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CANADIAN
ELECTRICAL NEWS
AND
STEAM ENGINEERING JOURNAL

OLD SERIES, VOL. XV No 4
NEW SERIES, VOL. IV No 4

FEBRUARY, 1894

PRICE 10 CENTS
$1.00 PER YEAR

CANADIAN

ELECTRICAL NEWS

AND

STEAM ENGINEERING JOURNAL.

VOL. IV. FEBRUARY, 1894 NO. 2.

THE ADAPTABILITY OF AN EDISON THREE WIRE PLANT.

BY JAMES MILNE.

THE electrical plant of the Incandescent Light Co., of Toronto, Ont., consists of two 200 K. W., driven direct, four 100 K. W. and six 60 K W. belt driven generators of the ordinary Edison type, shunt wound for 140 volts. The Company at present are supplying light and power on the three wire system, and also power for street railway purposes at from 500 to 650 volts. It is not necessary to describe in detail the working of the three wire plant, as that system is fairly well understood by the electrical fraternity; but a short description of the switch-board as it is arranged at present, together with the manipulation of same, will not be out of place.

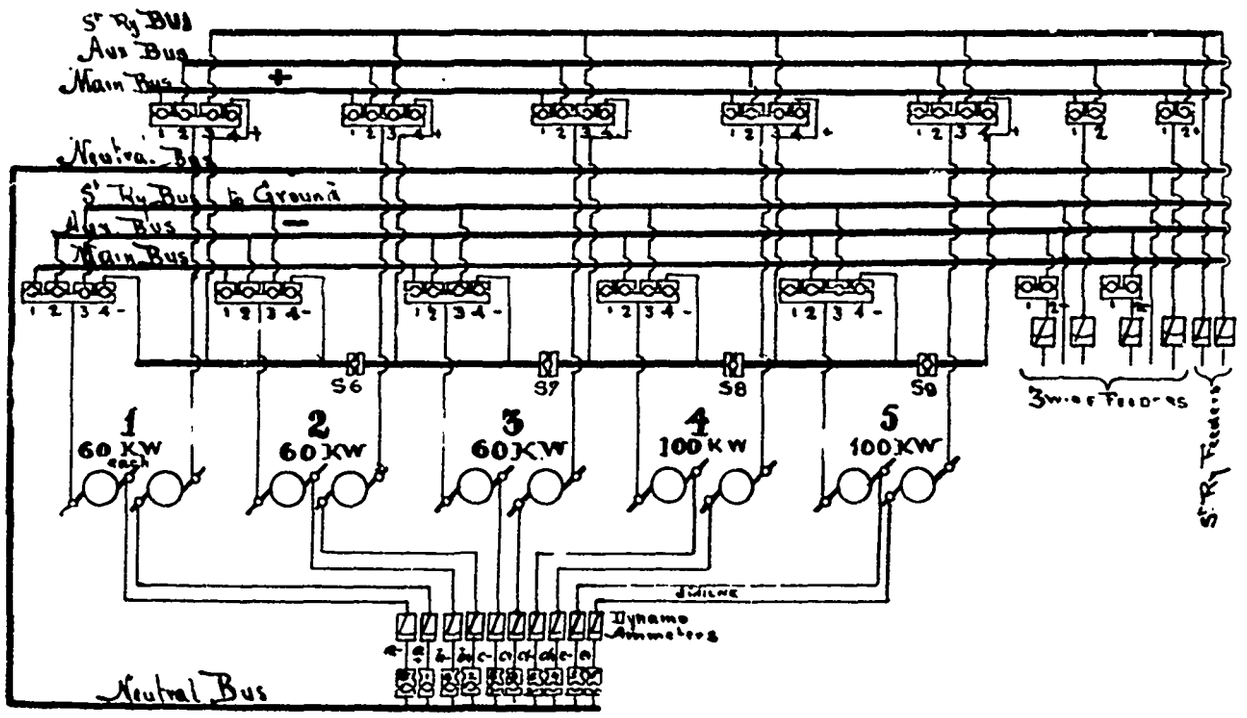

FIG. 1.—MILNE'S ARRANGEMENT FOR SUPPLYING LIGHT AND POWER AT 125, 250, 500, 1,000 AND 1,500 VOLTS.

The switch-board is arranged for running on two pressures, and by dividing the auxiliary bus three different pressures are run—this being found necessary owing to the distributio nof the load and the losses on certain feeders at certain times. In re-arranging the switch-board for the supplying of the 500 volt current, it had to be taken into consideration that this power could not be supplied by any particular set of dynamos, for various reasons, and also that the present three wire system had not to be interfered with; so that the generators could be switched in on the three wire or on the street railway system with the least possible delay. The accompanying sketches show very clearly how this was done.

As seen on Fig. 1, there are 4 switches on the + and − poles of each pair of dynamos. These are marked 1, 2, 3 and 4 + and −, and are for main, auxiliary, street railway and special bus bars respectively. The object of this special bus, as it has been termed for convenience, will be seen later on. The reader will please bear in mind that the three wire plant is in operation 24 hours per day, and it will easily be seen that should any error be made in the manipulation of the switches, it simply means disaster to some of the armatures. As no mistakes have occurred so far, we may safely assume that same will not happen.

We will now suppose that the dynamos marked 1 − 3 on Fig. 1, representing two pairs, are to be cut in on the street railway system. All main and auxiliary switches on these machines, together with those leading to the ⊣⊢ bus, are opened. This cuts out these generators from the three wire system entirely. All machines are now brought up to the same potential as indicated by the galvanometers, then close St. S. (shown between ammeters and =|= bus). This has simply the same effect as closing the =|= switches, but being disconnected from the neutral bus Close switch 4 + on No. 1 dynamo, and 4 − on No. 3. The special bus has now connected the four machines in series, switch 3 − on No. 1 generator is now closed, *i. e.* the − pole of the series is connected to ground, and all that now remains to do is to close the final switch 3 + on the No. 3 machine. Before this is done, however, care is taken to have the pressure the same as that of the bus bar. This is seen by galvanometer or voltmeter as in common practice. The arrangement is shown very clearly in Fig. 2, omitting the lower parts of the diagram. All switches are marked so as to agree with Fig. 1.

When two pairs of machines are running and it is necessary to cut in one and out another pair, Fig. 2 illustrates the method adopted. The diagram so clearly shows the arrangement that it is unnecessary to describe it. Two 100 K. W. generators can quite easily be switched in and the load transferred from two 60 K. W. with no trouble whatever; the only precaution to be taken is to have all machines doing precisely the same amount of work.

In figure 3 there are shown four pairs of generators in series multiple, supplying current at 500 volts, and also part of the current generated by one pair being supplied to the three wire system. One pair of the 100 K. W. is running at 400 amperes at 250 volts, while the other pair is generating 700 amperes at 250 volts. Therefore it will be seen that 300 amperes at 125 volts are being supplied by each of these 100 K. W. generators to the three wire system, and still in connection with the 500 volt system. This, of course is simply a modification of a 5 wire system, and has given excellent results.

The writer was a little dubious as to the successful operation

of this latter method, but as the load at 500 volts is remarkably steady, the variation in pressure is unobserved in the lights. The only serious objection to the running of the machine as in Fig. 3 is, that one of the poles on the light system is grounded. This in itself is harmless, provided all the rest of the system is free of grounds.

By again referring to the special bus of Fig 1, it will be observed that any pressure from 125 to 1600 volts can be obtained.

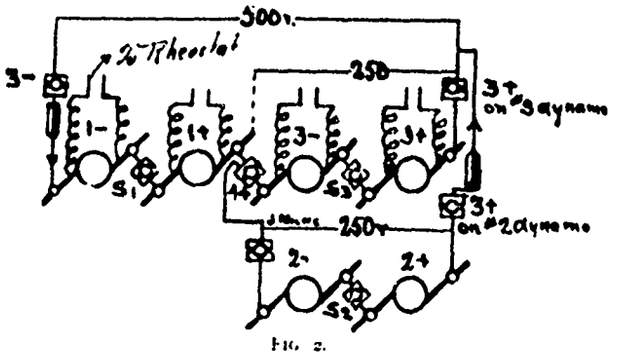

FIG. 2.

