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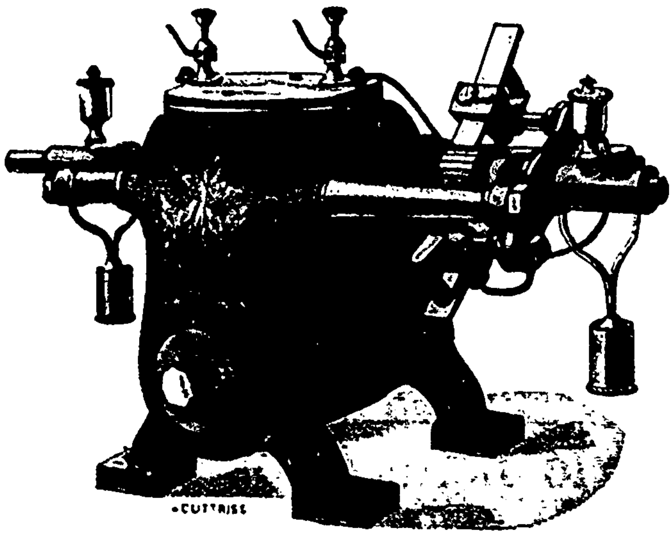

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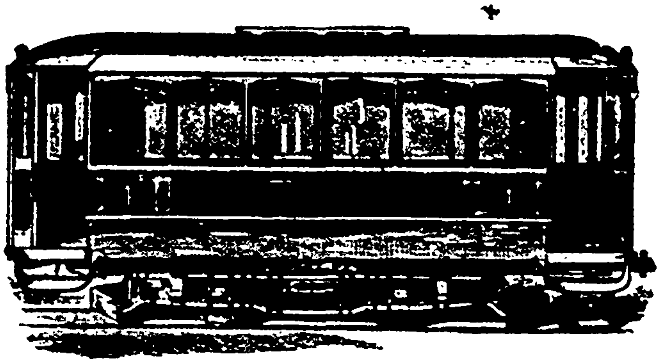

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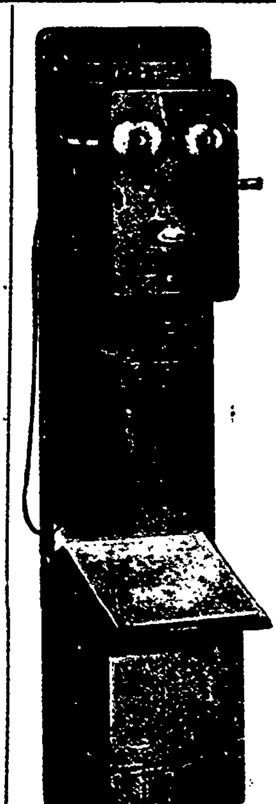

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WATFORD, ONT., Feb. 9, 1892.

T. W. NESS, Montreal, Que.

DEAR SIR,—We wish to secure four (4) of your telephones as soon as you can ship them to us. The ones we got from you last gave good satisfaction.

Yours truly, DRS. McLEAY & AULD.

MILVERTON, ONT., Nov. 9, 1891

T. W. NESS, ESQ., Montreal.

DEAR SIR,—The whole line is working first-class. Any one wishing to know about your telephones, you can refer them to me. I think any person with ordinary intelligence could set them up.

Yours truly,
J. F. CATTERMOLE, M.D.

MONTREAL, April 7, 1892

T. W. NESS, ESQ., City.

DEAR SIR,—Replying to your favor of the 5th inst., we beg to say that the telephone instruments which you put into our mill last year to connect our different departments are working very satisfactorily, and we find them a great convenience. We would certainly recommend anyone desiring a system of telephones for their works to adopt those made by you.

Yours truly,
DOMINION WIRE MFG. CO.

T. W. NESS

749 Craig Street, - Montreal.

CANADIAN

ELECTRICAL NEWS

AND

STEAM ENGINEERING JOURNAL.

VOL. II. TORONTO AND MONTREAL, CANADA, MAY, 1892. No. 5.

CANADIAN ELECTRICAL ASSOCIATION.

FOR the benefit of those who may never have had an opportunity of seeing for themselves its attractiveness, we publish views of some of the interesting features of the city of Hamilton, which has been selected for the first annual convention of the Canadian Electrical Association on the second Tuesday in June. Fortunately the convention is to take place at the pleasantest season of the year, when the city may be expected to appear in its best attire.

From an electrical standpoint, also, the city will be found to afford much interest and instruction to visitors. The Bell Telephone Company's new exchange is right up to date in point of equipment, and will be open for the inspection of those who may be on the lookout for pointers in this line. The new central station of the Hamilton Electric Light & Power Co., will also have been completed, and if we are rightly informed will alone well repay the visit of every convention delegate who is interested in this important branch of the electrical business.

Those interested in electric railways will find a valuable object lesson in this department of electrical work in witnessing the methods employed in the construction of the Hamilton street railway. The convention itself will undoubtedly be one of much interest. The following subjects, amongst others, have already been arranged for discussion :—"The Financial Aspect of Electric Lighting in Canada," introduced by Mr. S. J. Parker, of Owen Sound ; "Long Distance Telephony," with illustrations, by Mr Neilson ; "Safe Wiring for Electric Installations," by Mr. A. B. Smith ; "Line Construction," by Mr. Wadland ; "Central Stations," by Mr. D. Thomson ; "Carbons," by Mr. Fisk ; "Steam and Electric Power," by Mr. J. J. Wright ; "Multiple Switchboards," by Mr. Baylis. Questions of interest respecting electric railways and kindred subjects will also be introduced. Accommodation including power will be provided for manufacturers desirous of making exhibits of electric apparatus. It is yet too early to speak definitely regarding the social features of the occasion, but knowing as we do the energy of the members of the Association resident in the city, and the hospitality of the citizens, we have no hesitation in declaring that every visitor will find ample means of enjoyment in whatever time he may have at his disposal apart from the sessions of the convention.

VIEW AT THE GORE, HAMILTON, ONT.

Altogether, the indications point to a time of much profit and pleasure as being in store for those who shall take part in this first convention for the consideration of questions affecting electrical interests and progress in the Dominion. We would advise every interested reader to fix the date in his mind and memorandum book, and make it a point to be present

SUBSIDY FOR A CABLE TO JAPAN.

It is officially announced at Ottawa, that the Canadian Pacific Railway has received positive assurances that the Imperial Government will grant a subsidy toward the construction of a new submarine cable between British Columbia and Japan. President Shaughnessy of that railroad, who has just arrived from Yokohama, says that arrangements have been made with the Mikado's Government for the use of land lines in Japan. Efforts are now being made among English capitalists to raise the money and float a company to undertake the construction and operation of the proposed cable in conjunction with the Commercial Cable and the Canadian Pacific route, as already chosen. This route presents very few obstacles and is certainly much better than the Southren Pacific route

THE BOWMANVILLE ELECTRIC LIGHT COMPANY.

During the fall and winter of 1886-7 the plant now owned by the Bowmanville Electric Light Company, commenced operations. The water power and site formerly occupied by McDougall's flour mills one mile north of the town was purchased and a central station erected under the supervision of Mr. Stephen Wright and Mr. M. Sanford. One thirty-five light eight ampere Ball dynamo was installed, and lights were placed in a number of stores and four lights on the streets on approbation.

In the following spring the present company organized with Mr. *John McClellan as president, and Mr. W. J. Jones* as secretary treasurer, which positions they still hold. A three years contract was then made with the town for fifteen street lamps, since increased to nineteen, and a new twenty-five light Ball machine was purchased. In 1889 this machine was exchanged for a *forty lighter*, so that the capacity of the station at present is seventy-five arc lights.

The pond covers an area of about twenty acres and gives a head of water of twenty-two feet. The machines are driven by three Leffel wheels, two twenty inch wheels of twenty-five h. p. each connected to one shaft driving one machine, and one twenty-six inch wheel of *forty-five h. p.* driving the other, so that either machine may be stopped, started or run at any desired speed independently of the other.

The station is connected with the town office by telephones owned by the company. They are placed on a metallic circuit to prevent induction, which on a grounded circuit of that length would be very bad owing to the close proximity of the light mains.

Owing to the noise at the station made by the machines the telephone had to be placed in a room separate from the dynamo room, so that the present superintendent invented a small piece of apparatus which causes an incandescent lamp to be lighted whenever the bell rings and it remains lighted until the telephone has been answered, when it is set ready for the next ring.

About sixty arc lamps are now in use and twenty-five Bernstein incandescents. A record is kept of the time each machine is started each night, and the circuit on which it is run.

There are two circuits embracing about twelve miles of wire, one of which has on it store lamps only. The other has the street lamps, hotels, churches, and all lamps which have to be run on Sundays and holidays, so that one machine does all the work when the store lamps are not required. The motto of the station is, "Cleanliness is next to Godliness." Mr. F. G. Proutt, who was for three years with the Bell Telephone Co., has been in charge for the past two years.

View at the Reservoir, Hamilton, Ont.

ELECTRIC LIGHTING FROM A FINANCIAL STANDPOINT.*

By Erastus Wiman.

As a matter of course the profitableness of any undertaking depends upon the price obtained. In my judgment electric light projectors are themselves to blame for loss of profit through false representations as to the economy of operation. If the truth had been told, and contracts refused except upon a paying basis, the electrical business throughout the country would now be upon a much better footing.

The promoters of electrical enterprises, and the sellers of electrical apparatus and appliances are rapidly killing "the goose that lays the golden egg," by falsely representing the great economy of operation, and consequently the great profits of such undertakings, thus falsely educating the public into the belief that anything like a reasonable price is extortionate.

The policy of the friends of the electrical industry should be directed in just the opposite course to that which you propose pursuing, namely, to show that electrical undertakings, upon the basis of the present prices *are not profitable*, and if they expect perfect service they must pay better prices, prices that have prevailed because the companies themselves have not heretofore appreciated and understood the cost of operation, and the great loss due to accidents and rapid depreciation.

These two extremes of success and failure tell the whole story of electric lighting in the past seven years. The companies that have succeeded have done so under favorable circumstances, with a freedom from ruinous competition, exacting good prices, and above all other requisities, with good management. If there is any department in human activity where brains and tact are required to a degree greater than any other, it is in the administration of an electric lighting plant. This is evident, not only because there was a great lack of experience and knowledge of a business that was in the production of an article that was in a certain sense mysterious and unknown, but because there has been an amount of misapprehension as to its cost on the one hand and its value on the other, hardly ever experienced regarding any article of merchandise.

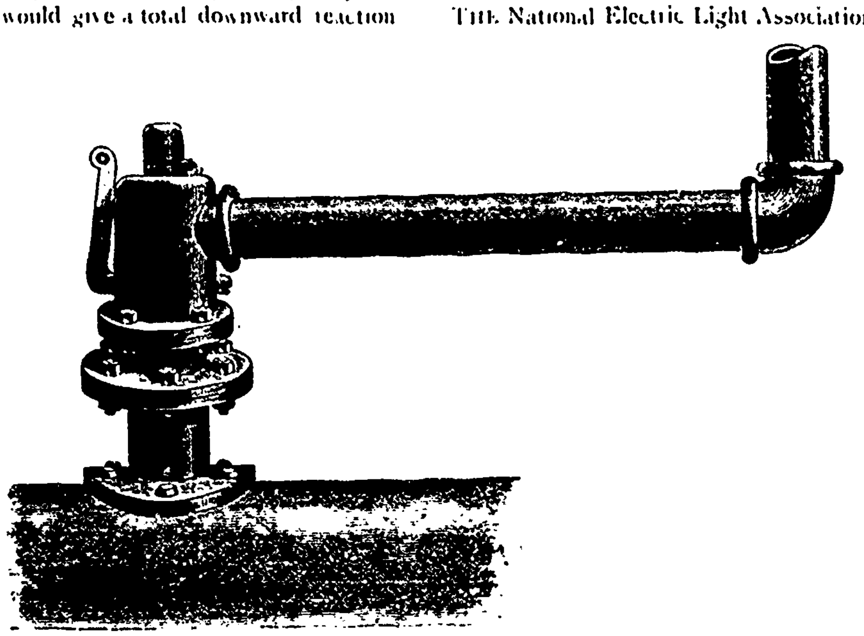
Some attempt has already been made to account for a misunderstanding as to the cost of electric lighting, but it is proper to allude to the folly which has prevailed in selling it for less than cost. The insane competition with each other in localities where one company was needed and more than one was ruinous is well-nigh passed, but there remains the competition with gas companies and the effort made to constantly lower the standard of electricity to that of gas. It is true that in the early history of the effort to use electricity as an illuminant, it was necessary to get down to the fumes of coal, and in order to show the superiority of one over the other, to yield for a time in the matter of profit. But so rapid has been the growth in the use of electricity, so immeasurably superior is the current to fume, in health, in brilliancy, in beauty and attractiveness, that the time seems near when electricity can claim the rightful place, and demand the price just so much higher as it is an illuminant just so much better. It took sixty years to introduce gas and make it a reliable servant of man. Its early history shows losses quite in proportion to those in electricity, while its later progress shows that long ago it reached its limit of illumination, its possibility of moderate profit, its constancy of danger, and its maximum of unhealthfulness. It has remained for electricity to show in every new edifice, in every modern place of public resort, in almost every commercial centre, in banks and hotels, as well as in thousands of miles of street lighting, how immeasurably superior is the electric globe of light to the meagre and inefficient gas burner. With this achieved, and a general verdict in the public mind as to the superiority of one over the other, is it not time to break away from a similarity of price, as we have broken away from a similarity of production? An advance in price commensurate with the superiority in the article produced, would add largely to the earning power of electric lighting companies, and it is time it was contemplated and acted upon.

*Abstracts from paper read before the National Electric Light Association, Buffalo, N. Y., February 24, 1892.

DANGEROUS POP-PALVES.

The pop-valve is coming into pretty general use on stationary boilers, the chief objection to it, we believe, being its expense. It responds quickly when the steam pressure exceeds the working limit, and, being direct acting, it has no levers that can get cramped, and the only way it can get fast is by the valve adhering to its seat, which is not likely to happen if it receives proper attention. Moreover, the pop-valve can be locked up, so that irresponsible persons cannot tamper with it or change the pressure at which it is set.

