engaged Mr. Roderick J. Parke, E.E., of Toronto, to prepare plans and specifications for improvements and extensions to the municipal electric lighting plant. Tenders for an alternator of 120 kilowatts capacity, transformers of a total capacity of 1,000 lights, slow speed engine of 125 h.p., and general supplies, such as weatherproof wire, insulators, cross arms, etc., are invited up to April 4th.

The corporation of the town of Barrie advertised for tenders for alternating current apparatus. The contract for 120 k.w. "S.K.C." two phase alternating current generator for power and lighting apparatus was awarded to the Royal Electric Company, of Montreal. The entire lighting and steam plant, which has been taken over by the corporation from the Barrie Gas & Electric Company, is being rebuilt and the capacity enlarged.

The Edison Electric Light & Power Co., of Springhill, N.S., are about to undertake the development of a water power, and invite tenders up to March 31st for the supply of generators, switchboard equipment, transmission line, extension of line in new district, wiring and necessary material for three thousand house lights, hydraulic machinery, and the construction of power house. The generators are to consist of two alternators of 75 k.w. each, with sufficient transformers. The president of the company is Mr. J. E. Simpson.

The Canadian General Electric Company have received an order from the T. Eaton Co. for one of their standard 130 kilowatt direct connected generators. This makes the fourth generator of this size which the T. Eaton Co. have purchased from the Canadian General Electric Company, in addition to one 75 kilowatt and one 25 kilowatt generator of the same type. The T. Eaton Co. are furnishing power from their electrical apparatus for operating all their manufacturing machinery and the lighting throughout the whole of their premises. The plant when finally completed will be the largest and most modern isolated plant in Canada.

It is reported in Buffalo that a deal has been consummated for the purchase by a New York and Philadelphia syndicate of the entire street railroad system of Buffalo and a number of suburban lines. The companies involved are given as: The Buffalo Railway Company, the Buffalo Traction Company, the Buffalo, Bellevue & Lancaster Railway Company, the Buffalo & Niagara Falls Railway Company, the Buffalo and Lockport Railway Company, the Niagara Falls Park and River Electric Railway Company (running along the river bank on the Canadian side), the Niagara Falls and Clifton Bridge Company, and the Lewiston & Queenston Heights Bridge Company. The capital of the syndicate is estimated at $25,000,000.

Mr. John R. Booth, of Ottawa, has entered into a contract with the Canadian General Electric Company for a large power transmission plant to be used in connection with railway shops at Ottawa. The power will be transmitted a distance of from three to four miles, at a pressure of 4,000 volts. The generating plant will consist of two 150 kilowatt revolving field three phase generators, together with the multipolar exciters and marble panels, with latest type instruments. At the receiving end for operation of the different departments, there will be installed three 100 kilowatt revolving field type 4000 volt three phase synchronous motors. The plant when completed will be a model in every particular, and Mr. Booth deserves admiration for being one of the first to recognize the advantages to be derived from a power transmission of this kind, where the power to be transmitted will be wholly for his own use.

A syndicate of Toronto capitalists, headed by Mr. J. A. Culverwell, electrical and mechanical financial broker, is reported to have purchased the Burleigh Falls water power, near Peterboro'. The purpose is to develop the power and transmit it to Peterboro' and Lindsay, twenty and thirty miles distant respectively. There is a head of twenty-five feet, and an estimated power of between three and five hundred horse power. The dam and power house will be located at the foot of Perry's Creek, at a point where the channel is so narrow that a concrete dam for the purpose can be built at a cost of about $5,000. The government canal dam will take the overflow of the spring freshets, while it is said that the peculiar situation removes all possible danger of interruption from anchor or frazil ice. At Lindsay Mr. Culverwell has secured the town lighting contract for ten years, and revenue for power and lighting amounting to some $15,000 per annum. The company will be capitalized at $200,000.

CONSOLIDATION OF ELECTRIC MANUFACTURING INTERESTS IN TORONTO.