By simply opening the switches marked S6, S7, S8, S9, and closing 4 - and 4 + on all machines, the latter pressure can be obtained. As we have had no occasion so far to run at this pressure, I cannot say how same would operate, but judging from the excellent results obtained by the method described already, I don't think that any difficulty would be experienced whatever. It may appear to the reader that the method in operating the 500 volt circuit is rather complicated, but when you take into consideration that any two pairs of machines can be started up and cut in on the 500 volt circuit in three minutes, without any undue hurry, it shows very clearly that any complications that might appear on paper do not affect the practical

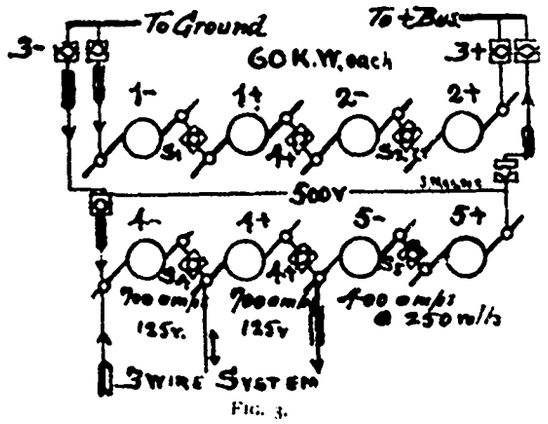

FIG. 3.

working whatever. The machines running on the 500 volt circuit can be cut in on the three wire in less than ¼ of a minute.

The writer has no knowledge of any other plant except the above being operated as per the sketch outlined, and I suppose there are very few even in the world where the same would be required.

LECTURES ON ELECTRICITY AT McGILL UNIVERSITY.

Following is an outline of a course of twelve evening lectures on Electricity to be delivered by Prof. Cox, at McGill University Montreal, for the benefit of persons whos circumstances are such as to prevent them from taking a regular course of study in the electrical department of the University:—

1. Introductory. Elementary Properties of Magnets. Identity of Frictional and Current Electricity. Production of Currents by Batteries and Thermopiles. Effects of the Current. Storage Batteries.

2. Measurement of Laws of Flow Current. Potential and Electromotive Force. Resistance. Practical Units and Instruments. Law of the Development of Heat by flow of Currents through Resistance.

3. Induction of Currents in Neighboring Circuits. Self-induction. Farady's Conception of Lines of Force.

4. Applications to the Electric Telegraph and Telephone.

5. The Dynamo Conversion of Mechanical into Electric Energy. Reconversation of Electric into Mechanical Energy by the Motor. The Transformer.

6. The Electrical Transmission of Power.

7. Theories and Modern Views of Magnetism.

8. The Electro magnet and its Applications. Designs of Electromagnets for Special Purposes.

9. Thunderstorms and the protection of buildings from Lightning. Change of views in recent years.

10. The relation between Electricity and Light. Radient Electricity Maxwell's Theory and Hertz's Experimental Proof, that both are conveyed by the medium—the Ether.

11. Electricity as a Revealer. Crook's and the "Fourth State" of Matter.

12. Modern Views of the Structure and Functions of the Ether in relation to Light, Electricity, and the constitution of Matter.

Through the kindness of the Governors these lectures will be held in the Physics' Building, at McGill, and will be continued every Friday evening, beginning January 26th.

Tickets for the course. To members, $1.00: Non-members, $2.00.

The issue of tickets is limited to 200, on account of the size of lecture room.

CONSTITUTION OF THE MONTREAL ELECTRIC CLUB.

1. This society shall be called the "Montreal Electric Club."

2. The object of the club shall be, primarily, the advancement of members' knowledge in electrical science.

3. The officers to be president, vice-president, secretary and treasurer, also a committee of management composed of officers of the club and three members to be elected yearly This committee shall not be considered a quorum of the club; the assent of the majority of the committee to be necessary to transact its business.

4. Members to be notified of all club meetings one week in advance.

5. The annual fees of both members and associates, to be three dollars, payable in advance, in instalments of one dollar each, on the following dates; 1st January, 1st April, 1st September; and must be paid within the month. Members two months in arrears to forfeit their membership, but may be reinstated by application to the committee and by payment of all arrears.

6. Names and addresses of candidates for membership are to be handed to the secretary in writing, showing the proposer, seconder, and qualifications of said candidates, they to be balloted for at next regular meeting of the club. Three black balls shall disqualify a candidate.

7. The club to meet once every fortnight at 8 o'clock.

9. The order of the proceedings at meetings to consist of
   - *a.* Minutes of last meeting read by secretary.
   - *b.* Report of committees.
   - *c.* Balloting for members,
   - *d.* Questions and suggestions by members.
   - *e.* Exhibition of apparatus, etc.
   - *f.* Reading of papers.
   - *g.* Discussion of papers.

9. Members of the press may be admitted to meetings, whose notes of proceedings are subject to revision by the chairman at his discretion.

10. Seven members shall form a quorum to transact business of the club.

11. Any member shall have the privilege of introducing a guest to the club meetings, who shall have the privilege of hearing and discussing papers.

12. Election of officers shall be by ballot, to take place at the annual meeting, of which notice shall be given.

13. Qualifications necessary for membership.

Members.—Those actively engaged in any branch of the electrical profession, and students in electricity equal to third and fourth years at McGill University.

Associates.—Business managers of electrical firms, and members of other branches of the engineering profession. Associates to have full club privileges, with the exception of holding office.

14. A candidate elected during any quarter shall pay the full dues for that quarter.

At the forty-seventh annual meeting of the Montreal Telegraph Company, held in Montreal during the past month, the annual statement showed the following satisfactory condition of the company's financial affairs:

ASSETS.	
Telegraph lines	$1,625,890 00
Telegraph cables	33,487 39
Offices and equipment	212,500 00
Real estate in Montreal, Quebec, Ottawa and Toronto	279,946 46
Cash, accounts, receivable stock, etc.	97,376 96
Total	$2,249,200 81
LIABILITIES.	
Shareholders' capital	$2,000,000 00
Dividend No. 118, payable 15th January	40,000 00
Unclaimed dividends, etc	1,288 40
Total	$2,041,288 40
Surplus of property over shareholders' capital	151,823 85
Contingent fund	56 088 56
Total	$2,249,200 81

The company's only liability is to the shareholders (1) for their capital stock, (2) for dividend No. 118, payable on the 15th instant, and (3) for unclaimed dividends, as shown in the foregoing statement. The extensive property of the company remains free from debt or encumbrance of any kind, and its continued maintenance and repair by the Great North Western Telegraph Company is provided for under clause 2, and guaranteed by the Western Union Telegraph Company in the last two paragraphs of the agreement between the companies. The old board of directors was elected as follows: Messrs. Andrew Allan president, Hector Mackenzie, Jesse Joseph, William Wainwright, Henry Archibald, William Rae, Henry Yates, whilst Mr. D. Ross Ross was re-elected secretary-treasurer.

WESTMINSTER AND VANCOUVER TRAMWAY.

By F. E. Handy.

This road (until recently 16 miles long) extends 12 miles between the cities of Vancouver and Westminster, exclusive of 6 switches or sidings. The gauge is four feet eight and a half in.; it is laid with 40 lb. T rails, on a roadbed which almost follows the natural grades of the land, through several miles of virgin forests, lined on either side with tall Douglas fir trees. The line crosses four trestle bridges, the highest of which is 86 feet and 120 feet long. The grades on this road are 5, 6, 7, 9 and 11%, so that the machinery at power house has occasionally to stand very severe changes of load.

The right of way has been slashed and burned the entire length and width, and all tall trees liable to fall on wires or track have been cut down. Cedar poles 25 feet above ground, with stretching wires in both cities' limits, and brackets in the urban sections support the trolley wires, carry feeders and

D. OPPENHEIMER.
President Vancouver and New Westminster Electric Tramway Co.

telephone wires along the entire system. A copper return wire is laid between the rails and cross bonded every alternate pair of rails.

WIRES.