There is one feature about the pop-valve, however, which may make it dangerous. In many cases a waste-pipe is attached to the escape opening in the manner shown in the cut, the horizontal pipe being, say, four feet long, and the vertical pipe long enough to direct the outflow of steam upward, or perhaps long enough to pass through the roof so as to discharge out of doors. Usually no adequate support is provided for the waste-pipes that are put on in this manner, such support as there may be being intended only to relieve the valve-casing of the weight of the pipe. Now, when the valve blows off, the escaping steam rushes upward through the escape pipe, and creates a downward reaction that brings a severe strain on the outside casing of the valve. Suppose, for example, that the waste-pipe is four inches in diameter, and that the pressure at which the boiler blows off is 100 pounds per square inch. The area of a four-inch pipe is 12½ inches, and a reactionary pressure of 100 pounds per square inch acting on this area would give a total downward reaction of 1,250 pounds. This, acting at the end of a four-foot lever (*i.e.*, the waste-pipe), would bring an enormous strain on the casting that forms the outside of the valve; and it should be borne in mind that this casting is all that holds the valve together, so that if the casting should fail under the strain, the entire valve would be blown from the boiler, and in a few moments the entire contents of the boiler would be blown out. The result would probably be that the boiler would be burned before the fire could be drawn, to say nothing of the likelihood of scalding employes. Several accidents of this kind have come to our attention recently, and we do not doubt that others will continue to happen unless this arrangement of the waste-pipe is discarded. To appreciate the danger fully, one only needs to be on the top of a boiler arranged in this way when the valve blows off.



A Dangerous Arrangement.

It might be objected that the full head of steam is not realized at the end of the waste-pipe, and that the strain on the casting would therefore be materially less than is indicated above. In reply to this we may say that even if the reactionary pressure is but 50 pounds to the square inch, the total reaction in a four inch pipe will be 625 pounds, and this, if the pipe is four feet long, will bring a bending moment on the casting of the valve 4×625 = 2,500 foot pounds, which is quite sufficient to endanger the casting if there should happen to be a flaw in it, and to bring on the bolts that fasten the casting to the neck below, a strain that is greater than they can stand with safety.

If this form of attachment is to be used at all, the outer end of the pipe should have a substantial support, capable of safely bearing a weight of a ton or so; and some method of draining the pipe should be provided, in order that it may not fill with water and set back into the valve. The valve is provided with a drip opening, it is true, but it is well to incline the waste-pipe downward and put an opening in it near the elbow (at the right hand end in the cut), in order that any water in it may pass off freely without running back through the valve-casing.

We advise that the waste-pipe from safety-valves, if any be used, should be a simple, straight piece of pipe, without elbows, and dipping slightly downward, so that water may run out freely. We also advise that the waste pipe should open *in the boiler room*, unless the available space is so small as to make this impracticable. We have known of a number of accidents that were caused by the freezing up of the outer ends of waste pipes discharging out of doors. If the boiler room is small, however, and the valve is large, it may be dangerous to blow off in the room, for pop-valves blow so suddenly that there is danger of the fireman being scalded, unless there is a large free space to blow into. Numerous fatal accidents have been caused this way.

Setting a pop valve under working pressure is always a dangerous proceeding. A safe way to set such a valve is to adjust it when the steam pressure is far below the blowing off point, and test it by bringing the steam pressure up to the point at which it is desired to blow. A further adjustment is made the next time the pressure is down, and after several attempts are made in this way, the valve may be brought to the desired blowing off point. This process is a long and tedious one, and the same degree of safety and accuracy may more quickly be attained by filling the boiler with hot water and adjust the valve under water pressure, which may be done without danger. *The Locomotive.*

THE CANADIAN ELECTRICAL ASSOCIATION.

The National Electric Light Association, since its inception, has been doing good work for the electrical interests of the United States. Although at the beginning of its existence it was thought by some that it was directly opposed to the business interest of the parent companies, yet its work has conclusively shown on the contrary that it was of mutual benefit all round. Although central station interests received the larger part of its attention, the exchange of opinion and the suggestions offered, proved to be beneficial to all concerned. Our Canadian friends, through the information obtained from the meeting of the National Association in a Canadian city, at its last session, have formed the Canadian Electrical Association, which will follow in the path of its contemporary and endeavor to advance the electrical interests of the Dominion in the same extensive and substantial way as has been done in the United States. Owing to the short time that electricity has been in use for so many diversified purposes, the increased number of applications that are constantly being made show that it has a field, wholly its own, in which no effort will be necessary to expel any force that may now have a strong footing, but rather it will work in conjunction with those already established for the increased benefit of both and the greater usefulness to mankind in the development of natural resources. If our Canadian friends will go at the work with the same degree of energy as was shown by the National Association, the improvement of the rich land to the north will follow with surprising rapidity. *Stationary Engineer.*

The commutator is a device for causing the current which flows from the armature alternately in opposite directions to flow into the circuit in one and the same direction. It is built on the armature shaft and consists of a metallic cylinder which is divided into as many segments in pairs as there are electro-magnets or armature coils. The ends of the wires from the electro-magnet or magnets or the coils used in building up the armature are connected with these segments or commutators. The current is taken off from the commutator by means of collecting brushes that rest thereon as the commutator is revolved.

SAFETY VALVES THEIR HISTORY, ANTECEDENTS, INVENTION AND CALCULATION.

By William Barnet Le Van

(Continued from April Number.)

Fig. 43 shows a section of the inside of a safety valve.

The United States Board of Supervising Inspectors of Steam Vessels require for *lever* safety valves one square inch valve area for every two

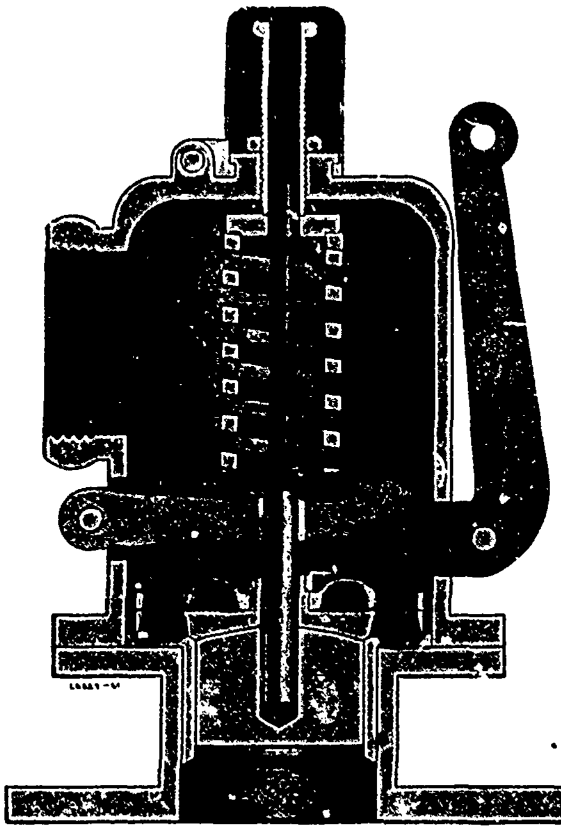


Fig. 43. Safety Valve for Stationary and Marine Boilers—Interior View.

square feet of grate surface of boiler. For *spring-loaded* pop valves, one square inch valve area for every three square feet of grate surface in the boiler.

LOCOMOTIVE POP SAFETY VALVE.

When the pressure in the boiler reaches the predominated point at which

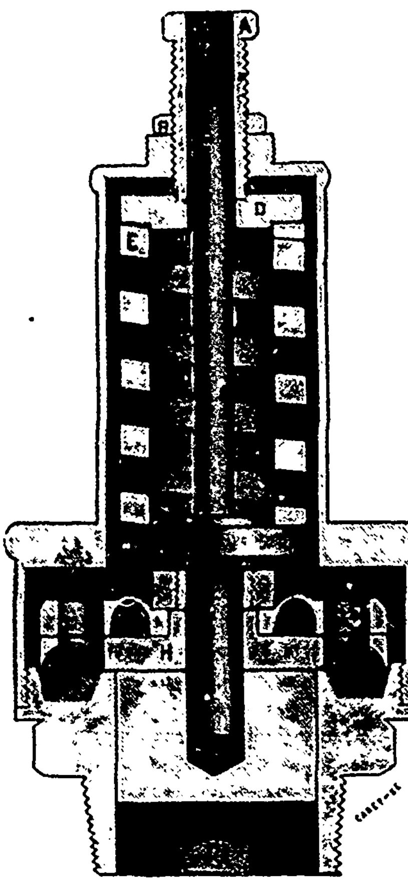


Fig. 44. Inside View of Locomotive Valve.

the valve H is set to blow, the valve will rise slightly from its seat and allow the steam to escape into the expansion chamber under and around the valve, and, as soon as the escaping steam into this chamber has created a slight pressure above the atmosphere, the valve H will at once be forced upward to its extreme lift when at that point. The steam passing through the inclined holes J will force off the automatic head G, causing a reduction of the increased area and a rotation of the valve until it again reaches its sit, *when the automatic head will be forced back into position by its spring* E, and the valve is ready for the next operation.

A—Screw to adjust spring to pressure required.

B—Check-nut to hold screw after being adjusted.

C—Spindle.

D—Follower for spring.

E—Spring.

F—Nut to hold adjustable head.

G—Adjustable or automatic head.

H—Valve.

J—Inclined holes in head.

The makers claim it the safest, most reliable, and *only* automatic adjusting pop safety valve, and that its action is such that it will *never stick* on its sit.

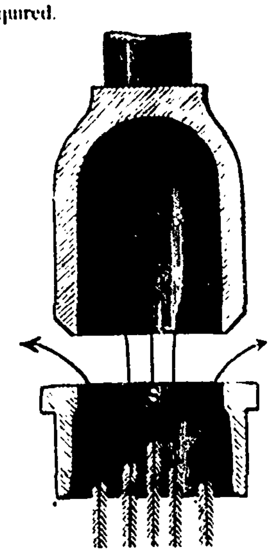


Fig. 45.

TURNBULL'S EQUILIBRIUM SAFETY VALVE (GLASGOW, SCOTLAND).

The inventor of this valve claims that it will lift with the slightest increase of pressure, *and will close practically at the* identical pressure at which it opens. The chief features in these valves are that they are entirely free from all obstructions, such as guides, feathers, etc., in the steam passages to which they are fitted, while the valves themselves are of bell form, as shown in Fig. 45, the arrows indicate that it is supported *somewhat on the principle of the hydrostatic paradox.*

The valve consists of an inverted cylinder, or bell, chamfered at its lower end, and resting on a flat surface of small extent (see Fig. 46).

For marine or stationary purposes the form of the valve is as above described, but the valve is guided externally at the lower end by a brass

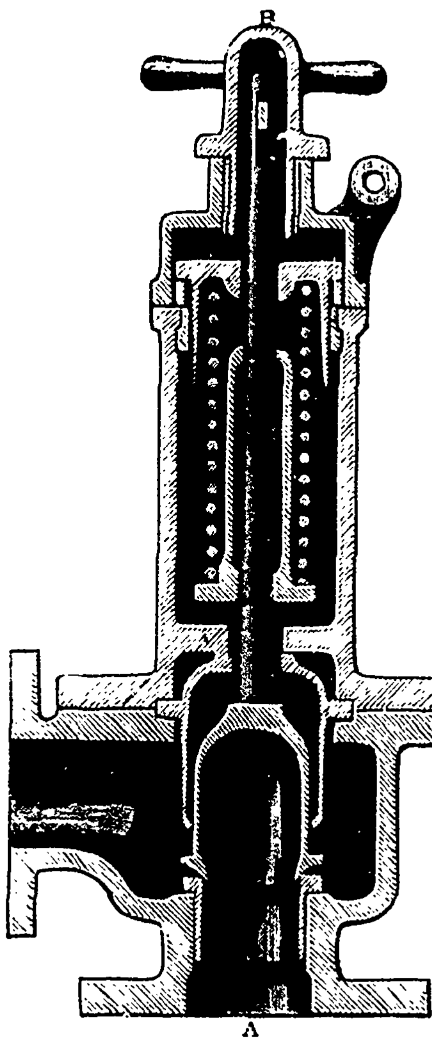


Fig. 46.—Turnbull's Lock-Up, Spring-Loaded Valve.

cylindrical casing, as shown in Fig. 46, this guide having only a narrow surface in contact with the valve. The arrangement of the spring will be readily understood from Fig. 46, and it will be seen that the upper end of the valve spindle is guided by an extension of the spring compression nut.

DISK SAFETY VALVE.

Through the use of the disk the same object is sought to be obtained by means of the reactionary principle. The disk is usually located below the ground sit of the valve, between which and the disk there is a space which may be designated as a reduction chamber, for the reason that when the valve proper is forced from its sit by the pressure in the boiler, the pressure in this chamber is reduced, thereby allowing a greater force to act against the lower and inner faces of the disk (which is of a greater area than that of the valve proper) than that acting between the valve proper and the disk forcing the valve further from its sit.

In valves constructed with disks attached to their spindles, either below or above their ground sit, the disks are of larger areas than the areas of the

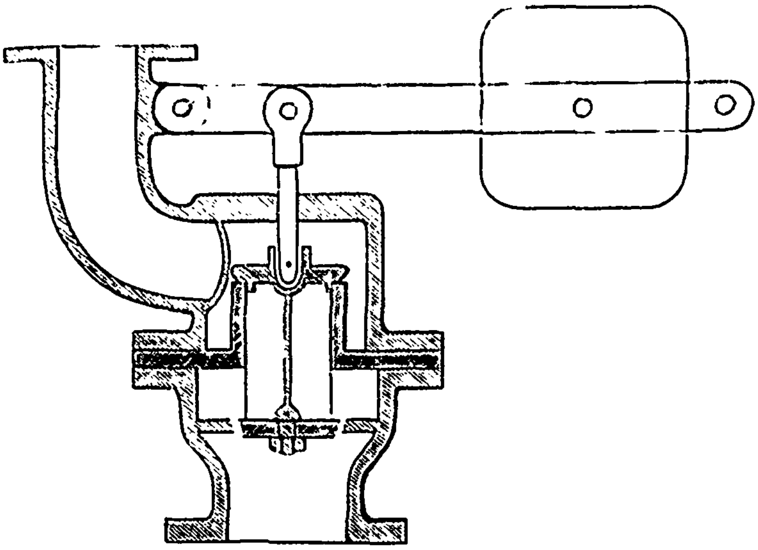


FIG. 47. DEAD-LOADED DISK SAFETY VALVE.

valve proper, and when attached to the spindles below the ground sits, operate in a recess, which may be termed a "reduction chamber."

The Cockbourne is a fair example of this form of safety valve.

COCKBOURNE DISK SAFETY VALVE.

Fig. 47 shows a section of this valve with a stationary weight, those spring-loaded being the same.