The amalgamation has taken place since our last issue of the W. A. Johnson Electric Company and the Toronto Electric Motor Company, Limited, of Toronto. About one year ago the business of the Toronto Electric Motor Company was reorganized as a joint stock company, Mr. J. W. Thompson at that time purchasing an interest and combining with it the manufacturing business formerly carried on in Hamilton under the style of the Thompson Electric Company. Recently Mr. Thompson secured control of the entire business of the Toronto Electric Motor Company, and now this company and the W. A. Johnson Electric Company have amalgamated their manufacturing business under the style of the United Electric Company, Limited, with head offices at 134 King Street west, Toronto. Both factories will be operated at present, and arrangements are being made for a considerable extension of their manufacturing plants.

The officers of the new company are as follows: W. A. Johnson, president; J. W. Thompson, secretary and treasurer; J. Norman Smith, engineer in charge of works. The official staff of the company have had a long and extensive experience in electrical engineering and manufacturing, and being practical and technical experts, the success of the new company would seem to be assured. Mr. Johnson has since 1882 acted in the capacity as superintendent and electrical engineer, and for many years general manager of the Ball Electric Light Company, Limited, the first electrical manufacturing business established in Canada, and for the last five years proprietor of the manufacturing business of the W. A. Johnson Electric Company. Mr. Thompson was also on the staff of the Ball Company, and later had entire management of the Reliance Electric Mfg. Company. Mr. J. Norman Smith was formerly superintendent of the Ball Company, and for the past five years engineer for the W. A. Johnson Electric Company.

The United Electric Company will have a capital stock of $150,000, of which $100,000 is fully paid in, and $50,000 treasury stock. The company will manufacture a very complete line of apparatus, including automatic arc dynamos and universal arc lamps of enclosed and open types, direct driven and belted direct current multipolar dynamos and motors, bipolar motors and dynamos, inductor alternators (having inherent regulation) for lighting and long distance power transmission by polyphase currents, induction motors, etc. To these other lines will be added not heretofore manufactured by the respective companies in the consolidation. The Toronto Electric Motor Company have done a large Canadian business in bi-polar direct current motors of the single-field coil type.

The various agencies of both companies will be maintained and agents will be appointed where neither company is now represented. With the enlarged facilities for doing business, the company will be in a position to cater for all classes of electrical work.

A manager is wanted for the St. Thomas Street Railway. Applications are to be made to the president, Mr. J. H. Still.

The Bear River Electric Light Company, of Bear River, N.S., have decided to extend their system to Digby, which will necessitate increased equipment.

Messrs. Darling Bros., of Montreal, have just issued a new catalogue describing some of the special machines which they manufacture, and for which they are sole agents in Canada. These include, among others, the Webster vacuum feed water heater, the Moore steam pump, the Morse valve reseating machine, and the Nordberg governor.

SPARKS.

Messrs. Brown & Boggs, manufacturers, of Hamilton Ont., have decided to operate their factory by electric power, and are installing a 30-h.p. two phase "S. K. C." motor. Power for the same will be furnished by the Cataract Power Company.

The Brantford Gas Company, of Brantford, Ont., has a bill before the Ontario Legislature providing for an increase of capital stock to $200,000. It is understood that the company have in view an amalgamation with one of the local electric light companies.

The Canadian Development Company, of Victoria, B. C., have been building a steamer on Lake Bennett, Yukon Territory, and expect to have it ready for its trial trip by April 1st. The boat is lighted throughout by electricity; the plant being furnised by the Royal Electric Company, of Montreal, and consisting of one of their C. W. multipolar dynamos, direct connected to a horizontal ideal engine, this making a very compact and complete plant.

The Winnipeg Street Railway Company have been supplying the electric light and motor services from the same wires, but finding their capacity inadequate, announced their intention of changing the system and substituting new motors, placing the whole service in a more satisfactory condition. The cost of new motors was given as follows: 1-1/2 h.p. motor, $30; 2 h.p $35; 3 h.p. $42.50; 4 h.p. $50; 5 h.p. $60; 6 h.p. $70; 10 h.p. $80; 12 h.p. $100. Their customers, however, have not taken kindly to the proposal, and at a recent meeting passed a resolution against any change being made.