Owing to the position of power house (3 miles from Westminster and 9 miles from Vancouver), a large amount of copper for feeders is necessary on the Vancouver end to obviate the loss on line. No. 4 B. & S. trolley wire is used, with the exception of the short line, which is No. 2 B. & S., feed wires No. 0000, 000, 00, 2 and 4, of which there is on poles 138,100 lbs. By means of a metallic return telephone system with instruments on all cars it is possible to call up the power house or the terminus offices from any part of the road.

CARS.

The car equipment consists of two Brill passenger cars, 26 feet bodies, 35 feet over all, with smoking compartment, full vestibuled, on Brill steel double tracks, fitted with two 30 h. p. No. 16 Edison single reduction motors, electric heaters and brakes; one Brill combination baggage and passenger car, dimensions and equipment same as above; four Brill passenger cars, 25 feet bodies, 35 feet over all, vestibuled, on Brill steel double trucks fitted with 2, 12a, 25 h. p. S. R. Edison motors, heaters and electric brakes. The above cars are wide and roomy and nicely upholstered, and have carried at Fair time 110 passengers each. Three Patterson & Corbin, St. Catherines passenger cars, 16 ft. bodies, on Brill trucks, fitted with two 15 h. p. D. R. Edison No. 6 motors. One freight car, 23 feet long, fitted with two 20 h. p., No. 14 S. R. Edison motors, used for carrying rails, ballast and heavy freight business. The usual tower cars, handcars, railway velocipedes and a tank car are in the barn.

BUILDINGS.

The power house contains boiler room, engine room, car barn, machine shop, store room and superintendent's office.

A boarding house for employees is erected near the power house, and close by are brick oil house, blacksmith shop, etc.

The boiler room contains two batteries of boilers, comprising four 125 h. p. Doty tubular boilers and three 100 h. p. tubular boilers (Ball Engine Co.), to which are connected two steel smoke stacks, 90 and 60 feet high respectively. A track is run into this room with truck carrying four cords of wood, from which the fires are fed.

Two 10 h. p. pumps supply the boilers with surface water from large tanks sunk in the ground, the water has to pass through a 500 h. p. feed water heater for the large boilers and through two 150 h. p. heaters for the smaller ones.

The engine room contains two 250 h. p. "Ideal" high speed engines, belted to two 200 killowatt 500 volt Edison railway generators; two 150 h. p. high speed Leonard Ball engines, belted to two 100 killowatt 500 volt Edison generators; large birds-eye maple switch-board fitted with the usual ammeters, voltmeters, four Westinghouse automatic switches on marble bases, also main line and equalizing switches.

During six days water famine in Vancouver current was supplied to the Vancouver street railway system, 9 miles away, giving slow but sure transit.

This line carries all the Northern Pacific passengers and baggage from southern points to Vancouver, and does a very creditable business.

The city service of Westminster is very small and unprofitable largely on account of the severe grades and numerous curves required to travel from south to north.

It is the intention of this company to extend their line to Sapperton, one mile up the Fraser, and to Lulu Island, some five miles down the Fraser, where it will do an immense business with the farmers. I have taken ampere readings both in power house and on cars which will appear later in this paper, showing the great difference in load on account of the severe grades on this road.

The officers of the company are: D. Oppenheimer, President; B. Douglas, Vice-President; P. N. Smith, Sec.-Treas.; H. Henlow, agent.

Mr. D. Oppenheimer, the president, whose portrait, together with that of Mr. F. E. Handy, the general Superintendent, we present to our readers herewith, is one of the most public-spirited, large hearted men of the city and province. In conjunction with his brother he has built up one of the largest wholesale grocery businesses on the coast. He was for several years the mayor of Vancouver, in which capacity he performed valuable service on behalf of the city. His purse is ever at the disposal of philanthropic objects. As President of the Westminster and Vancouver Tramway Co., he has manifested his ability, and is held in much esteem by the officials and employees as well as by the travelling public.

F. E. HANDY.
Manager Vancouver and New Westminster Electric Tramway Co.

PUBLICATIONS.

The publishers of the Electrical World have reduced the size of the pages in that journal, and by so doing have greatly improved its appearance and enhanced its convenient handling.

Money and Risks is the name of a new Canadian monthly journal which has been established to succeed The Budget. It is designed to be an authoritative review of insurance, financial and commercial opinion. The first number is creditable in appearance and ably written. The price of subscription is $2.00 per year. The Parr Press Co., publishers, 78 Wellington Street West, Toronto.

The Brush Electric Co., of Cleveland, who are the owners of most of the stock of the Trenton Electric Company, Trenton, Ont., have appointed Mr. S. M. Wheeler to succeed Mr. W. J. Clarke, as manager of the company. It is said to be the intention of the Brush Company to put the plant in a state of first-class efficiency, and if sufficient encouragement be obtained, to add to the plant machinery to supply incandescent lighting.

An enterprising Montreal electrical supply firm are advertising electric fans for a new purpose, viz., that when placed in store windows and connected from an incandescent light so that a current of air is directed against the glass, they dispel moisture and thus prevent the window from being covered with frost. Hitherto the business season for electric fans has been a comparatively short one, and it will be a satisfaction to supply firms to know that use has been found for them in winter.

CANADIAN ELECTRICAL NEWS
STEAM ENGINEERING JOURNAL

PUBLISHED ON THE FIRST OF EVERY MONTH BY

CHAS. H. MORTIMER,

OFFICE, CONFEDERATION LIFE BUILDING,
Corner Yonge and Richmond Streets,
TORONTO, - - CANADA.
Telephone 2362.

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Information regarding examinations will be furnished on application to any member of the Board.

THE annual convention of the National Electric Light Association of the United States will be held in the city of Washington on February 27th and 28th, and March 1st.

THE secretary of the Montreal Electric Club reports requests from New Orleans, St. Louis and Toronto for copies of by-laws. The first named place has started an electric club on somewhat similar lines. We trust Toronto will now have a try at it.

A RECENT number of the Electro Technicker describes an improvement in arc light carbons, as used by the firm of Krupp, in Essen, which consists in saturating the carbon, or mixing the carbon paste from which they are made with hongstic acid or tungstates.

AN ENGLISH contemporary draws attention to the fact that many stations could well afford to change their transformers. This is no doubt the case in Canada, too, where the old type of transformer is used, which is on practically no load during the day and probably wasting quite a lot of current by its inefficiency.

There are some cities in Canada in which electric companies furnishing power supply also lamp renewals free of cost. These companies could easily settle the momentous question of the "smashing point" of lamps by reducing their price for current and allowing the consumer to buy his lamps when and where he had a mind to.

AT McGill College, Montreal, a university extension course of twelve lectures on electricity will be delivered by Professor Cox. This is a step in the right direction. Many an electrical student, who unfortunately has not the means of going through college, but who would be willing to study hard, has no chance of so doing, his time being occupied during the day by his work, and in the evenings all such sources of education being closed up.

IN the case of the Montreal Street Railway Co. versus Leboeuf, wherein the latter sued the former for a car not stopping, hailed at a street corner, the Railway Co. were fined nominal damages of $5.00. The plaintiff's other contention that the cars were not run frequently enough as per their contract with the city, was dismissed. The case, however, will no doubt form a precedent for others. It is the first of its kind which has come up.

THE expiry of the main patent of the Bell Telephone Company in the United States, which has just taken place, has been anxiously looked forward to for two or three years past by companies and individuals eager to enter into competition with the company in the manufacture and sale of telephone instruments. In futue this competition will be likely to affect the prices of telephones for use in private systems, but otherwise the situation will probably remain almost unchanged, as it has done in Canada, where the Bell patent expired several years ago.

THE General Electric Co., of London, Eng., speak of a style of lighting by inverted arcs which they have introduced into some factories. This system, we believe, has never been tried in this country. The ceiling and walls of the machine shop for instance must of course be whitewashed. The light is thrown on the ceiling by a strong enamel reflector, thus being it is said perfectly diffused throughout the whole shop, the light being good enough for even working at a lathe.

IT may be interesting to some to know that incandescent lamps may be artificially colored by painting them with collodion in which has been dissolved analine dye of any color required, using a camel's hair brush. It is better to have the current on the lamps when they are being painted as the slight heat helps to dry the varnish quickly. These would be useful for decorative purposes during the holiday season but the coloring is not very lasting. Frosting is a more difficult matter, but a fair imitation may be made by dipping the lamp several times into a strong solution of Epsom salts.