The valve proper is constructed in the usual manner, with feather-edged wings, or guides, extending into the casing. These guides extend some distance below the point where they come into contact with the casing for the purpose of receiving and sustaining the disk, the disk being considerably

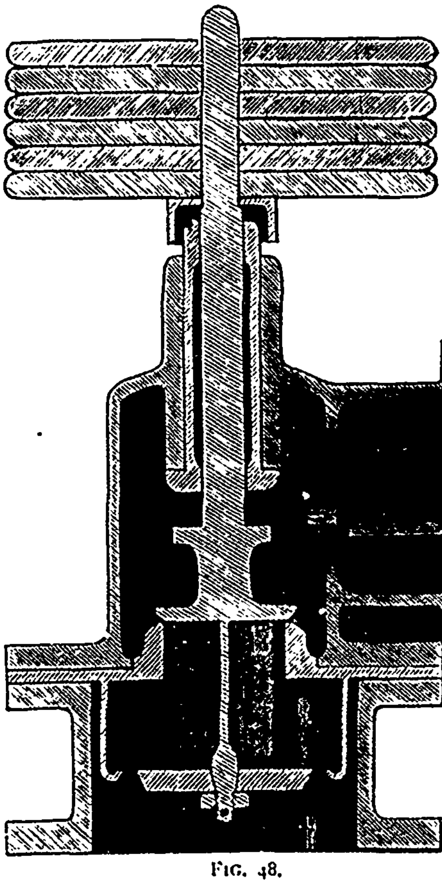


FIG. 48.

larger in area than that of the valve, and nearly filling the lower opening in the casing. The edge of this disk is bevelled. Below the casing, carrying the sit of the valve, and above the disk, is a chamber of considerable area in extent, as shown in Fig. 48.

The result of this arrangement is, that the steam, in its passage through the narrow space between the disk and the casing below the valve, becomes wire-drawn, thereby diminishing the pressure in the chamber upon the upper side of the disk. Consequently the under side of the disk, being exposed to the greater pressure in the boiler, is forced upwards, and a greater lift is thereby given to the valve than that due to the pressure and volume of steam in the boiler. The thickness of the edge of this disk, as well as its form, has much to do with the action of the valve.

These safety valves at the Washington navy yard trials showed no excess at 30 and 35 pounds pressure. Lift, 0.23 inch, area 1.82 square inches. The valve tested at 35 pounds was spring-loaded. The excess obtained at 70 pounds pressure, was one-quarter of a pound. Lift, 0.15 inch, area 1.18 square inches. This valve was loaded by a lever and weight.

REACTIONARY VALVES.

As the reactionary valves, such as the Adams, Turnbull, and others, of England, the Richardson, Crosby, American, and others, of America, constitute a type which has come into very general favor, and have just been described and illustrated, the construction of these valves is now widely known and a brief *résumé* will suffice. The outer edge of the valve is extended to form an overhanging lip, and the simple explanation of its action is, that the steam, in rushing out in the direction of an angle of say 45°, is deflected by the overhanging lip, an upward pressure tending to force the valve further from its sit is produced, and thereby obtain a larger area than that primarily due to the pressure and volume of the escaping steam when acting only upon the area due to the diameter of the valve proper.

It is quite evident, however, that if the steam, after passing *the ground-sit of a safety valve, and before it can make its final* exit into the atmosphere, is opposed by any means which will act to retard its escape and force it against the valve sit and any overhanging portion of the valve, will have a tendency to force the valve further from its sit than it would if left free.

It is a fact that such valves must expose a larger area than valves where the steam passes unobstructed by such means direct from their ground sits to the atmosphere, in order to *discharge the same volume of steam.*

In the report of safety-valve tests made at the United States navy yard, Washington, D. C., by a special committee of the Board of Supervising Inspectors of Steam Vessels, September, 1875, is the following.

"Some of these reactionary valves proved very efficient, but the committee are not quite sure that they will prove to be the best in a long run. It appears to the committee that the nicety of the adjustments of parts *required by the sharp lines of the structure,* as well as *the fact that no one* valve can be adjusted to more than one pressure, at least within a very narrow limit of pressure, without extra springs, will cause them more frequently to get out of order than the common lever valve, or some of the disk valves. The action of this construction of safety valve under pressure may be described, in general terms, as *erratic, tremulous* and in some instances, *tumultuous.* It was very difficult to adjust some of these valves twice alike, or to make them constant in their action, and they would not always give the same result under the same adjustment."

COMMON LEVER SAFETY VALVE.

The committee say, in regard to the trial of the common lever safety valve (see Fig. 22) as follows

"*First.* That the diameter of a safety valve is not an infallible test of its efficiency.

Second. That the lift which can be obtained on a safety valve, other conditions being equal, is a test of its efficiency.

Third. That the lift of a safety valve depends upon the velocity and weight of the escaping steam.

Fourth. That the valves with small areas made a greater excess than those with large areas, even when the former recorded a greater maximum of effective area.

Fifth. That two-tenths (0.2) of one inch is the maximum lift to be obtained on a common lever safety valve.

Sixth. That the common lever safety valve, when constructed upon correct principles, employing good material and workmanship, will correctly indicate the maximum pressure of steam in a boiler, and, when suitably proportioned, relieve the same of all excess."

They further say, that "in the arrangement of safety valves for any boiler, or set of boilers, the committee is of the opinion that a number of valves (where more than one is required) is preferable to one valve with a large area; and do not believe it advisable to employ a common lever valve, with either a beveled or flat sit, of more than 10 square inches area. According to these experiments, two such valves will discharge *four thousand* pounds of steam in one hour, at all pressures from 20 to 100 pounds per square inch, and if the results deduced from the experiments are taken as conclusive, the rule of proportion is all that is required in arranging the areas necessary to discharge the weights of steam generated, without any reference to its pressure."

The following rule is the nearest approximation these tests will warrant:
Weight of water evaporated in one hour, multiplied by 0.005; or,
An area of 5 square inches, up to 1,000 pounds evaporated per hour.
An area of 10 square inches, from 1,000 to 2,000 pounds.
An area of 20 square inches, from 2,000 to 4,000 pounds.
An area of 30 square inches, from 4,000 to 6,000 pounds.
An area of 40 square inches, from 6,000 to 8,000 pounds.

ANNULAR SAFETY VALVES.

These valves are constructed with two ground sits upon an annular opening, and allowed an external and internal escape for the steam. Some annular valves have attached to the valve or casing an adjustable lip, for the purpose of controlling the exit of the steam. The object sought in the construction of this safety valve is *an increase of area.*

(To be Continued.)

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

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WE have received a sufficient number of enquiries from engineers concerning the situation referred to in an editorial paragraph in last issue, to satisfy us that the ELECTRICAL NEWS is widely read. Several of these enquiries came from British Columbia readers.

SIX months ago the City Council of Montreal took note of the fact that for many years a considerable sum had been paid for insurance on city buildings, while there had been little or no damage from fire, and decided to allow its policies to lapse. The unwisdom of this action is now apparent in the recent destruction of the Bonsecours market. The Council have decided to again insure.

A SMALL vessel, the hull of which is made of polished aluminum and the machinery driven by a naphtha engine, has been built at Zurich. Only the hull is of aluminum, yet the use of that metal instead of steel caused a saving of 35 in weight. The polished surface diminished the friction, and a greater speed was obtained than from any steel or wooden vessel of same dimensions and power.

THE vice-presidency of the Great North Western telegraph Company, rendered vacant by the promotion of Mr. H. P. Dwight to the presidency, has been conferred upon the Hon. Adam Brown, postmaster of Hamilton. There is no reason to doubt the wisdom of the choice. Mr. Brown has had a long business and public career, and will give to the discharge of the duties of his new position the benefit of matured judgment.

WE do not suppose that our City Council's committee will find out much that was not known before they started on their trip to inspect electric street railway systems, but if it results in the City Council arranging that electricity must be used at once, few of the citizens will grudge the cost of the trip. The storage battery system seems about as successful as putting the horses inside the car and making them run a treadmill to drive the car.

A WRITER in the *Stationary Engineer* describes a boiler explosion which occurred in December last, and declares that "after a thorough examination of the wreck and some thought on the subject, I have come to this conclusion, that the cause of this explosion was electricity generated in the boiler and exploded the same as lightning." If electricity can be generated in a boiler and exploded, it surely can be generated and *not* exploded. Our friend should prosecute his thinking. If he can show electric companies how to generate the electricity without the use of the steam engine and the dynamo, his fortune is made.

THE Royal Electric Company has determined by the construction of dams, etc., to utilize the water power of the Richelieu river at Chambly for the supply of light and power to the city of Montreal. The planting of poles and stringing of wires to conduct the current will shortly be commenced. The Company expect to be able by this means to deliver 20,000 h. p. in Montreal, which would be sufficient to operate 200,000 incandescent lights. The Royal Co. by means of this improvement will be in a position to supply light and power at the cheapest rate, and to outbid competitors for the city lighting when their present contract shall have expired at the close of 1893.

A BOILER Inspection and Registration Bill is now before the British House of Commons. The object of the bill is said to be to prevent boiler explosions and save human life. The bill, if it passes, is to come into operation on the 1st of July, 1893. It provides for compulsory annual inspection and registration of steam boilers. It does not provide for Government inspection. Each boiler owner must select his own inspector, and is held responsible for the competency of his inspector. Boilers used exclusively for domestic purposes, in private houses, locomotives and boilers in sea-going vessels are to be exempt from the operation of the bill. The bill seems to be a fair and reasonable one, but is sure to be well discussed before allowed to become law.

THE rate of combustion of coal in a boiler furnace varies very much, but seems to be on the increase. Pressure of steam has increased, piston speed has increased and the tendency is to force everything to its utmost. The coal consumed per sq. foot of grate surface is a measure of the intensity of the fire used. In many cases with natural chimney draught it ranges from 10 lbs. per hour to 20 lbs. per hour. With forced draught it has been as high as 120 lbs. per hour. It is evident that there must be a limit, as the formation of ashes and clinkers increases rapidly, and with a rapid combustion the grates would soon need cleaning off. We are not aware of any experiments to determine what the limit of practical work in this matter is, but we should judge that a furnace using 200 lbs. of coal per sq. foot per hour would be found very difficult to keep in order. The production of heat in nature is still a long way ahead of any human contrivance. Some of the most careful experiments to determine the amount of heat radiated from the sun show the startling result that it is equal to a combustion of nearly 2,000 lbs. of coal per sq. foot per hour. The sun heat is certainly not produced by coal combustion, but the spectroscope proves that many of the gaseous elements are the same as are found in our coal fires. What a change in steam boilers if furnaces could be got that would give results equal to the sun's rate of heat production, and as little trouble with ashes and with clinkers!

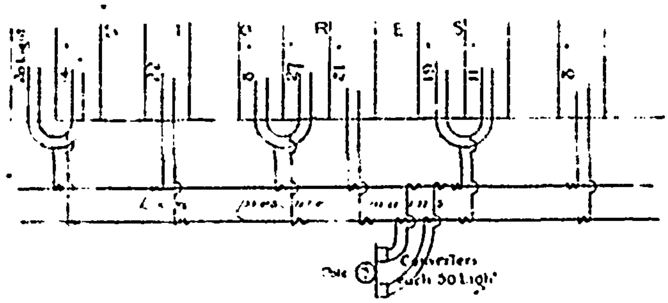
ELECTRIC railway business in Canada promises to be very brisk the present year. The electric railroad was given its first test in Canada in some of the smaller cities and towns, and on suburban lines. Having demonstrated its practicability and advantages over existing methods of transit, the cities of Hamilton, Toronto, and Montreal have determined to adopt it. In Hamilton the contract for construction and equipment has been let, the power house is in course of erection, and track laying is under way. In Toronto, matters are being delayed to give opportunity to dispel from the minds of the mayor and some of the aldermen the theory of the "storage battery" as compared with the trolley. We imagine the theory has about dissolved into thin air, and it is therefore to be hoped the change of system will at once be made. The news comes from Montreal that the street railway will be converted to the trolley electric system at once; it is expected that the change will be effected by the 1st of September. In addition to these larger undertakings, there are also a number of smaller ones in process of development. For the carrying out of these enterprises a large amount of electric and steam apparatus will be required, the cost of which will run into the millions. To us it seems a matter of regret that Canadian electrical manufacturers do not seem to have made preparations to make the greater part at least of this apparatus and reap the profits which will probably find their way into American pockets. There is also the benefit which would result to our workmen from the making of these goods in Canada. We see it stated that an American firm has been given the order for cars for the Hamilton road. We hope that such is not the case. The cars made for the Ottawa road by Messrs. Patterson & Corbin, of St. Catharines, seem to us to meet every requirement, and we can therefore see no reason for going abroad for what can be satisfactorily produced at home.