The Metropolitan Railway Company will erect a supplementary power house at York Mills to assist the generation at the large station at Bond's Lake. Concerning the improvements now being made by the company, the consulting engineer, Mr. W. T. Jennings, says: "Considerable additions are being made to the rolling stock. Although the company has the right to use steam, it will depend entirely upon electric power. The dynamos, the motors, and the rest of the machinery will be first-class in every particular. A special class of heavily equipped freight cars will be used, suitable not only for carrying very considerable loads themselves, but also for drawing other loads. If business warrants it, an electric locomotive of orthodox type will be purchased. These locomotives are of the Baldwin-Westinghouse pattern, are capable of drawing immense loads, and weigh from 22 to 25 tons. The passenger cars will be of the latest and best description, and of the style most suitable for the business of the Metropolitan Railway. The intention is to make the road first-class throughout for both passenger and freight business. It is possible that connections with the Grand Trunk Railway at Newmarket or Aurora and with the Canadian Pacific Railway at North Toronto will be made, but this will depend upon the probable results.

PERSONAL.

Mr. Geo. White Fraser, of Toronto, has been appointed by the Dominion Government to survey the boundary between British Columbia and the Yukon district.

Mr. Geo. Morrison, at one time a well-known manufacturer of engines and boilers in Hamilton, died in that city last month. Some years ago he was associated with Mr. J. H. Killey.

Mr. J. C. McLachlan, who recently disposed of his interest in the Toronto Electric Motor Company, is reported as having decided to engage in the manufacture of gasoline apparatus for horseless carriages.

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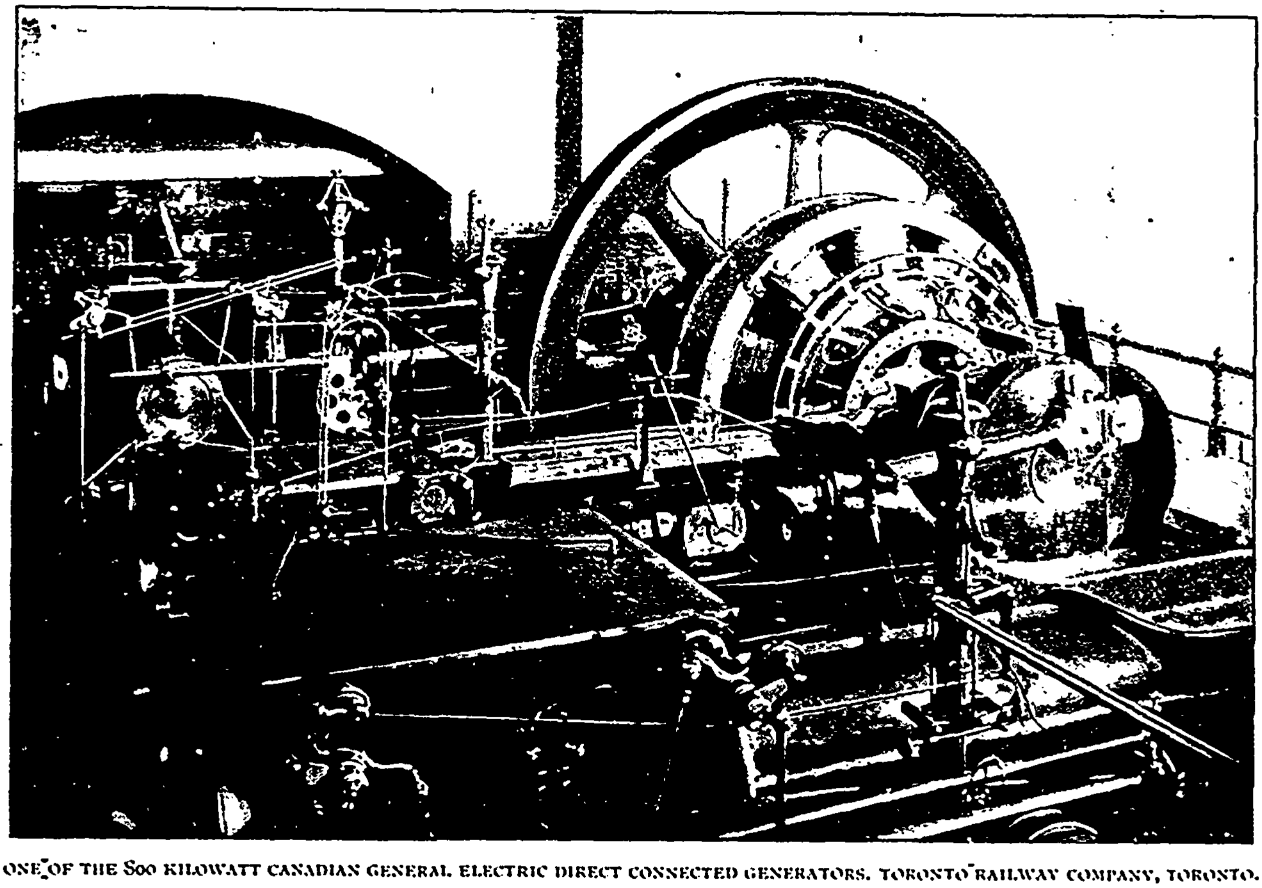