IT is said to be the intention of the Dominion Government at the approaching session of Parliament to introduce a measure providing for the inspection of electric meters in the same manner as gas meters. A delegation comprising Mr. C. Berkeley Powell, Standard Electric Co., Geo. T. McDonald, Superintendent of Fire Alarm, J. W. McRae and A. A. Dixon, Chaudiere Electric Light Co., Ottawa; Frederic Nicholls, General Electric Co., Toronto; D. A. Starr, R. A. Ross, Royal Electric Co., Montreal; waited upon the Controller of Customs a few days ago to urge the passing of a measure for this purpose.

THE position of an expert in the eyes of the law appears to be an enviable one. The Niagara Cataract Construction Company refuse to pay the account of $10,000 rendered by Prof. Rowland of Johns Hopkins University, for services in considering and devising plans for the construction of a dynamo of 5,000 h. p. to transmit electric power from Niagara Falls to Buffalo. The company offered to pay $3,500 as the outside value for the services rendered. Thereupon Prof. Rowland amended his account, charging $150 per day for the entire period of service, viz., six months, and secured a verdict for $9,000. Who would not wish to be considered an expert?

OUR contemporary the Electrical Engineer describes at some length a plant installed by Donaldson & McRae, a Baltimore firm, in the Baltimore offices of the Postal Telegraph Cable Co., consisting of storage batteries to take the place of the usual gravity cells. Motor generators, it is true, also dynamos, have done this work perfectly, but we doubt whether the storage battery even for such work is reliable enough. The cells are new ones also, and it would be well to wait the results of several months' tests before taking this as a criterion in other cases. Messrs. Donaldson & McRae claim great things for their new storage battery, and while it may be quite true, yet there have been so many storage batteries rise with the sun only to go down again when it sets, that people may be pardoned for being somewhat skeptical.

A MONTREAL dispatch published in the daily papers last week stated that the Canadian Pacific Railway Company had decided to substitute the electric trolley for locomotives on some divisions of their road through the Rocky Mountains, and that the contract for motors, etc., for this purpose had already been let. As the result of personal enquiries made by our agents in Montreal, the ELECTRICAL NEWS is able to state the facts of the case, which are, that the C. P. R. managers recently sent one of their engineers to the Rocky Mountains to investigate and report on the feasibility of using electricity for this purpose, and he has reported favorably. Should the experiment be tried, it will be watched with world-wide interest by those interested in the possibility of electricity superseding steam for railroad locomotion.

IN a recent issue we referred to the fact that the appeal of the Consumers' Gas Company, the Toronto Electric Light Company and the Incandescent Light Company, of Toronto, against the assessment levied for the first time on their mains, wires, poles, etc., in the streets of Toronto, was being argued before the County Judge, whose decision, being final, would form a precedent for the guidance of other municipalities. The argument has resulted in the case of the Gas Company, in the confirmation of the assessment of half a million dollars on mains and plant. In the case of the Toronto Electric Light Company and the Incandescent Light Company, of Toronto, an agreement was arrived at, under which these companies has consented to an assessment of $50,000 each upon their property. Under a by-law of the city, machinery and plant of manufacturing companies is exempt from taxation except in the case of companies who hold franchises from the city. It was claimed by the assessment commissioner that the electric companies held city franchises and were therefore subject assessment. The companies disputed the correctness of the commissioner's interpretation of the word "Franchise." They contended the word to mean permanent privilege conferred by the city, as distinct from a contract terminable at a stated time. In the absence of any authoritative definition of the word, the compromise above mentioned was agreed upon.

MOONLIGHT SCHEDULE FOR FEBRUARY.

Day of Month.	Light.	Extinguish.	No. of Hours.
	H.M.	H.M.	H.M.
1.....	P. M. 5.30	A.M. 6.00	12.30
2.....	" 5.30	" 6.00	12.30
3.....	" 5.30	" 6.00	12.30
4.....	" 5.30	" 6.00	12.30
5.....	" 5.30	" 6.00	12.30
6.....	" 5.30	" 5.50	12.20
7.....	" 5.30	" 5.50	12.20
8.....	" 5.30	" 5.50	12.20
9.....	" 5.40	" 5.50	12 10
10.....	" 7.30	" 5.50	10 20
11.....	" 9.30	" 5.50	8.20
12.....	" 10.40	" 5.50	7.10
13.....	" 11.00	" 5.50	6.50
14.....	" 11.40	.....	
15.....	.....	" 5.40	6.00
16.....	A.M. 1.30	" 5.40	4.10
17.....	" 3.20	" 5.40	2.20
18.....	No light.	No light.	....
19.....	No light.	No light.	....
20.....	No light.	No light.	....
21.....	P. M. 5.40	P. M. 8.30	2.50
22.....	" 5.40	" 9.30	3.50
23.....	" 5.50	" 10.30	4.40
24.....	" 6.00	" 11.30	5.30
25.....	" 6.00	A. M. 1.00	7.00
26.....	" 6.00	" 1.30	7.30
27.....	" 6.00	" 2.30	8.30
28.....	" 6.00	" 3.40	9.40
.....	.....	.....	...
.....	.....	.....	....
.....	....	.....	...
		Total,	2.0620

SPARKS.

The Lethbridge & Cardstone Telephone Co., Lethbridge, N. W. T., are seeking incorporation.

The Carberry electric light plant, owned by Thomas Oliver, is reported to have been seized by the sheriff.

The Bertram Engine Works Co., Toronto, has been granted provincial incorporation, with a capital of $300,000.

Mr. F. W. Mount, secretary of the electrical department of the St. John, N. B., Gas Company, has patented in the United States a device for securing perfect regulation of automatic engines when run in pairs.

The contract between the city of Hamilton and the Hamilton Electric Light and Power Company will terminate on the first of September next. The city authorities are talking of purchasing the necessary plant to do their own lighting.

The Board of Trade of London, Ont., appointed a committee at a recent meeting to wait on the Council and the Street Railway Company with a view to securing the substitution of electricity for horse power on the street railway of that city.

Mr. F. V. Hedenburg, superintendent of the Canadian General Electric Company's lamp works at Hamilton, was recently made the recipient of a couple of handsome presents from the employees of the factory, expressive of their appreciation of his many admirable qualities.

A convention is said to have taken place at St. Catharines a few days ago between some Buffalo gentlemen and the promoters of the Hamilton, Grimsby and Beamsville Railway, in relation to the scheme for utilizing for electrical purposes the waste power at the DeCew Falls, near St. Catharines.

The Royal Electric Co. is said to be bringing suit against the Montreal Street Railway Company for $27,626.07, the amount of expense to which the plaintiffs allege they have been put by reason of interference with their underground return wires by the placing underground of the Street Railway Company's return wires.

From some correspondence recently appearing in a Halifax paper, there seems to have sprung up a feud between the electric lighting company and the telephone company at Truro, Nova Scotia, as a result of which the former have gone into the telephone business, and the latter are said to be preparing to furnish electric light. Meanwhile the citizens, as usual, are trying to squeeze all they can out of both companies.

Notice is given that application will be made to the Legislative Assembly of British Columbia, at its next session, for an act to incorporate a company for the purpose of acquiring all property, both real and personal, tolls, rights, privileges and franchises of the Vancouver Electric Railway and Light Company, with power to purchase or lease the property and franchises of and amalgamate with any other railway or lighting companies.

Notice is given that application will be made at the next session of the Dominion Parliament for an Act to incorporate "The Niagara Falls Electric Railway Bridge Co.," to build a bridge across the Niagara River at some point between Niagara Falls and the whirlpool rapids, and to operate thereon an electric railway system, with power to connect with the electric railways on both sides of the river.

PERSONAL.

Mr. F. H. Badger, jr., who is well known in Canada from his long connection with the Royal Electric Co., of Montreal, has resigned his position of superintendent of the lighting department, and accepted that of general manager of the Montmorency Electric Power Co., of Quebec. This company is largely increasing the capacity of its system by the erection of a new station to be equipped with new machinery.

NOTES ON THE THOMSON-HOUSTON ARC DYNAMO.*

By James Burnett.