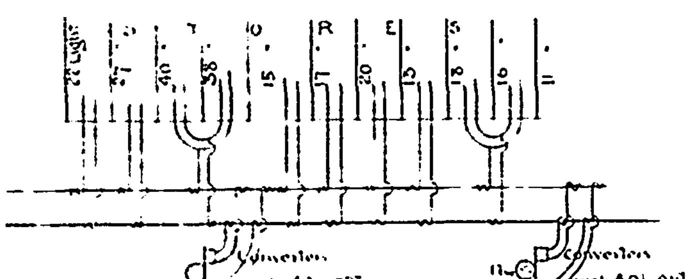
ECONOMY in the operation of electric apparatus for the production of light and power, should be of primary consideration with managers or superintendents, not such economy as would detract from the service that is required to be given, but such as will make the plant a paying one, if it is possible at prices obtained to so make it. By economy in this relation we mean looking closely after the small leaks and wastes that are bound to exist unless the most stringent means are used to prevent them. It may be the oil, the cotton waste, or even the coal pile. It no doubt is a difficult matter in some cases to locate small and sometimes even large leaks, so well are they covered up; not that it is our intention to say that deception is practised in covering them up, but only to point out that employees get into a rut in performing their daily work. By close observation small savings can be made that in the long run amount to a considerable sum in dollars. It may be that the waste box is patronized by the cleaner to too great an extent, and waste thrown into the coal hole to be burnt that would do considerable more duty were the fact pointed out to him. This also applies to the engineer and his assistants as well as to the dynamo cleaner. Then there is the oil question—a gigantic one with some stations. Let us look at it from the point of economy, and see if there are not some leaks that could be effectually stopped. Have you an oil filter? and does it do its work well? If not, by all means get one as quickly as possible; again, have you some of your dynamos throwing oil around and acting as though their whole duty was to see how much good oil they can manage to cover a certain part of your floor or wall with in a limited time? if so, be sure to stop it at once. If necessary, have the journal rebabbitted and made to fit the shaft, for ten chances to one that is the cause of it, then cast your eye occasionally on the oil cups, and place your hand on the bearings that your man is supposed to attend to and keep in good shape, for be it known that one of the worst sources of waste in lubricating oil is caused by a hot or heated journal and the consequent amount of oil that must be put through it to bring it back to its normal state again. While on this question of oil we would like to say that it is poor economy to use a cheap article cheap only in price per gallon, dear when the amount consumed is taken into consideration. This applies equally to cylinder, engine, or dynamo oil—they *must all be the best to get good and economical service.* Bad oil as well as inattention will cause hot boxes with consequent cutting of the babbitt, necessitating the expenditure of good money in time and material to make right again, all of which should be added to the price per gallon of the oil used. Last, but by no means least, is the coal pile, for if there is one part of an electric lighting plant that requires greater care than another in order to secure economical results, it is the steam plant. Economy there consists in having good firemen, men who know just when to put more coal on their fires, and just where to put it, and how much to put; to clean out the boilers frequently and use some good article to prevent scale from adhering to the shell and tubes, and who know how to keep steam up to a pressure just inside of the blowing-off point. It means a drop of from 3 to 7 lbs. in pressure before a valve will close down after it is once lifted by the pressure; that means that a considerable lump of your coal has been burned to no purpose. See to it also that steam pipes around your boilers and those running to the engine have no leaky joints, and that they are well covered with a good fire-proof non-conductor one which will allow you to place your hand on the outside and *suffer no inconvenience thereby, even if there should be a pressure* of 100 lbs. of live steam on the inside of the pipe. Such things are made, and we have come across them more than once; they should not be clumsy, and in no case greater than *1¼ to 1½ inches in thickness,* except where they are used for covering the outside of a boiler. Another point in this connection is to have your steam pipes sufficiently large to cause no wire drawing of your steam, and your exhaust pipes large enough to let the spent steam reach the air without any choking, thereby causing back pressure on your engines and the consequent waste of so much money in coal to force it out. In conclusion we may say that just such faults as are enumerated above have all come under our direct observation at times, and the wonder sometimes has been "how came it so."

THE BLOCK SYSTEM OF DISTRIBUTION.

IN the distribution of electricity for store lighting by means of converters, the practice is usually to place a converter on the house front or on a pole close by for each individual store, or at the most for two stores adjoining one another, but this is being superseded by a system of block distribution either from one *central point or pole, on which converters are erected to supply* the whole block, or if there is a large number of lights in any one block which would require mains say of 000 or 0000 capacity to carry the current, they can be much reduced in size by having two *central points of feeding from converters to the same* set of mains, in which case the converters are best located at about a quarter of the block's length from each end. This also is an advantage, in that a pole to carry converters for say 200 lights, would require to be a veritable mast in thickness, on account of the enormous weight contained in the converters, whereas with the load (in weight) divided between two poles, it only needs one of ordinary thickness to carry them; the different shops or stores are then fed from these mains. This is decidedly advantageous in another direction, viz; that now it is possible to operate say 200 lights from a converter capacity of not more than 150, as there is seldom more than that number in use at any one time out of the 200, and if there should be an occasion when the entire number would be lighted at once, the converters will carry a temporary overload of 30 to 50 per cent, if they are of proper construction and reliable make, in contrast to which, if each store was supplied from its own individual converter the probabilities are that the capacity of the converters totalled up in lights, would reach well into 300. It is evident then that the loss on converters at little or no load would in this case greatly exceed that in which the capacity of converters in lights is 150. Then again it is a well established fact that there is less constant loss in proportion by using few converters, instead of a number of small ones to do the same work.

To illustrate more fully what we wish to convey in this block system of distribution we append two outline sketches, the first





of which is the one centre of distribution spoken of above, and the second the two centres. By referring to the diagram it will be seen that two fifty light converters connected in multiple will supply mains from which 150 lights, as wired, can be fed to the stores, and in like manner, from 225 to 250 lights can be operated from four 40 light converters connected in multiple with the one set of mains at two different points, the supply wires being dropped off at any point desired. Of course the mains must be of such a size that there will be an even drop, or loss in voltage all over.

THE TELEPHONE IN CANADA.

WE print below some interesting statistics which we have gathered concerning the growth and present extent of the telephone industry in Canada. By comparing these statistics with those of other countries it will be seen that we occupy an enviable position, both as regards the extent and efficiency of our telephone service, and the moderateness of the price at which it is furnished:

The telephone rentals charged in some of the principal cities of the United States are as follows:

New York	$240
Boston	200
Chicago	125
Philadelphia	100
St. Louis	100
Cincinnati	100
Buffalo	50 and five cents per call.
Kansas City	72

In the whole of the United States the average cost per connection per subscriber varies from 2 to 14 cents.

In London and Paris the rates are $100.

The following table will give some detail of the rates charged in Canada, the average rate being $31:

Size of Exchanges.	Rate.	Cost per call.	Average No. of calls per day per subscriber.
Under 100 subscribers	$20	.016	4
100 to 200 "	25	.0163	5
200 to 500 "	30	.016	6
500 to 1000 "	40	.014	9
Toronto, 3965 "	45	.012	11¾
Montreal, 5872	50	.013	12¾

The use of the telephone in Canada is an evidence that the rates charged are but reasonable. In Great Britain there are 167 telephones in use for every 100,000 inhabitants, in the United States 350 telephones for every 100,000 inhabitants, and in Canada 540 telephones are in use per 100,000 inhabitants.

In Paris, where the telephone is under Government management, and service is furnished as cheaply as possible, there are but 4.2 telephones in use per 1,000 inhabitants, in London, England, where the Government controls the patents and has been liberal with its licenses there are but 1.5 per thousand in use, in Vienna there are but 5 telephones per thousand inhabitants, and in Berlin, where the use of the telephone is supposed to be exceptionally large, there are only 17 per thousand, while Montreal has 25 instruments in use per thousand inhabitants.

The number of telephones in use in Canada is greater in ratio of population than in any other country, and this because of the lower rates charged. In 1880 there were only 2,100 subscribers to the Bell Telephone Company, while to-day there are 26,212.

As an evidence of local growth we give a schedule of the number of subscribers in 1880 in fifteen Canadian cities, and the number of subscribers in those cities to-day:

	1880.	1892.
Montreal	312	5,872
Toronto	353	3,965
Hamilton	181	1,160
Quebec	124	1,011
Halifax	87	955
Ottawa	230	942
London	104	805
Winnipeg	35	798
St. Johns, N.B.	116	617
Brantford	33	314
Guelph	11	226
Windsor	22	205
Woodstock	27	186
St. Thomas	28	173
Cornwall	10	67

The business is still largely experimental. When the value of the telephone first began to be appreciated (between 1878 and 1880) the public and cities welcomed it, and were as anxious to grant facilities as they are to-day prompt to refuse them. At that time it seemed as though every city took pride in having as many poles as possible, and in one notable instance the city gave permission to erect poles in its streets provided they were placed in every street, or in the words of the contract, "the city shall be fully poled." Construction was then relatively cheap, but as the number of wires increased, larger and vastly more expensive poles were erected, and they being finally overladen with wires, the introduction of cables became a necessity. These again were experimental, and the companies hardly got their lines in cables before defects in the old and improvements in the new, compelled their abandonment for other forms. Hardly had a standard been reached in aerial, grounded circuit cables, when the introduction of electric light, electric railway and electric power wires made another change absolutely necessary, since the old grounded wires were rendered useless by the induction from the electric light and power wires. This, by doubling the number of wires, again overloaded the poles, the height of which had reached its limit, bringing about another change, namely, underground construction. Here again everything was novel and experimental. Hundreds of different forms of conduits and cables were brought forward for purchase by the telephone companies, only to be tried and eventually abandoned. This work seemed for a long while to resemble the contest between big guns and iron-clad ships. The companies no sooner procured a cable which overcame the electrical difficulties consequent upon underground work, than some element in the conduit came to light which destroyed the cable. Many of these systems have been abandoned, both conduit and cable being a total loss to the companies, until now both cable and conduit have become so expensive that all over the world, with the exception of Canada, it has been necessary to nearly double the rentals. The cost in Canada of some of the underground conduits when equipped with cables will be nearly $80,000 per mile, and this expense no company would be warranted in incurring unless they were quite sure that they had the field to themselves.

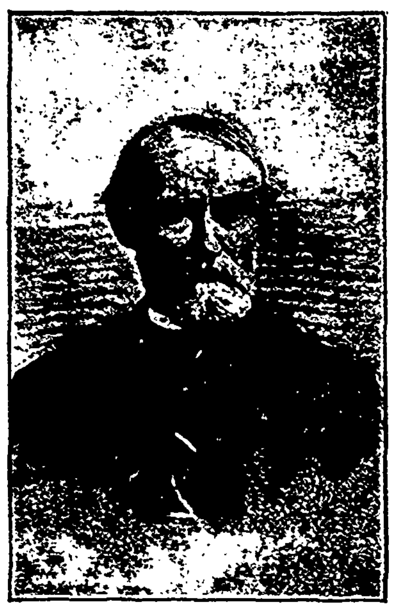
The office equipment has changed as often as the line construction, and it is safe to say that the most expensive part of the apparatus (switchboards and magneto bells) has been wholly changed at least four times within the last twelve years. The expense of this apparatus has increased in the same proportion, until the cost of equipping an exchange with multiple metallic circuit switchboards of the latest pattern, with a capacity of 3,000 subscribers, will be in the neighborhood of $200,000, in addition to the cost of the lines and the apparatus at subscribers' stations.

Another very serious source of loss to the companies is the frequency of the sleet storms, which have in many instances totally wrecked their plant and rendered entirely new construction imperative, without any increase of revenue. The storm of the 11th March, 1892, in Ottawa, caused a loss to the companies, in poles and overhead wires, of probably between $20,000 and $30,000, all of which has to be met from surplus revenue.

Certainly these figures are sufficient to convince any disinterested person that the telephone companies, possessing a property of a very hazardous nature in itself and subject to continual change, must be able to earn not only their expenses and their dividend, but a large sum to be placed to reserve in order to meet contingencies.

THE NEW PRESIDENT OF THE G. N. W. TELEGRAPH CO.

HARVEY PRENTICE DWIGHT was born in Belleville, Jefferson County, New York, in the year 1827. He received his early education at a small country school house in this district, and at the age of 14, with but 50 cents in money and the clothes on his back, left home to seek his fortune, walking ten miles to a small village, where he procured employment in a general store, and where he remained for a space of three years. At this period telegraphy was in its infancy in Canada, and held out bright inducements for young men to enter its service. He left his employment in the store and sought and secured a position in the telegraph office at Oswego. After learning the art of an operator he made application for employment with the Montreal Telegraph Company, then commencing operations in Canada. He was first stationed at Belleville, Ontario, where the first telegraph office was opened in August, 1847. Here he remained a few weeks, and was then transferred to the head office at Montreal, where he remained for nearly three years, and was then sent to Toronto to take charge of the business. The company at this time had a line of one wire between Quebec and Toronto, a distance of about 500 miles, and some 12 or 15 offices. Extensions were rapidly planned and carried out under Mr. Dwight's direction throughout the Province of Ontario, and he was made Western Superintendent of the Company. In 1881 a consolidation of telegraph interests took place under the charter of the Great North Western Telegraph Co., through the instrumentality of Erastus Wiman, who became President of the Company, Mr. Dwight being appointed General Manager of the consolidated interests. Four years ago he was elected Vice-President, and on the resignation of Mr. Wiman on March 30th last, appointed his successor as President, and thus became the most prominent personage in telegraph circles in the Dominion.



MR. H. P. DWIGHT, PRESIDENT G. N. W. TELEGRAPH COMPANY.

The Great North Western Telegraph Company is the most extensive and far reaching telegraph enterprise in the Dominion, controlling about 40,000 miles of wires and nearly 2,000 offices. Its ramifications extend throughout the provinces of Ontario, Quebec, New Brunswick, Manitoba, and parts of the States of Maine, New Hampshire, Vermont and New York. The completeness of the system is due in great measure to the broad executive ability, foresight and judgment of Mr. Dwight, and for cheapness and efficiency Canada may be congratulated on possessing a system of telegraphs in the Great North Western Company second to no country in the world.

A POPULAR DESCRIPTION OF THE MAIN PRINCIPLES OF THE DYNAMO.

BY JOHN A. GRIER.

THE collection of electricity, or its generation as it is often called, is no more or less mysterious than the generation of heat. For those who make no pretensions to understand the governing principles underlying the generation of electricity by a dynamo we present the following brief explanation which we hope may be easily grasped.

Perhaps every reader has played with a common horse-shoe magnet. No one can have one in his hand even for a few moments, without noticing that the small piece at the two ends, called the armature, when brought close to these ends, not allowed to touch them, is affected by some invisible influence which tends to draw it towards these ends. This mysterious influence is called magnetism. On laying a horse-shoe magnet on a piece of a paper placed in a horizontal plane and loosely sprinkling iron filings around these ends, it can be seen that there is an apparant current of influence projecting into space from the ends and running across the space at the open ends of the magnet. These imaginary projections or currents of this mysterious influence are called "*lines of magnetic force*." Here we have the magnetic force and the next thing is to get the electricity. By moving an armature across these lines of magnetic force at the ends of a magnet we find it requires an expenditure of energy. In the case of a dynamo we obtain this energy from steam, water-power or some other source. The generation of electricity is as easily understood as the method of getting power by a steam engine. It is known that if we take a conductor of electricity, like a common copper wire, and by any means cause it to move through lines of magnetic force in a certain direction that *electricity will be developed* in this conductor. No one pretends to explain why. This is the whole mystery of the dynamo with all its astonishing possibilities in the service of man.

We know how to do it but are as much in mystery about the reason Nature acts in this way as we are to explain why an apple goes down instead of up when rolled from your open hand.

A dynamo consists principally of two parts, one of which is a large mass of soft cast or wrought iron called the magnet and the other part is called the armature. Soft iron does not remain permanently as a magnet except to a very slight degree. However, some magnetism always remains stored in iron. There is a germ of magnetism great enough to be easily and quickly increased when properly handled by well-known methods. The revolving shaft, as seen in the ordinary dynamo, is called the armature. The armature is usually constructed by having hundreds of insulated copper wires in it and is made to revolve at a high velocity by some mechanical force, such as steam. Suppose this speed is 1,000 revolutions per minute, which is not unusual, and that we have 500 wires on this armature, then we will have, as the armature revolves, what would be equivalent to a single wire cutting across all the lines of magnetic force of 500,000 times each minute. The magnet generally entirely surrounds the armature and these magnetic lines of force are shooting through the armature in a continuous stream at an inconceivable velocity. All the wire conductors on the revolving armature as they move these lines of magnetic force are constantly picking up their little share of electricity and unloading it by means of ingenious mechanical devices connecting with the conducting wire that leads from the dynamo, and receiving the returning electricity on another wire leading into the dynamo.