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TRADE NOTES.

Mr. H. D. Symmes, of St. Catharines, has recently installed one of the Royal Electric Company's 35 light, four pole, direct current dynamos.

The Canadian General Electric Company have received an order from the Montreal Street Railway Co. for ten G.E. 1,000 two-motor equipments.

The Canadian General Electric Company have just received an order from the University of New Brunswick for a direct current lighting generator and motors.

The McPherson Shoe Company, of Hamilton, are installing in their works one of the Royal Electric Company's 50 h.p. "S.K.C." two phase motors. This is to replace their present steam plant.

A. W. Hepburn, of Picton, is fitting out his steamer with electricity. The order for a 12½ k.w. generator has been placed with the Royal Electric Company, and is to be installed at once.

The Montreal Cotton Co., of Valleyfield, Que., have just placed an order with the Canadian General Electric Company for three additional induction motors of 10 h.p., 50 h.p. and 75 h.p. respectively.

The Eagle knitting mills of Hamilton, Ont., are now operating their factories throughout by electricity. They have installed one of the Royal Electric Company's 40 h.p. "S.K.C." two phase motors, and have found the result very satisfactory, the power being very steady and the minimum attention required.

The Port Perry Electric Light & Power Co. have given the Royal Electric Company an order for one of their 2½ k.w. four pole exciters, to replace the exciter at present installed there.

The Hawthorn woollen mills, of Carleton Place, Ontario, are increasing their incandescent lighting plant, and have placed an order for a 200 light machine with the Royal Electric Company of Montreal.

The Royal Electric Company of Montreal have just completed the installation of a 100 h.p. "S.K.C." synchronous motor in the Iron Mask mine at Rossland, B. C., to operate the hoisting machinery and air compressors.

The Eclipse Whitewear Company of Toronto have been changing their motive power and increasing their factory. They have placed their order with the Royal Electric Company for one of their 10 k.w. four pole 250 volt motors.

The Penman Mfg. Co., of Paris, Ont., have purchased a 150 light direct current generator from the Canadian General Electric Company for the purpose of lighting their new factory at Paris. The contract includes the wiring installation as well.

The Kootenay Standard Publishing Company, of Rossland, B. C. are having placed in their printing house one of the Royal Electric Company's "S.K.C." induction motors to operate their printing presses, the power being furnished from the Kooteney long distance line.

Messrs. Lawry Sons, & Co. of Hamilton, pork packers, are changing from steam to electricity for power, and have placed an order with the Royal Electric Company for a 30 h.p. two phase "S.K.C." induction motor. They are also lighting their factory throughout by electricity.

(See Table of Contents in February Issue.)