The dynamo used in the Thomson-Houston system of arc lighting is the result of a long series of experimenting, covering a range of years, 1880 to 1885, principally through the efforts of Professor Elihu Thomson, of Philadelphia, Pa., and Lynn, Mass.

The machine as it stands to day does not bear much resemblance to the earlier types, as from time to time a great amount of labor and painstaking research has been devoted to it, changes in design have been the consequence. The result has been, however, to make it the foremost arc dynamo in the world at the present time.

The efficiency of this machine is about 80, at full load, which at first sight may appear rather low, but in a high tension, open circuit coil dynamo of this type, this apparently low figure occurs from the space required by increased insulation and large amount of wire on the armature and fields. The large diameter of the fields and the opening in the center, necessary to get sufficient periphery speed, partly explain this result. Other reasons are, that the field magnets are of cast iron, of low permeability, where the limit of B is soon reached, and as the fields of this dynamo are supersaturated at full load, other causes of inefficiency are explained. Heavy leakage of lines of force, and the fact that the armature is short circuited for a brief period at every revolution, as explained later, all reduce the efficiency figure.

Notwithstanding these apparent discrepancies, the machine is a great success as proved by its enormous sale, competent authorities stating that nearly half the arc lighting in the world is done by this dynamo and the same make of arc lamps. There can be no doubt that these things were

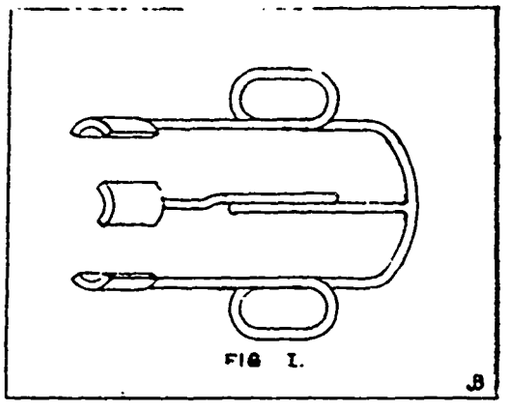


FIG 1.

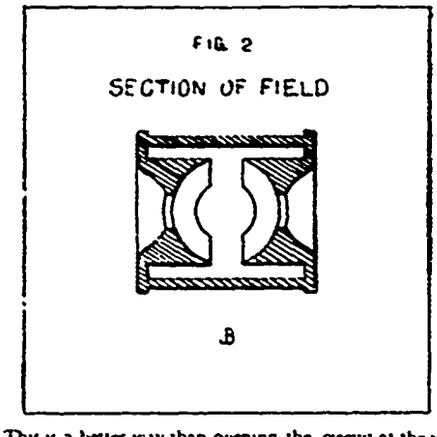
amply considered by the designers, and that the machine is the most economical on the market on account of its practibility of operation, and comparative freedom from trouble and repairs. Though of a somewhat complicated design, it only requires a fair amount of attention on the part of the attendant, which I might say is not always accorded it.

We will now pass on to the principal features of the dynamo, which are, the three part commutator, the three coil armature, the automatic regulator and the automatic blower.

The commutator is of the "air insulated" type, and consists mainly of three segments, with about ¼" gap between each. These are made of extra quality copper. The connections are readily detached, and the segments are numbered to prevent mistakes in connecting up.

The armature is a "sticker" for a novice, and in the older type, the winding is most peculiar—starting from the pulley end from a common junction as shown in Fig. 1, and wound over the laminated iron core and spider longitudinally with the shaft in three main divisions. Each division is approximately 120° apart. The winding is done in such a manner as to make each coil electrically equidistant from the iron core. This is necessary, as at certain positions of the armature, coils are placed in parallel with one another, and injurious heating is thus prevented, which would otherwise ensue. In the latest type of armature manufactured by this company, the winding takes the form of a Gramme ring, rounded on the outside, so as to closely adhere to the cup shaped fields, which are retained. The opposite coils are connected together, of course, and the coils are rectangular in cross-section, being in the M D type, 15 layers deep and 11 wires wide. These are held on in both old and new types, by very heavy and wide binding wires. The ventilation of this ring armature is excellent, and its construction facilitates the repairing of a damaged part.

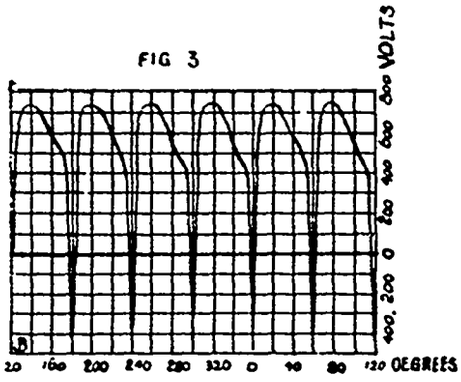
The machine is series wound as shown in the diagram; a switch is provided for short circuiting the armature, when we want to shut down the



dynamo. This is a better way than opening the circuit at the wall switch, as by doing this, the sudden discharge from the fields may perforate the insulation and spoil the machine. The Royal Electric Company provide another switch which is very serviceable. It short circuits a certain number of layers of the winding on one field, and thus increases the range of the regulator. The functions of the blower are needed when the slanting brushes, characteristic of this dynamo, short circuit an active coil. When this occurs, a knife-like blast of cold air is delivered at the gap where the arc is established, the result being the rupture of the arc.

The automatic regulator is the very soul of this system, and to it, to a great extent, the success of the Thomson Houston system of arc lighting is due. A reference to the diagram will show its operation. Its functions may be described as raising or lowering the electro-motive force, at the terminals of the dynamo, in response to increases or otherwise in the number of lamps on the circuit, or of changes in the length, and consequent resistance of the arcs. When lamps are thrown off, by being short-circuited, as is usually the case, the current (normally 6 6 amperes for a 1200 candle power lamp and 9 5 amperes for a 2000 candle power lamp) becomes excessive, and the solenoid B (see diagram,) raises. This opens the silver-mounted switch, and the bulk of the current passes through the powerful controlling magnet. This magnet with parabolically shaped end, attracts a cast iron armature below it, and by means of an elaborate set of chain work, it moves the 4 brushes set tangentially to the face of the commutator. The two "leading" (top) brushes are moved about three times as fast as

FIG 3



the two "following" (side) brushes. The result of this is that the most active coil on the armature is sooner cut out of action, and put in parallel with a weaker one. To prevent flickering of the lights, a dash-pot filled with glycerine, is used to dampen the regulator's movements. A carbon shunt E, of about the same resistance as the magnet referred to, is inserted in the switch to prevent injurious sparking when the switch is opened.

Diagram 3 shows the behavior of the current during one revolution of the armature. It will be noticed that the lines fall below zero six times during each revolution. (This is at full load on a 10 light 1200 candle power dynamo). This "dip" is the result of the short circuit caused by the arc, at the commutator, as before mentioned. The polarity of the field magnets is then reversed to a certain extent, for only a short period of time, which time depends a great deal, of course, on the conductivity of the arc and the strength and effectiveness of the air blast. This is probably the reason this machine will not run separately excited. No injurious effects occur from this reversal, as by looking at the diagram No. 3 it will be seen that the area of the space enclosed by the dip is practically *nil*. The steadying power of the large masses of cast iron in the fields of a series dynamo, giving intermittent or fluctuating currents, is well known. Curves have been plotted, comparing current with potential, showing a remarkable similarity, which is attributed to these large fields.

Diagram 2 illustrates a section of this field.

I think that a few remarks as to the running of this plant may not be astray. The construction and theory of this dynamo should be well understood by the person in charge. Much trouble will be avoided by this, and if trouble should happen, it can be at once remedied. On starting up, the regulator lever should be first raised. No injunous effects can then ensue if a short circuit happen to be upon the line, as the brushes are collecting at a period of minimum activity. Grounds should be carefully avoided and frequently tested for. The dashpot should not be allowed to get too stiff in its action, as when lamps are turned off either at the switch-board or on the line, an excess of current will flow for a while till the regulator reduces it. On an ordinary arc circuit no bad effect would result, but on a line with

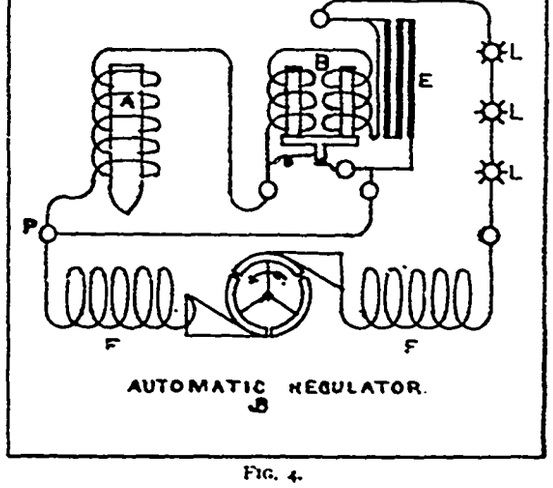


FIG. 4.

distributor boxes, and incandescent lamps in series-parallel, the lamps are liable to be destroyed. A little alcohol added to the glycerine usually has the desired effect.