One of Nature's wonderfully mysterious laws causes soft iron to become magnetic when surrounded by a current of electricity. In the ordinary dynamo this law is of the greatest utility. As the electrical current is being collected by the revolving armature, it is led around the magnet and thus the magnetic germ is quickly changed into a mighty force, again feeding the armature which transforms it from magnetic to electrical force. The average reader may not choose to seek any farther into these mysteries, but may be satisfied to understand these main principles that underlie the mechanical generation of electricity by a dynamo. Stated more concisely, permit me to repeat. A conductor of electricity if made to pass through a magnetic current in a certain direction will have a current of electricity generated in this conductor. A dynamo consists mainly of a magnet and an armature, one of these must be put in motion by some outside force in order to generate electricity, then these small portions of electricity as it is generated are led off, concentrated for use. Thus the generation of electricity by a dynamo is a happy combination of these two closely related, omnipresent forces, magnetism and electricity, brought about by the expenditure of energy derived from some other source. It is not a new creation of energy, but only a change in its form more convenient for our use. Instead of a belt or gearing as in a steam engine or a water-power, we can convey this form of energy far more economically by a wire to the place we wish to use it to produce motion, heat or light. The dynamo is not a substitute for the steam engine or water power, but is simply an auxiliary. By its use there is always a considerable waste of energy, but we get the energy we use, in the most economical way, to the place where it is most required. *Mechanical and Electrical Progress*

WORK AND POWER AS MEASURED BY THE STEAM ENGINE INDICATOR.

THE following paper on the above subject was read by the author, Capt. Wright, at a meeting of Montreal Branch No. 1, C. A. S. E. Introductory to the paper, as printed below, the author gave a brief history of the invention and improvement of the indicator.

I will now proceed to an investigation of the revelations of the indicator diagram. First, it is simply a record of the pressures against one face of the piston during a complete revolution of the crank pin. It goes no further; the rest we must do ourselves. I am aware that there are able engineers, men fit for any position, intelligent and reading men, who yet consider the whole thing a humbug, and look at indicating an engine as mere playing with a toy. To do them justice I will defend them. They have never given the subject a serious thought, and during their education as engineers, the instrument was not in use. I have often told them that if James Watt, Wm. McNaught and Dan Gooch found it necessary to invent instruments to tell them what was going on in their cylinders, perhaps it would do us no harm to follow their example.

I am aware that the standing of the indicator has been injured by quacks and prodigies men who will practically tell you, that what they don't know is not worth knowing. It is plain that they have not learned the first lesson in indicator practice, that we know very little about steam doing work in a cylinder, and it is advisable to be modest. But it is said that nothing was made in vain, and so the indicator quack performs the important mission of bringing the instrument to the notice of the public. The mechanical terms, "Work," "Power," "Energy," which must be used in our present enquiry, had better be defined. These words have a technical meaning in engineering which cannot be found in our common dictionaries. "Work" is motion against resistance. A resistance is overcome, motion takes place, work is done. "Power," as understood by the modern engineer is simply the rate at which work is done; thus, the hammer of a pile driver weighs 3,000 lbs. and it is lifted 30 feet high; here a certain amount of work is done, viz., 3,000 lbs. lifted 30 feet, or its equivalent in foot pounds, 9,000 lbs. lifted 1 foot high. So far we can say no more. But when I say that 3000 lbs. is lifted 30 feet high in half a minute, a rate of work is named. And these three factors, namely, amount of resistance, distance moved, with the rate or time it was done in, is the "power" which is generally expressed in units of 33,000 lbs. lifted 1 foot high in a minute called a horse power. But it must be remembered that this so called h. p. is only a convenient unit. It would be absurd for the Grand Trunk or C. P. R. to express distances between stations in inches. The figures would become so large, that we could not compare or comprehend them. In consequence a unit of 63,360 inches is used, called a mile. It is just so in our business. The units of work done by engines pile up so fast, that a unit of 33,000 foot pound per minute is used, which brings the amount within our comprehension.

The engineering "Energy" is the ability to do or the capacity for performing work. We now wonder how the old engineers, managed to express their ideas without this word, for its use by engineers is quite modern. They were in the habit of coining some word from Latin or Greek, with the result that they confused themselves, and other people could not find out what they meant. Go to the Bonaventure station at 4.30 in the afternoon, and you will see several locomotives, standing in front of trains. They look quiet and peacable they are doing no work. Look in the cab, you may see the finger of the gauge pointing to 100. We have the idea there is something about her quite different from what would be, if the finger stood at 0 on the gauge. In the state she is in, she is possessed of energy; she is capable of doing work, and the amount can be determined. In this case energy exists, but for the time being is not used, it is at rest. I imagine the train going along at 40 miles per hour; steam is suddenly shut off; she keeps on going; there is now no force drawing her along; it is the energy stored in the train by the work previously done by the engine. In this form it is energy in motion, and in proof that it is capable of doing work, look at the destruction caused by a collision.

The mechanical idea of work covers every case of resistance overcome, whether it be the sawing out of a board in a mill, or the breaking of it up in a collision. And so in the case of a fly wheel, energy is stored in the early part of the stroke, and restored in the latter part. Build a dam across a river—the impounded water is a store of energy; work is capable of being done there. A boiler under steam is a store of energy; no work is done by the boiler except in case of an explosion. The small matters of every day have their examples. I wind up my clock at night; in doing so I have done work; by raising ten weights I have stored energy in the weight. It is capable of doing work in driving the clock for the next 24 or 30 hours. In all the cases mentioned, the amount of work that can be done is in proportion to the stored energy, either at rest or in motion, and it can be computed. From this standpoint an indicator diagram is a diagram of energy. Give me the scale of the spring with which it was taken, the diameter of the piston and the length of stroke, and I can compute the work done per stroke. Give me the number of revolutions per minute and I can compute the power, or the rate at which work is done.

There are many distinct classes of engines slide valve, with lap or without it, with a governor and without; some have cut off valves on the back, some cut off outside of the steam chest. Then there are automatic engines, condensing and non-condensing, compound engines with two, three and four cylinders. Each class of engine, if in good working order, makes a diagram with characteristics of the class to which it belongs. A glance is generally sufficient to tell the family it came from.

In the multiplicity of peculiarities and forms observed in diagrams, it would be impossible to take notice of all, I think one is enough, aud I have selected one of the Corliss class: it may be a Brown or a Green, or any other of the automatic family, with a cylinder 16" diameter and 42" stroke, making 70 revolutions per minute, a piston speed of 490 feet per minute. This engine is a common size, neither very large nor very small, with a fair speed of piston. Another reason why I selected this size cylinder and speed of piston is to avoid fractions, which if any, required constants, are so small in this case that they can be neglected without any sensible error.

In determining the performance and efficiency of an engine by means of an indicator, it is usual to calculate certain quantites, called "constants," which save a great deal of after time and trouble. A constant is a reality, it is the result of a calculation carried out to a certain point, which point is common to all engines of that size piston, and speed of piston. A power constant, for our selected engine may take this form. What is the power of a 16"x42" engine, with a piston speed of 490 feet per minute and 1 lb. M. E. P.? Work this out in the usual way - multiply the piston area by the M. E. P. and by the piston speed, divide the product by 33,000. The quotient is 3, which is the h. p. with one pound M. E. P. This is the power constant in this particular case. Look seriously at this for a few moments, and you will perceive that if the M. E. P. was doubled, you would have double the power; if the M. E. P. was trippled, you would have three times the power; of course all other factors remain the same. If you have doubts of this, work it out, and you will find it is true.

It is then established that the M. E. P. multiplied by 3 is the h. p. of any diagram taken from a 16" cylinder having a piston speed of 490 feet per minute. It is sometimes best to know exactly what we are doing. If anyone here works out this constant, he will find that the real constant is a three-hundredth part less than 3, which I have dropped as insignificant and of no consequence. An extra piston speed of 20 inches per minute would bring the constant up to 3. Looking at the thing from a money point of view, a tenant rents 1 h.p. from our 16" engine at the rate of $75 per year. In working up the h.p. of the engine the constant 3 was used, our tenant is paying one-twelfth of a cent too much per day—an amount of no consequence in such a bargain.

Another constant much used and a powerful weapon in the hands of the engineer, is known as "piston displacement," or the volume swept by the piston while making one stroke, or one revolution, or during one minute or one hour—or for that matter, one day if you wish, but for good reasons it is customary to count it by the hour. A moment's thought will convince any engineer that at work the cylinder and piston of an engine are actually performing the functions of a meter. She discharges every stroke a certain volume and weight of steam. The volume is constant, but the weight varies according to the pressure existing in the cylinder at the end of the stroke, or the "terminal pressure," as it is called. The amount of both of these factors can be determined as easily and accurately as the cubic contents of a box, or the weight of a bar of iron. It is generally advisable and always beneficial to know with precision what is going on around us—a fly wheel turns around; a piston goes backwards and forwards, but that is not all; let us see what is really being done in our 16" cylinder, with a piston speed of 400 feet per minute, and only in relation to the simple idea of distance travelled by the piston. The piston travels 490 feet per minute; in sixty minutes or one hour it travels sixty times 400 feet, or 29,400 feet, and in a working day of ten hours duration, ten times that amount, or 294,000 feet—a number too large for us to grasp—I therefore divide this distance expressed in feet by 5,280, the number of feet in a mile, and get as the distance travelled by our piston in a working day of ten hours, 55 miles and 360 feet. To get a step further, in a year of three hundred working days of ten hours each, our piston has travelled in the cylinder a distance of 16,704 miles. Some may think that such things as this is merely the gratification of idle curiosity, but the facts that I have stated have a bearing on our investigation this evening in a manner not suspected by the fault finder. Our 16" cylinder has a piston area of 201.062="; and moves 42 inches each stroke. The displacement of the piston or volume of steam passed through the cylinder each stroke is 201.062 x 42, or 8444.604 cubic inches; in two strokes, or one revolution, 16889.208 cubic inches. This number is getting incomprehensible already, so I will reduce it to cubic feet by dividing it by 1,728, the number of cubic inches in one cubic foot, and get for answer 9.7738 cubic feet, being the volume displaced by the piston during one revolution. But our engine makes 70 revolutions per minute, therefore the revolutions made per hour is 4,200. This number multiplied by the piston displacement per revolution gives me 41049·96 being the piston displacement in cubic feet during one hour's work. You will perceive that this is also the volume of steam that has passed through the cylinder during that time. The number 41049.96 is known as the displacement constant of one of our 16" engines making 70 revolutions per minute, and I shall use the whole number 41050 as being sufficiently close for the purpose.

Armed now with our power constant of 3, and displacement constant of 41050, we are in a position with the assistance of an indicator to quickly and accurately determine the amount of work done and the cost, whereby we can compare the performance with other classes or sizes of engines and also discover defects, if any exist, and point out the remedy.

You all know how indicators are attached to cylinders, so I will not occupy your time with that. As a general rule, the shorter the pipe and the fewer the elbows, the more reliable is the diagram. Then some form of reducing the motion is necessary to bring the stroke of the piston within the limits of the instrument. The swinging lever and the pantograph are examples of that. Nothing in indicator practice appears to have given engineers so much trouble and concern as a true reducing motion that could easily be applied to any engine. Differential pulleys, spring pulleys, inclined planes, levers, screws and pantographs have all been used. It appears to me that the proper solution of the question is to have every builder of engines put on as a permanent fixture some approved form of reducing motion.

I will now suppose that we are ready to take a diagram. The pipes have been blown through to clear them of dirt, the instrument is in place and warmed up, a card is in place on the paper drum, a true reducing motion is in place and at work with a string of the proper length communicating motion to the paper drum, and the instrument is in free communication with only one end of the cylinder. After being sure that all is right and in good working order, apply the pencil to the paper on the revolving drum with light pressure during at least one complete revolution of the crank-pin. Next shut off the steam from the instrument in the proper manner so that atmospheric pressure is on both upper and lower faces of the piston; put the pencil on the paper again and draw the atmospheric line; then unhook the string; the drum stops revolving; take off the card and you have a diagram of the pressures which existed against the face of the piston then in communication with the instrument.

I wish particularly to again call your attention to the fact that an indicator diagram is neither more nor less than a record of pressures, and from that record we perceive at once the state of affairs in that end of the cylinder. Thus if the steam port was not open at the beginning of the stroke the pencil does not rise; we see it at once on the diagram; or if the steam is held too long in the cylinder and the pencil remains up when it should be down, we see it. If the back pressure is heavy during the return stroke, if cushioning is excessive or none at all, if the steam pressure drops excessively during admission, or if the general behavior of the steam while at work is faulty, you can read it on the diagram. Besides, most important results can be obtained from it by calculation and measurement. In all cases, the length of the diagram, whatever it may be, is the stroke of the engine from which it was taken, and the heights or amounts of pressure on the diagram are measured by the scale of the spring that was in the instrument when the diagram was taken. Generally the first thing to be done is to determine the M.E.P. Till within a few years ago the only method in general use was by ordinates. In this case, any line drawn perpendicular to the atmospheric line is an ordinate, same as these perpendicular lines on the blackboard. To do this in the usual way take a short, straight edge and lay it on the diagram, so that one edge coincides with the atmospheric line; then with a small set square erect two lines touching the diagram at its ends. This defines the length of the diagram, and this length is to be subdivided into any number of equal parts, but not less than 10. This can be done by trial with a small pair of spring bows or dividers, but much better with a scale of 30, 40 or 50 to the inch. Apply the scale to the diagram and slant it till a convenient number can be read between the perpendiculars already erected, then with a needle point, or a fine point of a hard pencil make marks on the paper corresponding to the divisions on the scale; then with your straight-edge and set square draw ordinates through your divisional points. But an incomparably better method is to use this instrument which is made specially for this purpose. Lay it on the diagram and open or close it till the length of the diagram is bounded by the corresponding edges of the two outside bars. Hold it there, and with a sharp pencil rule off each bar; then you have it most accurately divided into 10 equal parts. Looking at our diagram after this is done we see that each division has two properties in common—they are all of the same width, and the sides of each are bounded by straight lines. This makes it possible to measure the height of each with close accuracy; then with the scale of the spring, measure the mean height of each division between the lines of the diagram. Pay no attention for the present to the atmospheric line. Add these all together and divide by the number of divisions—the quotient is the M.E.P. of the diagram. A better way is to lay off the division heights on the edge of a strip of paper, one after the other in succession, no breaks; measure the length of the whole with your foot rule, multiply that amount in inches and decimal parts by the scale of the spring, and divide by the number of divisions. This method is more expeditious and accurate than the first one.

(To be Continued.)

PERSONAL.

Mr. J. C. Palmer, a promising young electrician, son of the proprietor of the Palmer House hotel, Toronto, succumbed to a severe attack of diphtheria in this city, a fortnight ago. He had recently resigned a position with a New York electrical firm to take the management of the Kirby House at Brantford, of which his father is also proprietor. Deceased was a member of the National Electric Light Association of the United States and his application for membership in the Canadian Electrical Association was to have been presented at the next meeting of the Executive Committee. Of a genial disposition, the deceased was held in much regard by a wide circle of acquaintances, by whom his untimely death is deeply deplored.

PUBLICATIONS.

The April *Arena* is rich in able, thoughtful papers. Its table of contents is as varied as it is inviting. Although the most liberal and progressive of all the great reviews, the *Arena* is prospering in a manner which indicates the trend of public thought and proves that the people admire brave, outspoken, and earnest magazines.

Germany now employs for its electrical machines 731 stationary steam engines, which represent a total of 38,544 steam horse power and 63 locomotives, developing 1,266 horse power, says *Fielden's*. This 39,610 horse can furnish 400,000 incandescent lamps of 16 candle power each. One hundred and seventy-seven stationary steam engines and 12 locomotives of 10,000 horse power are used in other electrical industries.

THE ELECTRIC TRANSMISSION OF POWER.*

By Gisbert Kapp.

Lecture III.

(Continued from April Number.)

I have occupied some time in putting before you this transmission plant, because exact information about successful engineering work is of great value to practical men, and the Schaffhausen plant is certainly one of the best and most successful examples I could have chosen. The power transmitted is certainly large, according to our present ideas, but there is good reason to believe that in point of magnitude at any rate this transmission will very soon be eclipsed by other work of this kind. There are projects afloat for utilizing the power of the Rhine, near Bâle, to the tune of tens of thousands of horse power, and at Niagara, as you all know, a total of 125,000 H. P., or a little over 3½ per cent. of the total power of Niagara, is to be taken from the Falls and transmitted to various distances, the longest distance being some 20 miles. I am not in position to give you details of any of the schemes which have been submitted to the Niagara Commission, since these are the property of the Cataract Company, but, by the courtesy of several members of the Commission, notably Dr. Coleman Sellers, I am able to give you a general outline of the schemes. My object in applying to the Niagara Commission for information of this kind was to obtain some indication of the opinions which leading modern engineers entertain of electric power transmission, and to put the result of my inquiry before you. Lest the general condition of the Niagara scheme may not be quite familiar to all of you, I shall now throw upon the screen a picture of the Falls, and give you very briefly an outline of the objects for which the Cataract Company has been established.

Of the immense power represented by the descent of the river from its upper to its lower level over the Falls (about 3½ million H.P.), there is utilized at present an aggregate of only about 5,000 H.P. in the mills you see on the left of the picture. The water is brought to these mills by a surface canal from the upper reaches of the river, and, after passing through turbines is discharged into the open air about half way between the level of the ground and the level of the river below the tail races, forming a number of miniature water falls. Only about half the available head is therefore utilized. If the system adopted hitherto could be followed in future, there would be little difficulty in establishing a station for the generation of any amount of power in this locality, but there is a strong tide of public opinion against the establishment of any more hydraulic works on the river bank, to say nothing of the difficulty of finding room for them and the open-air canal which would be required. The Cataract Company have, therefore, resolved to carry out their operations, to a great extent, underground, and at the present moment are driving a tunnel 30 ft. high by 20 ft. wide, and about 6,700 ft. long which is to serve as a tail race for the water coming away from their power station. This tunnel is shown on the picture by two dotted lines, and its mouth is partly submerged under the level of the lower river. The total fall between the upper and lower river is 200 ft., and the net fall available for the turbines is 140 ft. The fact that the tail race is a tunnel necessitates the turbines being placed at least 110 ft. underground, since the suction tube of a turbine cannot be made longer than the column of water which can be balanced by atmospheric pressure, and this increases very materially the engineering difficulties of the work.

Last summer the Cataract Company invited a limited number of engineers to send in projects for the creation and transmission of power, and instituted a Commission, under the presidency of Sir William Thomson, to investigate and report on the projects. There were in all 20 competitors, but of these only 14 complied with the programme drawn up by the Commission, and were therefore held to be qualified to have their projects examined. Of these 14, eight competitors sent in combined projects for the creation and transmission of power, four referred only to the creation, and two to the transmission of the power. The point of interest to us is what methods were suggested by the 10 qualified competitors in transmission. The question is somewhat complicated by the fact that some competitors have suggested mixed systems of transmission, and that, in classifying the schemes into electrical, pneumatic, and hydraulic, we must count some competitors twice over. On this basis I find that the following represents the transmission projects: Electrical, 7; pneumatic, 6; hydraulic, 2. It is certainly remarkable that the balance in favor of electric transmission should be so small. And it is equally remarkable that there should have been as many as six competitors who either wholly or partially advocated pneumatic transmission. The experience of colliery managers goes to show that even over the comparatively short distances over which they use pneumatic transmission, the total efficiency lies generally between 20 and 30 per cent., and does certainly not exceed 40 per cent. We cannot suppose that engineers who have sent in pneumatic projects are ignorant of this fact, or, at any rate, we must suppose that the majority of them are quite aware that high efficiency cannot be expected from compressed air transmission. If, nevertheless, they have adopted compressed air in preference to electricity, it must be for one of two reasons. Either they have no confidence in the capabilities of electric transmission, or they consider the cost so high that the interest on the extra capital and the greater depreciation of the plant will more than counterbalance the advantage of high efficiency. It cannot be denied that, in the present state of our knowledge of electric transmission, there is some ground for both these views. The Niagara problem is unique, both in magnitude and distance, and I am bound to confess that we electrical engineers are at the present moment not quite prepared to face it. At the same time I must say that I feel convinced that in a few years from now there will be not one, but a dozen men ready to face this problem with a very good chance of successfully solving it. As a matter of fact, we are at present on the threshold of a new system of electric power transmission. The old system of using continuous currents and ordinary dynamos has been perfected to a point which leaves little to be desired, but it has its limits, and, unfortunately, the Niagara problem, or at least a part of it, is just a little beyond these limits. Hence we find that only about half of the competitors have had the courage to propose electric transmission. Of these, only two suggested the use of alternating currents at voltages of 5,000 and 10,000 respectively; the others followed the old lines of continuous current transmission at voltages varying between 1,600 and 4,500 volts.

This brings me to the consideration of a subject which is of great importance not only in regard to the Niagara problem but to long distance transmission generally, namely, the limits of distance up to which the usual system of transmission is practicable. If you will refer to the table giving the cost of transmission plants, given in my last lecture, you will find that, for large powers at any rate, an increase of distance up to four or five miles does not make the cost prohibitive, and you will conclude from these figures that, within a five mile limit, the whole system of electric transmission is certainly feasible. How much farther you might go is a matter for theoretical consideration; the table does not help you much, as the only example of a very long distance transmission is one where the power is small, and is, therefore, in a certain sense, misleading. I have given you a formula by which you can calculate the most economical voltage for any distance; and if you do this for many cases, taking, for instance, 500 H.P. as your unit of power, you will find that as the distance increases beyond five miles, the economical voltage begins to grow beyond the limit which might be considered practicable for one machine. It is quite impossible to lay down hard and fast rules. Under certain conditions, especially if you have to transmit cheap water power, you may possibly reach a distance of 10 miles before getting to the limit of voltage; but, whatever may be the special conditions of the problem, there is a limit of distance beyond which a single machine will not reach. "Very well, then," you might say, "if a single machine cannot be made to give the required pressure, let us put two or three machines in series." To correctly appreciate such a suggestion, let us first of all see what limits the voltage of a machine. Two things limit it, the commutator and the general insulation. Practical dynamo makers will tell you in large machines they are quite prepared to put 1,000 volts on the usual Pacinotti commutator; if necessary, they will go to 2,000 volts, but with some misgiving; and if you ask them to make a machine for 3,000 volts, they will, as likely as not, refuse. I do not refer to the Thomson-Houston or Brush machines, which have special commutators, but to large machines giving an even current and a high efficiency, such as we require in the transmission of power. We may thus conclude that 2,000, or, at the outside, 3,000 volts, is the limit of voltage to be obtained from a single commutator. But the general insulation of the machine must also stand this pressure, and where, as in dynamos and motors, the insulation consists of cotton, paper, fibre, varnish, and like materials, which are subjected not only to electrical, but also to mechanical strains, 3,000 volts is quite high enough for safe working. The commutator difficulty can, of course, be got over by putting several machines in series and insulating their frames from earth. The difficulty of general insulation can, however, not be met so easily. This you

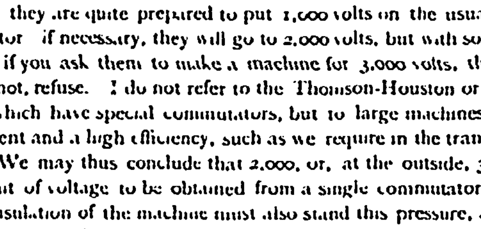


Fig. 7.

will see by referring to Fig. 7, which shows, diagrammetically, three 2,000 volt machines placed in series. Shunt excitation at the high pressure of 2,000 volts is of course, out of the question; series excitation introduces complication and certain difficulties, especially at the motor station; and separate excitation although simple and easily worked, has the disadvantage of throwing great electrical strains upon the insulation between the exciting coils and the frames of the machines. Imagine, for instance, that there is a weak place at A, between the exciting coil and the frame of the first machine; then the strains between the exciting coil and the frame of the third machine at B, will be about 6,000 volts, even if all the machines are perfectly insulated from earth. With series self-exciting machines, the strain would of course, be limited to 2,000 volts, but there still remains the difficulty that all the armatures would have to be mechanically connected by insulated couplings, and there would also be great danger in touching even the iron frame of any machine. You see the use of several machines in series is not such an easy matter as it may look at the first glance, and this method has, as far as I know, only been adopted in cases where the total voltage was under 2,000.

The net result of our investigation may be stated by saying that the electric transmission of power by continuous currents is economical and safe up to distances for which the most economical voltage does not exceed 2,000 or at the outside 3,000 volts, but that beyond these distances some other system must be applied. That this other system must also be electrical is evident, for we know perfectly well that distances beyond the reach of our present electric transmission systems are hopelessly beyond the reach of lines

*Cantor Lectures delivered before the Society of Arts, February and March, 1891.

of shafting, flying ropes, air, or water. Now what is this new electrical system which shall enable us to carry power over ten or twenty, or perhaps a hundred miles?

In attempting to answer this question I must perforce leave the safe ground of solid facts and engineering practice, and enter into the domain of speculation. Yet speculation based upon experimental results which in themselves are as reliable as were those experimental results which have led to the practical development of electric power transmission as we know it now.

The starting point in the theory which I have now to bring before you is the well-known disc of Arago. If a copper disc be rapidly revolved under a compass needle, the latter is also set into rotation. I am able to show you this experiment, by the kindness of the Science and Art Department, who have lent me the apparatus you see before you. Between the copper disc and the compass needle is placed a sheet of glass so as to prevent air currents from affecting the needle. If I set the disc in motion you see that the magnet very soon follows. To make the motion of the latter better visible, colored pieces of paper are attached to the poles. Now, the fact that the magnet revolves is evidently due to there acting upon it some mechanical force. The explanation is perfectly simple. The disc, in passing under the poles of the magnet, becomes the seat of a very complex system of electromotive forces, which produce an equally complex system of currents. Some of these currents cross the path of the lines of force emanating from the magnet, and thus mechanical forces are set up between the disc and the magnet, causing the latter to rotate. It is as though there existed between the disc

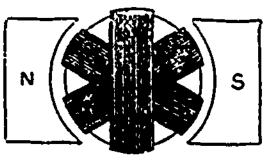


Fig. 8.

and the magnet a kind of electro-magnetic friction by which the magnet is dragged after the disc. Since all motion is relative, it is perfectly clear that we might regard the magnet as revolving, and then the disc will be dragged after it. With the apparatus before you this experiment would not succeed, since the magnet is small and the disc is heavy, but if we were to employ a very strong magnet, and revolve it rapidly enough, there would be no difficulty in setting the disc in rotation, and even obtaining power from it. I have said a moment ago that the system of currents set up in the disc is very complex, and you will easily see that only those currents which are more or less radial, and of those only their radial components, are instrumental in exerting mechanical force, whilst all the other currents represent simply so much waste power. To make an efficient machine we must, therefore, not employ a continuous disc, but a system of conductors, so arranged as to force the currents to flow as much as possible in a radial sense, and only in those places which are immediately under the influence of the magnetic field. Or, better still, we may abandon the disc shape of conductors altogether, and substitute an armature with a laminated iron core of the drum type, seen end on in Fig. 8, and use, instead of a straight magnet, a horse-shoe magnet, so shaped as to bring its poles, N S, to opposite sides of the drum, and wind the latter with a number of coils closed in themselves. If we now revolve the magnet, strong currents will be generated in each coil successively, and a very small torque will be exerted on the armature. The torque will, in fact, be comparable to that required to revolve an ordinary continuous current drum armature in a strong field, if we short circuit the brushes. Here, you see, we have, by applying a few very obvious improvements to the Arago disc, at once obtained a machine of very considerable power. Imagine both the magnet and the armature mounted on independent spindles (not shown in the diagram, but passing both at

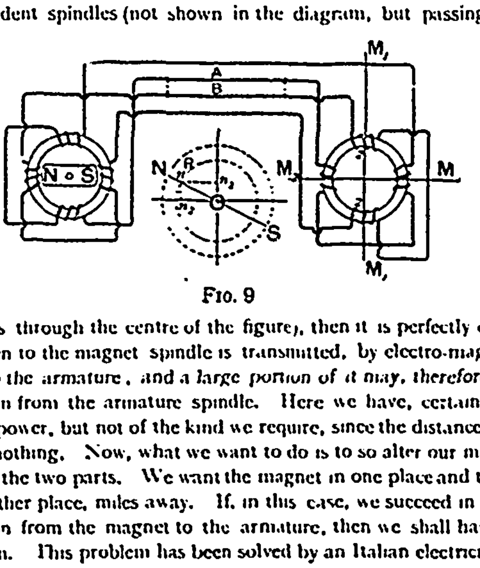


Fig. 9

right angles through the centre of the figure), then it is perfectly clear that power given to the magnet spindle is transmitted, by electro-magnetic induction, to the armature, and a large portion of it may, therefore, be obtained again from the armature spindle. Here we have, certainly, transmission of power, but not of the kind we require, since the distance of transmission is nothing. Now, what we want to do is to so alter our machine as to separate the two parts. We want the magnet in one place and the armature in another place, miles away. If, in this case, we succeed in transmitting rotation from the magnet to the armature, then we shall have solved the problem. This problem has been solved by an Italian electrician, Prof. Galileo Ferraris, of Turin, who, early in 1888, communicated to the Turin Academy the results of his investigation on rotating magnetic fields produced by alternating currents. To clearly see the bearing which Ferraris's investigation has on our problem, let us inquire what it is we want at the motor station. We want there an armature, as shown in Fig. 8, and a magnetic field, the lines of which shall pass through the armature, and shall revolve round its centre. Whether the field is due to a real magnet, or is produced by any other means, is immaterial, and it is the merit of Ferraris to have shown us how to produce such a revolving field without the use of a real magnet, but simply by the use of two distinct alternating currents passing through fixed coils.