Flashing at the commutator is often a source of trouble, on this dynamo, and may occur from a variety of causes, such as a large and sudden variation of speed, the commutator not being set aright at the start, or a blower out of order. These are the most frequent causes. A wing may not work freely or is worn unevenly, and possibly the air jet is not directed to the right point. A slight lifting of the commutator may remedy it, but this of course is supposed to be set aright in the factory before shipping, and not to be changed after then. It should be borne in mind that shifting the com-

* Paper read before the Montreal Electric Club.

mutator not has the same effect as raising the regulator. In the first case the brushes have the same relation to each other, and in the latter they do not. When brushes are put on the dynamo, they should be set exactly to guage, viz., 4¼ inches from the holder. After using for some time, the segments invariably have a hollow near the gap, which is often a source of trouble, through the brushes being too springy; an easy and practical remedy is to insert a piece of cotton waste underneath the holder and over the brush, wedged in tightly.

The three lead wires which come through the shaft from the armature have different colored braided coverings, viz., red, white and blue, which go to segments marked 1, 2, 3, respectively. Care must be taken to return them to their proper places, as results will be had that were not thought of by the designers. Loose contacts should be guarded against, and though broadly speaking, contacts on an arc circuit do not require much carrying capacity, there are one or two which should be guarded against. One is the triple binding post at the end of the field, marked P on the diagram. Any resistance interposed here, has the result of cutting out the large magnet, and the regulator may not work from this cause. The carbon shunts may also be damaged.

Only the best mineral oil should be used, especially in the blower, where thin oil must be used. The gauze wire in the inlet of the blower, should be frequently cleaned from impurities.

In conclusion—*a careful study of this dynamo will repay itself.*

QUESTIONS AND ANSWERS.

A correspondent asks:—

1. What proportion should the piston rod of an engine be to the piston?

ANSWER.—The problem is one upon which there are differences of opinion. A little consideration will show the difficulty. The load is on the piston, and the resistance is at the cross-head, hence the *length* should be taken into account. Then it is not enough that the rod will not *break*, but it must not *bend* at all, for if it does it will spoil the packing at the cylinder gland, increase friction, and do other mischief. The material of which the rod is made is subjected at one time to a pulling strain and the next instant to a compressing one. The following, is however, a good safe rule for diameter of piston rod:—For a wrought iron rod, multiply the diameter of the cylinder in inches by .018 and by the square root of the highest steam pressure. Example —The cylinder is 30 inches in diameter, and the boiler pressure 100 lbs.—what should be the diameter of a wrought iron piston rod and of a steel one? By the rule, multiply 30 by .018 and by the square root of 100.—30 × .018 × 10 = 5.4 ins. diameter. For steel, instead of .018, use the figures .012—30 × .012 × 10 = 3.6 inches, for a steel rod.

2. What rule can I go by to plan out the crank pin and cross-head pin of an engine?

ANSWER.—The crank pin in a single crank is like a beam fixed in the one end and the load uniformly distributed, or it may all come on outer end. It must, however, be sufficiently rigid not to bend in the slightest degree. The following is a safe rule, and will give rather larger sizes than are usually found, but as steam pressures and speed of engine are increasing, it will be found necessary to increase size of crank pin:—For diameter of pin, multiply diameter of cylinder by .02 and by square root of highest steam pressure. Example:—For 30-inch cylinder with steam at 100 pounds pressure, what diameter should the crank pin be? 30 × .02 × 10 = 6 inches. The length may be varied from about same as diameter to one and a half times diameter, but the diameter and length should be checked by the following method:—The total pressure on the pin must not force out the oil, and to ensure this, the pressure must not exceed 1200 lbs. per sq. inch of surface. In the example, a 30 inch cylinder with 100 lbs. per sq. inch on piston will exert a pressure of 70,686 pounds on the crank pin, and that the pressure shall not exceed 1200 pounds per sq. inch, 70,686 divided by 1200, gives 67.—That is, the diameter of crank pin multiplied by its length, should give 67. If the crank pin be made 6-inch diameter, then its length should be 10¾ inches. It would be better, however, to increase the diameter to say 7½ inches, and make the length 9 inches. The cross head pin may be smaller than the crank pin, as it is usually supported on both sides, and as the motion is so much less, the oil is not so ready to be forced out.

3. What amount of surface of the cross head should be in contact with the guides?

ANSWER.—The principle here is, that the pressure on the guides should not force out the oil. The pressure on the guides varies with the proportionate length of connecting rod, to crank. Short connecting rods throw a heavier pressure on the guides than long ones. The pressure may be estimated to vary from one fourth to one eighth of the total pressure on the piston when at the middle of its stroke. To find the area of sliding surface, multiply the area of cylinder by the average steam pressure, on piston, and divide by four. That will give the total pressure on the sliding surface; then by allowing about 100 lbs. per sq. inch as a suitable pressure, the area is just one hundredth part of the total pressure. In some locomotives the slides are so large that the pressure amounts to only 40 lbs. per sq. inch. The larger the surface, the less wear there will be.

In the December number of the ELECTRICAL NEWS, Mr. Joseph Ogle, of Brantford, Ont., gave a description of the heating system in use in the factory in which he is employed as engineer, and asked for an expression of our opinion as to certain proposed improvements. Our reply to Mr. Ogle's inquiries was also published in our December number. We have since received the following letter from him on the subject: Enclosed you will find a rough sketch of our heating system. Since I wrote you, you will notice we have changed the 4 in. header to a 6 in.; we had also the header tapped on both sides with the five 1¼ in. pipes, leading around the factory to the opposite side, these each having a separate 2 in. drip but only for a few feet where they are connected and lead the remainder of the way through one 2 in. pipe. Will you kindly express your opinion on the change. If you would suggest any further change, kindly explain fully the reasons for the same, if any.

ANSWER.—Mr. Ogle has not yet carried out quite correctly our former suggestions. 1. One 6 in. header supplies the two coils. A separate header to each would have been better and would have enabled him to control the amount of steam going to each.

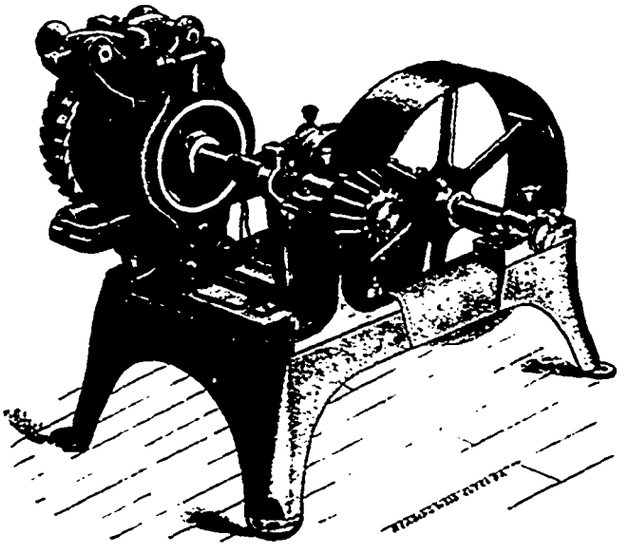
2. The returns should not be joined together, but should be dropped down as vertically as possible.

3. The returns should not discharge into the heater, but may be led into a *low* tank from which the water may be lifted.