As the subject is new, and will not be found in any of the numerous text books dealing with electrical engineering, you will, perhaps, not think it out of place if I put it before you in rather an elementary manner, beginning with the simplest possible case, and passing gradually to the more complicated cases. Assume, then, a combination of apparatus, as shown in Fig. 9. Here you have, on the left, an annular iron core wound with two coils, which are connected in series, and to a pair of line wires going to a similar

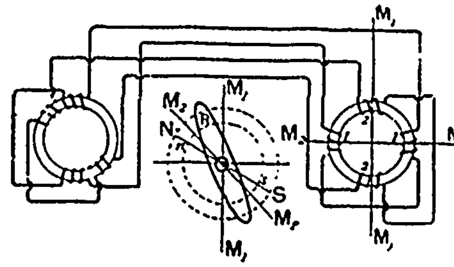


Fig. 10.

coil on the right, which may be at any distance. Into the circular space enclosed by the first coil we put a straight bar magnet, N S, which can revolve round the centre. As the poles sweep past the wire turns, an E.M.F. is induced, and a current is caused to flow, the direction of which changes twice in every revolution. We have here, in fact, an ordinary alternate current generator, with stationary armature and revolving field magnet. By suitably proportioning and placing the various parts of the apparatus, we can make the E.M.F. and the current curve of a true sine character; and in order to simplify the treatment, I shall assume that in this, and in the cases which follow, the design is such that all the E.M.F. and current waves follow the sine law. The alternating current, in passing through the coils on the right, magnetize the iron core, so as to develop north and south polarity in the line $M_1 M_1$. The effect is the same as if we placed into the ring a vertical magnet which is collapsible, the two poles shrinking into a point at the moment that the current strength is zero, and coming apart vertically as the current increases. We must imagine this magnet alternately shrinking into nothing and growing larger and stronger, also reversing its polarity each time that it passes through its zero condition. In the apparatus shown by Fig. 9, therefore, rotation of a real magnet on the left produces merely an oscillating magnetic field on the right. As you know, a magnetic field may be represented graphically, in direction and magnitude, by a straight line, and, in this particular case, the line so representing the oscillating field is the projection of the radius, O n, on the vertical $M_1 M_1$, if the length of the radius, O n, represents the strength of the field at maximum current. At the moment to which the diagram refers our collapsible magnet will, therefore, have grown to the strength represented by the length, O n_1, and,

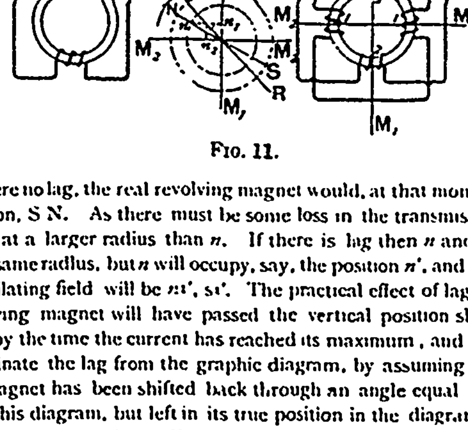


Fig. 11.

if there were no lag, the real revolving magnet would, at that moment, occupy the position, S N. As there must be some loss in the transmission, I have shown N at a larger radius than n. If there is lag then n and N will not lie on the same radius, but n will occupy, say, the position n', and the strength of the oscillating field will be n_1', s_1'. The practical effect of lag is this, that the revolving magnet will have passed the vertical position shown in the diagram by the time the current has reached its maximum, and I can, therefore, eliminate the lag from the graphic diagram, by assuming that the revolving magnet has been shifted back through an angle equal to the angle of lag in this diagram, but left in its true position in the diagram representing the apparatus itself. In Fig. 9 the coils on the ring on the right hand are placed on the horizontal diameter. If, as in Fig. 10, I place them on the vertical diameter, the resulting oscillating field will be horizontal, namely, on the line, m_2 m_2, and the projection of n on the vertical must be taken over to the horizontal, as shown by the dotted quarter circle. Let us now suppose that we have both horizontal and vertical coils on the ring, as shown in this figure, then the combined effect of these coils will be to produce an oscillating field on the line, R R, the strength of the field being, as you will easily understand, about 40 per cent. greater than in either of the former cases, but still the field is not a revolving one. I can show you the production of an oscillating field, as here explained, by means of a mechanical model.

Up to the present, then, we have not advanced in the solution of our problem. We have produced at the distant point an oscillating field, but what we want there is a revolving field, and to get this we must duplicate the apparatus shown in Fig. 9, by putting horizontal coils on the generator and vertical coils on the motor ring, in addition to the coils already there. This arrangement is shown in Fig. 11. Now, the field produced by the coils, 1 1, is given by the projection of O *n* on the vertical; and that produced by the coils 2 2 is given by the projection of O *n* on the horizontal. The resultant of these two fields is therefore O *n*, the point *n* revolving round O as a centre on the circle R. The effect of revolving a real magnet within the generator ring is, then, to produce a revolving magnetic field of the strength O *n* within the motor ring, a kind of revolving phantom magnet which, for our purpose, is quite as suitable as a real magnet. I can also shew you this effect by means of the mechanical model.

You observe that in Diagram 11 four wires are shown, connecting the generating and receiving machines. Now, as the absolute potential of any of these wires may be chosen arbitrarily, there is obviously nothing against choosing it at such a value as will make it coincide with the absolute potential of another wire not belonging to the same circuit. We might thus, for instance, equalize the potential between the wires A and B by connecting them at either terminus, as shown by dotted lines, and not disturb in any way the satisfactory working of the machines. Or, better still, we may omit one of the wires altogether, and use the other as a common wire for both circuits, and thus reduce the total number of wires to three. The common wire must, however have about 40 per cent. more carrying capacity, since the algebraical sum of the two currents is 1·4 times the strength of each current taken singly. Here you have, then, the theoretical solution of the problem of how to transmit power by alternating currents, as indicated by Ferraris, but the first to attack this problem practically was Mr. Tesla, an American electrician, and such motors are, therefore, also known under the name of Tesla motors, though the name "Ferraris motort" seems to me to be more appropriate, as distinguishing this motor from the two-wire Tesla motors, about which I shall say something presently. To carry out a power transmission by means of such a system, we must have at the generating station an alternator, the armature of which is wound with two circuits giving currents with a quarter period phase difference, three-line wires, and a motor having a laminated field magnet, which is excited by coils placed alternately in the two circuits so as to produce a revolving field. The armature of this motor must have an iron core, surrounded with coils closed in themselves.

The necessity of using three-line wire is, to a certain extent, a disadvantage of this system, and several engineers Mr. Tesla foremost amongst them, have tried to improve the system in such a way that two-line wires only should suffice. The methods suggested have this in common, that all aim

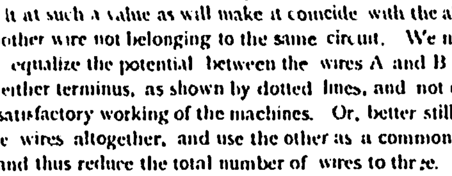


Fig 12

at producing a difference in phase between the currents passing through the motor, without the use of a second set of coils on the generator. If we insert, for instance a large inductionless resistance into the branch B in Fig. 10, and a coil having very little resistance, but great self induction, into the branch A the current in the coils 1 1 will lag by a small amount behind the E.M.F. impulses of the generator, whilst the current in the coils 2 2 will lag behind the impulses by a larger amount. The phase difference between the two currents can, of course, not amount to 90 deg., which angle is required for producing the best effect, but some difference of phase can certainly be produced in this way. The arrangement will, in fact, be equivalent to that shown in Fig. 12, where the distance between the two sets of coils on the generator is less than 90 deg.

An easy geometrical construction, which I need not explain at length, shows that in this case the path of either pole of what I have before called the revolving phantom magnet is an ellipse, but that it can be made to be circular by a dis-symmetrical arrangement of the coils on the motor, though in this case the diameter of the circle is much reduced. In either case the value of the machine as a power-producing appliance is also much reduced, whilst at the same time the efficiency must be low, owing to the waste of power in the resistance coil. I can also show you the action of this two-wire motor by means of the mechanical model.

(To be Continued.)

TRADE NOTES.

The largest driving belt ever manufactured in Canada is that which is now almost finished and to be seen on a monster 60 inch hydraulic press erected for the purpose) in the leather belting manufactory of Messrs. Robin & Sadler 2520 Notre Dame street This belt, when finished, will be placed in position on the driving pulleys of the Royal Electric Light Company's new engine at the establishment on Wellington street and will transmit 800 horse power It is made without a rivet and is a solid mass of leather three ply cemented together by a pressure of thirty tons weight from the press. Its width is fifty-three inches length 130 feet and about an inch in thickness, and of 2,000 lbs. weight. The outsides of the belt are without a patch, while the whole contains one hundred steer hides selected for their superiority from a collection of over 2,000 From the press the belt will be submitted to a special process known only to this firm whereby the surface will be made proof against oil absorption, when it will be ready for use. This firm is also manufacturing a belt forty inches wide, three-ply, for the Royal Electric Co.'s new 600 horse power engine. *Montreal Daily Witness.*

SPARKS.

The City Clerk of Quebec invites tenders until the 4th inst., for supplying plant and lighting the streets.

The Bell Telephone Co. of Canada has been empowered by Act of Parliament to increase its capital stock from $500,000 to $5,000,000.

It has been found that half burned arc carbons will cut glass. The street Arab has, unfortunately, discovered this fact, and now amuses himself by scratching plate-glass windows.

The Edison company has the contract for supplying an electric light and power plant at the Thousand Island Park. There are to be two dynamos with a capacity of 750 incandescent and 22 arc lights.

An electric plant for the purpose of drilling and lighting has been put in at the New Rockland Slate Co.'s works at Richmond Que. Two electric drills are now in successful operation, and a third will shortly be added.

A. Shaw's electric light works at Victoria, B.C., have been converted into a joint stock company with a capital of $75,000. Twenty-five per cent will be retained by Mr. Shaw and the rest is taken up in New York, Vancouver, and Victoria

The promoters of the Hamilton, Grimsby and Beamsville electric railway have arrived at a satisfactory understanding with the Hamilton civic authorities concerning right of way, and have in consequence definitely decided to build the road.

The Hamilton, Ont., street railway will be equipped with electricity. The contract, consisting of thirty cars and three multipolar generators with a capacity of 750 h.p., has been awarded to Ahearn & Soper, of Ottawa, Canadian representatives of the "Westinghouse system."

Messrs. Goldie & McCulloch, of Galt, have received the order for three 250 horse power engines for the power house of the Hamilton electric street railway. It is the intention of the company to fit motors to fifteen of the present closed cars. Ten new large cars will be constructed.

The Westminster and Vancouver Tramway, connecting New Westminster with Vancouver, B. C., consists of 14 miles of track, vestibule cars, 30 feet long The round trip ticket is 75 cents, single fare, 50 cents, city fare, 5 cents. The traffic has averaged 400 passengers daily for eight round trips a day.

The Council of Toronto Junction is putting through a by-law granting cheap water and tax exemption to the City and Suburban Electric Street Railway Co It is understood the company are acquiring the Davenport street railway franchise, and if the privileges asked for are granted they pledge themselves to commence the construction of both roads immediately.

An interesting and amusing instance of the efficacy of the London-Paris telephone occurred the other day which is worth recording. The Salvation Army band were marching from the Royal Exchange, London, playing the "Marseillaise" when an idea struck the members present in the telephone room. The windows and doors were thrown open and the attendant at the Paris end was asked if he could hear anything. The response (in French) was immediate. "Yes I can hear a band playing the 'Marseillaise.'"

On March 3rd the Bell Telephone Company paid to the city of Toronto $1,636, being five per cent. on its quarterly earnings, which goes to the city in payment of its franchise privilege. Last month the company made a contract with the city of Hamilton by which it binds itself to pay to the city $1,500 a year in quarterly payments, for the privilege of doing business there. The contract also specifies the rates to be charged for telephones, and is for the period of ten years, the tax to be readjusted at the end of that time.

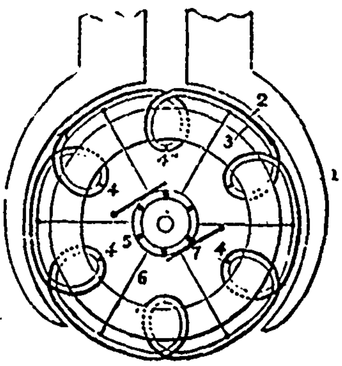
Faraday discovered that whenever a conductor was moved between the poles of a magnet a current of electricity was produced, and that it flowed in a reverse direction when revolved near the face of one pole to what it did when revolved near or across the face of the other pole. This principle underlies every description of dynamo or electro motor. The dynamo does *not*, as so many appear to think, produce its electric energy by friction. The energy is due entirely to the inductive action of the magnetic poles on the wire coils of the armature. The dynamo is a mechanical electric generator as a battery is a chemical electric generator, *i. e.*: in the first case the mechanical force expended on the dynamo to drive it will be converted into electric energy for lighting and running the lamps, or in driving the motor, and in the second case the chemical action or energy of the battery is likewise converted into electric energy for lighting and running the lamps or driving the motors, etc.