4. There should not be a rising pipe from the return, open to to the air. In a well proportioned exhaust steam heating coil, there will be at times, a partial vacuum, that is, the pressure inside the coil will be below atmospheric pressure. Hence to get the water discharge from the coil, the return pipe must be led down, so that the weight of water may overcome the resistance offered to the discharge by the difference in pressure. For the same reason all connection between the atmosphere and the return pipe should be avoided, and the return from each coil should discharge under water. There should be a valve at the steam header end of coil, so that when engine is stopped, by the opening of this valve air may be admitted to the coil, to make sure that all the water will be discharged before the temperature falls low enough to freeze up the coil. The pipes should have a good fall from the steam end to the discharge end.

ELECTRIC WATER WHEEL REGULATOR.

The accompanying illustration represents an electric device for controlling the speed of water wheels. The device consists of a regulator, a high-speed engine governor, and a gravity battery with its circuit. The regulator is strong enough to control the gates of water-wheel, and receives its power directly from the wheel. It is also so sensitive that the battery current will cause it to act upon the gates. The engine governor is simply used as an indicator, and as the pointer rises or falls with the slightest variations of speed, it touches a contact point, and



ELECTRIC WATER WHEEL GOVERNOR

this telegraphs the regulator which way to move the gates. The engine governor is always belted to the shaft to be governed, so that variations due to transmission do not affect the driven machinery. There is no limit to the distance that may be between engine governor and the regulator. It is claimed that by means of switches, perfect control of wheel can be had from any point in or out of plant or factory.

Messrs. Wm. Kennedy & Sons, of Owen Sound, Ont., who are the manufacturers and vendors of this device in Canada, in answer to our enquiries concerning it, write. "We have been watching the record of these governors for the last two or three years and feel sure that they have no equal as a water-wheel regulator, hence the reason for our taking hold of them. For electric work, we feel sure that they will give satisfaction and greatly improve the service when the motive power is water. We give thirty days' trial of the machines when they are placed by us before they are taken off our hands as a guarantee that they will do the work. We are fitting one to the water-wheel of the power house plant which we have almost completed at the Canadian Soo."

ENGINES FOR ELECTRICAL WORK.

AMHERST, N. S., January 26th, 1894.

Editor CANADIAN ELECTRICAL NEWS.

DEAR SIR,—Mr. J. H. Killey, in his letter published in your January number, thinks he may be expected to give an unbiased opinion of what has come under his observation in regard to high speed vs. slow speed engines. I hope no one will doubt the sincerity of the statements expressed by any of those who have ventured to state their views through your valuable columns on this important subject, but it is possible that any or all of us may not have had so wide experience with the various classes of engines as would enable us to decide this question positively of our own knowledge. For my own part, although I have had a somewhat varied experience, and could name many instances of good and bad performances of both slow and high speed engines, I would feel unwilling to express an opinion based entirely on my own experience, and although I have no doubt Mr Killey's experience as he states, has been unfavorable to the high speed engine, I feel sure he has not had an opportunity of observing or testing the best engines of this type. The statement he makes in regard to the high speed engine taking 4½ lbs. of coal per I. H. P. per hour shows that he has not, because it is a well known fact that high speed engines are in use that develop an I. H. P. with 15 lbs. of water per hour, which, with an evaporation of 10 lbs. of water per pound of coal, would give 1 5 lbs. of coal per I. H. P. per hour, and it is a common practice in the United States to guarantee 20 lbs of water per I. H. P. per hour for high speed compound engines. I have no doubt there are simple high speed engines of small size using 4½ lbs. of coal per I. H. P per hour, or even more, if they are overloaded or as badly constructed as some I have seen, and I know of long stroke engines which are not doing any better, but it is not fair to compare them with a compound condensing engine of about 200 H. P. such as Mr. Killey reports as having a consumption of rather less than 1½ lbs. of coal per I. H. P. per hour. (By the way, I make it 1 77 lbs. which is rather more than 1½). However, the result is remarkably good, and if the engine will do this duty under the usual conditions of street railway work the owners of the plant should be more than satisfied. There are two features of Mr. Killey's report, however, which show an error somewhere. He says "the test of the engine extended over ten hours, *88 diagrams having been taken during its continuance* showing a large and immediate change in the power as the work came on and off it, varying from 80 to 230 H. P., *yet not the slightest variation could be detected in its speed from a friction load with current switched off, or the whole load of say 230 H. P.*" (The italics are mine).

1st. It is a well known fact that the centrifugal governor, which is used in various forms for all steam engines, depends for its regulation upon a variation of speed, and it is not possible to have such a governor operate without some variation of speed in proportion to the amount of load on the engine. The best high speed engines regulate with a variation of 2 to 3 per cent. from no load to full load, and supposing that a long stroke engine may regulate with no more variation than the amount stated from no load to full load, this only takes into account the average speed during one minute as compared with the average speed during another minute, while the variations may be, and always are, very much greater during shorter periods when the fluctuations of load are sudden, as they are in street railway work, the load going off and on in an instant, a slow speed Corliss engine makes only about one revolution in a second, and if the load comes on after the cut-off has taken place there is no opportunity to regulate until the begining of the next stroke. Even after a change of cut-off has taken place, particularly if the engine is compound, it will take several strokes before the necessary change in pressure can reach the low pressure cylinder and the engine be brought to its normal rate of revolution.

2nd. 88 diagrams were taken in ten hours, which, if they were single diagrams, would be 22 sets from both ends of high and low pressure cylinders, or only one complete indication every 27 minutes; or even if 88 sets were taken it would only be one set for every 7 minutes. In either case, with a load varying suddenly between wide extremes, there is room for a considerable error in horse power, which in connection with the apparent failure to note the variations in speed, may have caused a still greater error in the horse power upon which the economy is based.

Engineers who have attempted to make tests of engines doing street railway work realize the difficulty of getting a true average of the work done except by means of recording watt meters, giving the total electrical horse power, or almost continuous indications of the engines, and with very sensitive tackometers or continuous revolution counters to indicate the speed.

Mr. Killey states in closing that "the whole tendency of electrical engineering at the present day is towards larger machines and slower speeds." Charles E. Emery, Ph. D., in a recent article entitled "Lessons of the Columbian Year," published in Cassier's Magazine, says "it is probable that this type (referring to the Corliss engine) will be a permanent one for engines of moderate speed, say 100 revolutions or under, although the speed of this type of engine is being constantly increased." He also refers to the pleasing display of so many high speed engines at the World's Fair, "all apparently operating well without the difficulties of heated bearings which used to be incident to this class of engine, and many of them regulating with an accuracy that is as surprising as it is gratifying." Dr. Emery is, I believe, considered one of America's foremost engineers, and has had a wider experience and more opportunities of observing the performance of engines under all circumstances than almost any man in the engineering profession. I have, in my previous letter, quoted from his report on the cost of producing a horse power by various classes of engines, showing that the high speed engine will, under certain circumstances, produce a horse power cheaper, including cost of repairs and maintenance, than a slow speed engine. I have also quoted from a report by three of the leading electrical engineers of the United States, Messrs. Connette, McIntyre and Pearson, positively recommending high speed engines for small plants. In addition I would refer you to the report of a test of three large street railway plants at Minneapolis and St. Paul. Two of these were driven by low speed triple expansion condensing engines of large size, the average horse power of each engine being from 418 to 705, the third plant was driven by high speed compound non-condensing engines, the average horse power of ten engines being 522. The tests were made by Messrs. William A. Pike and T. W. Hugo members of the American Society of Mechanical Engineers, and Mr Ard Collins, Agent of the Hartford Boiler Insurance Co., at the instance of the Twin City Rapid Transit Co., for the information of the company who owned them. No pains or expense were spared to make the test complete and accurate in every particular. The report is embodied in a paper presented to the American Society of Mechanical Engineers, and may be found in their transactions. These tests show that the total cost of power per car mile by the slow speed triple expansion condensing engines is only about 3 per cent. better than the total cost of power per car mile by the high speed compound non-condensing engines, and the experts report that if the high speed engines had been furnished with the proper pressure of steam they would have done about 2½ per cent. better than the long stroke engines. The same report shows that, while the variation in speed of the high speed engines was never more than 5 per cent., the long stroke engines varied at times over 40 per cent. In regard to speed, the report reads as follows: "Another matter which cannot help affecting economy, is the very rapid regulation of the smaller engines, thus adapting themselves more readily to the variations in load than is possible with engines of the Corliss type. In a regulation test, October 26th, 1892, it was found that the governors on the Westinghouse engines were able to change from a very heavy load to a mere friction load within four revolutions, or one second of time." While this test furnishes conclusive proof that high speed engines, not of the highest type, are better adapted to the peculiar conditions of street railway work than the highest grade of long stroke engines, I do not think it detracts, in the slightest degree, from the value of the long stroke engines for certain other circumstances to which they are adapted.