Prof. Elihu Thomson, the man whose brain has worked most of the mechanical ideas that have made the Thomson-Houston Co. rich and famous, is only about 5 feet four inches high, or, perhaps, a little taller. His figure is boyishly slight, and his face is very young in appearance. As it is, he is a few years short of forty. He was always famed for his precocity, and he had to wait two years before he could enter the high school in Philadelphia, because he was so young. He was a professor of chemistry before he was 23 years old. When he was 11 years old he began experimenting with Leyden jars, and continued experiments in electricity uninterruptedly until he was 13 years of age. He lived in Philadelphia, and when he'd try his prentice hand on his first dynamos he used to travel into the woods away from home to strip the elderberry bushes and get elder pith to make insulating material He ought to be worth, says a contemporary, hundreds of thousands of dollars to-day, but he is comparatively poor, and he devotes his energies to the supervision of the technical electrical works of the company exclusively Professor Houston, the man whose name is joined with his in the title of the company, is not directly connected with the concern, but is a professor of physics in Philadelphia.

EDISON'S WAY OF REDUCING SPARKING AT THE COMMUTATOR.

THIS improvement, says *Electricity* of New York, is described in the present instance as being applied to the armature in the form of a Gramme ring. Instead of winding a single wire on the armature core, as usual, Mr. Edison winds two or more conductors at the same time. Of the two wires thus wound, one is preferably a coarse copper wire and the other is a fine wire of a metal having a higher specific resistance, such as German silver. The latter conductor is employed particularly as a resistance wire, while the former is the wire which carries the larger part of the current generated in the machine.

The drawing will give a clearer idea of the method. 1, 1, are the two poles of a field magnet, 2, is the insulated copper wire of



the armature, and, 3, is the insulated German silver resistance wire. At the centre of each section of the coil of the armature ring the copper and German silver wires are electrically connected, as indicated at 4. The armature coils are connected to the segments of the commutator, 5, by German silver or other wires, 6, leading from a point approximately midway between two of the connections, 4.

Assuming that the armature is used in a dynamo, the operation may be explained as follows ;—As the armature is rotated, current is generated in opposite directions in the two sides of the armature, and these currents meet approximately over or above the commutator, the direction of the current being indicated by arrows. When the current on one side reaches the section between the points, 4' and 4", it will pass across the connection as 4', to the German silver wire, 3, and thence to a commutator segment and commutator brush, and the current on the opposite side of the armature will pass across at 4" to the German silver wire, and thence to the commutator, thus putting a section of the resistance wire in circuit and reducing the sparking at the commutator when the brushes pass from one segment to another.

It is not essential that the two wires be wound together for the whole length or that they should be wound together at all, and conductors of other materials than those mentioned may be employed. It will be evident that current will also be generated in the resistance wire, which current will be in the same direction as that in the copper conductor.

In an article on trade journal advertising, *Printer's Ink*, which is published by Geo. P. Rowell & Co., advertising agents, who naturally have more business with newspapers of general circulation than with trade papers, says: "An inspection of the rate-cards of the best trade papers shows that they uniformly charge rather high rates, and an inspection of their columns shows that they secure a much larger proportion of advertising, than the mediums of general circulation. The conclusion is irresistible that advertisers find them to be worth what they charge."

VICTORIA B. C.

(Correspondence of the CANADIAN ELECTRICAL NEWS.)

The C. P. R. are now stringing their fourth wire between Montreal and Vancouver, three of these will be used for commercial purposes, and the fourth for company's business. They have just added Edison's phonoplex system to their line between this city and Victoria which is for the greater part under water.

A series of lectures on "Electricity" has just been given in the Whetham College. The first was delivered by Mr. J. G. Wilton, the second by Mr J. Balfour Kerr, who handled "The Telephone" in an admirable manner. The third is to be by Mr Gaudil, who is to have the "Graphophone, Photophone and the Phonograph" as his subject. No admission fee is charged, which may or may not be the cause of the crowd who attend so far every lecture night.

A second Edison incandescent dynamo has been added to the sugar refinery plant, it is for the day circuit.

At Nelson, B. C., a small village a 1,000 light plant is being set up.

The Edison General Electric Co. have decided to build a much larger and more handsome block than the present block which they built last year, it being now found to be too small for the perfect handling of their business which has developed enormously.

Messrs. Marshall & McRae, lithographers, have put in an Edison motor, this makes the sixth machine in operation.

A new accommodation car has been tested on the tramway line and proved satisfactory. The car is constructed on the plan and about the size of the regular interurban carriages, about one-third of the space being partitioned off in front for baggage and express parcels, with a through passage from the messenger department of the car and with sliding side doors. The car will be run in connection with the Great Northern Express Company's service over the G. N. R.

After an interesting and very lucid paper by J. Fletcher, chief operator of the Canadian Pacific Telegraph, on "Telegraphy," in Whetham College, interesting experiments were tried over the wires, connected at the college with Portland, San Francisco, and Winnipeg. These cities were asked for weather reports, and a number of news questions were asked and answers received on the typewriter, and read to the audience. From San Francisco in one minute and 30 seconds, Portland, one minute and five seconds, Winnipeg, two minutes. Frank Dowling, operator on the C. P. R., took 253 unabbreviated words sent by Mr. Fletcher from the main office, on a typewriter, without a mistake, in five minutes.

WESTERN NOTES.

(Correspondence of the CANADIAN ELECTRICAL NEWS.)

Being an interested reader of your columns, and wishing the NEWS every success, I take it upon myself to send you some items respecting this part of the province.

The Port Arthur electric railway has been accepted by the town, and is proving to be a paying speculation from the start. The Council are now laying ties to continue the road into Fort William and have two years to complete the road to Fort William west. Farther west at Rat Portage, an electric fever seems to have struck the town. An electric light and telephone company have had a monopoly of the business for from three to four years, and have been charging high rates for light service, until the citizens rose in their might and have had incorporated another company known as The Citizens' Telephone and Electric Co. The charter is expected daily I understand, and upon its arrival work will be commenced upon the new works. They have a grand water power which will developed, furnishing power for the works, and they have already contracts for in the neighborhood of 1,200 lights. Another company is seeking a charter for the Rat Portage and Keewatin Electric Street Railway Company, and as soon as the incorporation is completed will, it is expected, proceed with the construction of a road uniting the three places, Keewatin, Norman and Rat Portage, making a road probably five miles in length.

The Winnipeg horse-cars will during the coming summer give way largely to the new electric street railway company, and arrangements are now being made for commencement of work upon the road.

The Peterborough Light and Power Co. is said to have contracted with the town for seventy-five all-night arc lamps at 25 cents per night, omitting moonlight nights.

SPARKS.

The Edison Company are introducing incandescent electric light at Kincardine, Ont.

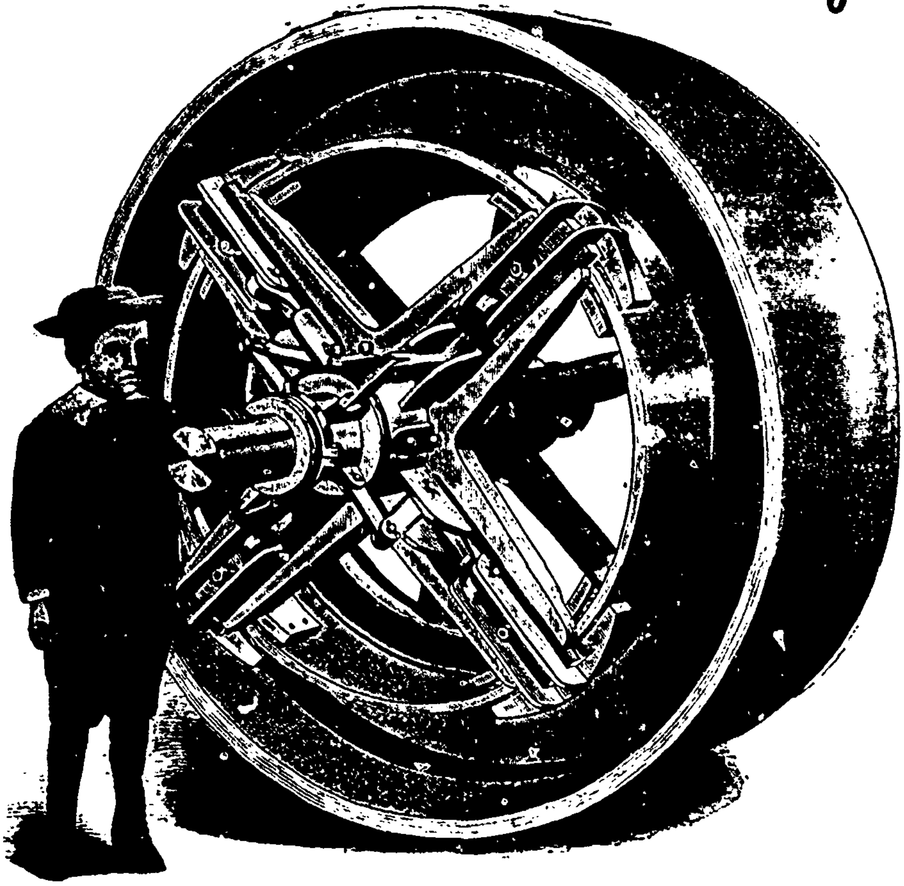
The town of Huntsville, Ont., has given an order to J. A. Farlinger & Co., of Toronto, to install a lighting plant. Four hundred lamps will be required.

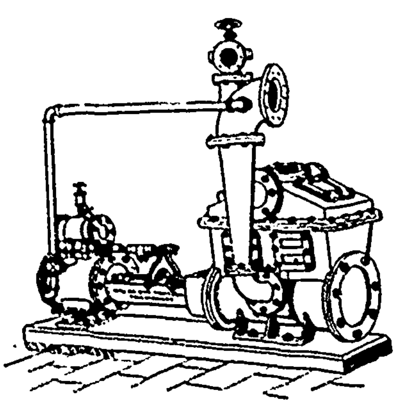
Prof. Alexander Graham Bell has returned to Washington from his recent European trip and will soon leave for Boston, where he will engage in experimental work.

The necessary plant has been forwarded from Victoria for a telephone line between Port Simpson and Georgetown on the Pacific coast. This will be the most northerly telephone line on this continent.

If the volt and ammeters show that more current is being delivered than can be accounted for by the devices in use—then look for leaks and remove them, for so soon as formed they are a source of danger.

Acid spray from a battery of accumulators is said to be a great deteriorating agent where metal fittings and brass or copper conductors are about. A London firm set to work and invented an anti-sulphuric acid enamel, which is now largely used in many electrical works. For coating woodwork, iron and copper in the neighborhood of batteries it seems to have proved itself thoroughly successful, and the long list of names of electrical firms using this enamel shows its popularity and usefulness. Even with strong sulphuric acid it will resist for weeks. It is also a perfect protection against acid spray. It is applied exactly like varnish, in black or other colors.





SPARKS.

The offer of the Edison Company for supplying an electric plant to the village of Lachine has been accepted.

It is said that the largest telephone switch-board in the world is that in the exchange in Berlin, with 7,000 wires.

Tracklaying on the new Hamilton electric railway has commenced. A couple of hundred men are engaged on the work.

Mr. J. J. Wright, manager of the Toronto Electric Light Co., accompanied the Toronto civic deputation in the capacity of electrical expert, to the United States in search of electric street railway information.

The amount of electric current that a very small wire will carry without heating to a dangerous extent, is many times greater, in proportion, than could be carried under the same conditions by a wire of larger size.

Mr. K. J. Dunstan, local manager of the Bell Telephone Co., Toronto, in company with the Co.'s electrician, will make a tour of a number of American cities, with the object of picking up the latest improvements in the line of telephone work.

Mr. F. N. Gisborne, chief of the Dominion Government Telegraphs, is advocating the advisability of the Government taking over the telegraphs. Mr. Gisborne favors using the more modern forms of multiplex apparatus which would materially reduce the number of wires required.

A lineman named Williams, employed by the Hamilton Electric Light and Power Company, fell from the top of a pole a few days ago and was severely hurt. The daily papers of course attributed his fall to contact with a live wire, but the manager states that such was not the case, as Williams was too experienced to touch a live wire.

According to the report read at the annual meeting of the American Bell Telephone Co., there are 512,407 telephones in use in the United States, requiring 266,456 miles of wire, which on the average allows a trifle over half a mile of wire to each instrument. This length of wire would circle the earth ten and a half times if stretched out in a continuous length, and dividing it by the number of years the telephone has been in operation (sixteen) would give 16,656 as the average number of miles of wire stretched each year.

A new arc lamp has recently been perfected by the Thomson-Houston Electric Company for indoor lighting on either arc or incandescent circuits. It is but 27¼ inches from top to bottom, six inches wide, and weighs 21 pounds without the globe. The feeding and regulation are said to be perfect, the arc being always the same length, perfectly steady, brilliant and free from hissing. The entire mechanism is carefully protected from dust and dirt. On arc circuits the lamps are run in series, and regulate and cut-off automatically. On incandescent circuits they are run in multiple or two in series, a small rheostat or bank of incandescent lamps being used as a controlling device.

It is a well known fact that in every dynamo the magnetic force necessary to develop the field in which the armature revolves is always greater than that which is usefully employed, that is to say, more lines of force are generated than actually pass through the core of the armature, the discrepancy being attributable to leakage at different points. To find out the amount and location of the leakage, ascertain exactly the ratio of lines of force actually generated to the lines passing through the core of the armature. This ratio will always be greater than unity. Some of the lines pass directly from one limb to the other, and some leak out of the yoke to the pole-pieces. By placing a galvanometer in circuit and observing the deflections, the number of lines of force cutting or cut by a coil of wire in two or more given fields can be compared. The galvanometer must be a delicate one, as the resulting E. M. F. is usually comparatively low.—*Electrical Age.*

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The electric street railway between Windsor and Walkerville is now in full working order, and is claimed to be one of the best equipped and complete roads on the continent. It runs in connection with the Sandwich branch at Windsor.

A local paper tells of a novel bet that was wagered and won in Kincardine recently. It was not an election bet, but an electric bet Sam McLure, who runs the electric light dynamo in that town, made a bet with Ben Hadley, a blacksmith, that the latter could not lift a door latch with a poker. Hadley thought he had a snap, no doubt, as he readily accepted. McLure had previously run a concealed wire from the battery to the latch, and lay in weight for the blacksmith. Hadley went to work, McLure turned on the cur rent. The result need not be described.