Now, Mr. Editor, although you seem to think, as stated in your last issue, that "the preponderance of opinion so far was in favor of low speed," (I suppose you meant as expressed through your columns), I think you will admit that there is quite weighty evidence that the high speed engine is better adapted to electric railway work, especially for small plants, and I think I may safely add that I believe every consulting engineer, either mechanical or electrical, who has had extensive experience with street railway plants in the United States will agree, in the main, with my statements; and in Canada I think there are a large number of practical engineers who, like the Power House Engineer quoted in your last issue, would stick up for high speed for railway work. In regard to the two correspondents who oppose me, I cannot but think they misunderstood my intention and took my remarks as a reflection on the low speed engine, or an attempt to claim superiority for the high speed eengine, in a genral sense, but I hope I have made it clear that such was not my aim, but rather to show how and where each class has advantages.

Yours truly,

D. W. ROBB.

ENGINES FOR ELECTRICAL WORK.

Editor ELECTRICAL NEWS.

PETERBORO', ONT., 3rd January, 1894.

DEAR SIR,—I have been much interested lately in the correspondence on the above subject, appearing in your paper from time to time, being at present deeply engaged in the study of the various forms of slow and high speed engines now upon the market. As a designer of steam plants, I feel that I should like to take a part in the discussion upon the subject, as there are many things pro and con that I must necessarily keep in mind.

Upon the above subject I reason with myself thus: that concentration of power in a small space is the feature much sought after in the steam engine,—in fact, it is its power to concentrate the strength of thousands of horse power in the space of an ordinary room that renders the steam engine so useful and indispensable to us. Because of this we cannot go on increasing the volume of the engine without a proportionate increase in power, and that cylinder whose stroke equals its diameter contains the maximum of volume, with the minimum of condensation.

The reduction of condensation surface is being more and more sought after by engineers, and is thoroughly appreciated by them, and just so soon as we become better acquainted with the laws of inertia, the shortening of the stroke or constructing the engine cylinders square or nearly so, that, together with the high speed of the reciprocating parts of the engine, will prove a less terrifying object than hitherto to engineers. And yet there is no more unsafe proceeding in engineering science than to attempt to predict the limitations of the development of the steam engine. It is in the utilization of the steam after it reaches the engine that we must hope for improvement—diminution of condensating surface, shortening the duration of time for condensation, which means of course an increase in the number of strokes. By a study of the laws of condensation we are led to the conclusion that a squared cylinder should be the controlling consideration. That the fast speed should have any effect upon the structure of the steam engine cannot I think be fairly argued to-day, for where there is a clear knowledge of the dynamics of the steam engine, the defects of a faulty designed structure will not be present. High speed necessitates increased length of crank pin and shaft bearings; the diameter of all bearings should be as small as the pressures allowable upon the contact surfaces will admit. The co-efficient of friction is much affected and reduced by the state of the rubbing surfaces; the method of lubrication and the lubricant used requires consideration. The design of the connecting rod requires that it be larger in cross sectional area at the crank pin end, than at the cross-head end.

The long stroke engine is not as desirable as the short stroke for incandescent lighting, for by a careful observation of the lamps you can count with great precision the revolutions made by a long stroke engine, the effect of which upon the films of the lamps is most injurious. For example, we have a slow speed engine making sixty revolutions per minute; the dynamo runs 1,500; one revolution decrease in the speed of the engine would mean 25 on the dynamo. With a high speed engine running 250 revolutions per minute, one revolution decrease would only be 6 on the dynamo. The visible effect then upon a high speed engine if run at or nearly at its regular speed would be very little. By necessity the short stroke requires that a much greater attention be paid to any increase of the revolutions than in the slow speed in proportion as the stroke is shorter. The same factor of an increase of speed from the commencement to the middle of the stroke and the decrease of the speed from the middle to the end of the stroke, is present in the short stroke as in the long stroke engine, but it becomes less in percentage as the stroke is shortened and becomes more frequent. Regular speed does not mean a great variation, but a close approximation to a certain line; any variation from this is noticeable.

I have said nothing regarding clearance, port area, pipe area,

&c., and methods of constructing the engine, but may do so with your permission at a later day.

I remain, yours truly,

AL. C. McCALLUM, M. E.

ECONOMICAL FIRING.

PORT CREDIT, ONT., Jan. 19, 1894.

Editor Electrical News.

SIR,—I have noticed in engineering papers the writings of men who say that a good fireman can save money to his employer and a poor one can waste it, but they stop right there without giving any directions or methods by means of which we firemen can improve ourselves. I would like to learn the methods that other firemen adopt in order to keep up steam and save coal. I will give mine, and would like more experienced men to tell me where I can improve.

I am firing two horizontal tubular boilers, rated about 75 horse power each, and there is so much steam used that if I lose 5 lbs. pressure it takes 45 minutes to get it back again. I use screenings, and carry my fires about 7 inches thick all over the grates, which are stationary ones.

I stir all my fires, then put coal on one side of each furnace; in four minutes I stir all my fires again and put coal on the other side; and so on every four minutes, gauging the amount that I put in by the thickness of my fires. My reason for firing alternate sides is: when I have a white hot fire on one side and fire new coal on the other side, the smoke rolls over and some of it at least gets consumed. If I neglect doing the stirring, the pressure goes down immediately. I have what experienced engineers consider to be good draught.

R. B.

[Our correspondents method of firing slack coal is a good one. The only point to which we would call attention is the thickness of the fire. He says he keeps it *seven* inches thick, and if he neglects to stir it down goes the pressure. This seems to point to the fire being too thick for the strength of draught, and that sufficient air to maintain good combustion does not get through the coal till he breaks it up. The *thinner* the fire can be kept, the more effective will the combustion be, and the thickness which will give best results depends largely upon the strength of draught. We would suggest to try a thickness not *exceeding* five inches, or even less, and let our readers know the result. If he has to fire up at intervals of four minutes, he may not have sufficient boiler capacity for the steam required to use such a class of fuel. However, we would like him to experiment with *thin* fires, and let us know the result.—Editor ELECTRICAL NEWS.]

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

Note.—Secretaries of the various Associations are requested to forward us matter for publication in this Department not later than the 20th of each month.

OTTAWA ASSOCIATION NO. 7

Editor Electrical News.

SIR,—The last regular meeting, in December, of Ottawa No. 7 was held with Bro. J. H. Thompson in the chair. On that evening engineering questions did not receive much attention, as the most important business was the election of officers for 1894. Those who have been chosen are: President, Frank Robert, (Russell House); Vice-President, Mr. H. Graham; Rec. Secretary, J. A. B. Latour, (41 Bolton St.); Fin. Secretary, Albert Cane; Treasurer, Wm. Hill; Conductor, John Harris; Doorkeeper, Charles Schofield; Trustees, J. D. Thompson, M. J. Campbell, Frank Merrill.

After some appropriate remarks from the past President and the newly elected officers, Bro. Robert presented the Association with a model of a plain slide valve engine, donated by the engineering supply firm of McKinley & Northwood, which was highly appreciated, as it will be a valuable addition to our educational department.

At the first meeting in January, the time of the meeting was very much taken up with routine business, including the installation of officers, so as to leave very little time for discussion on engineering, but as the meeting was about to be closed, an inquisitive member thought he could not rest at ease if he went home without knowing on what principle the Osborne-Killey engine governor worked, when some one having had experience with that class of engine explained the office of the weights and springs attached to the fly-wheel, at the same time making a sketch to show that it consisted of a sleeve carrying an eccentric, revolving on the engine shaft, driving an auxiliary valve over the main valve, the latter being driven by a fixed eccentric. When the weights fly out against the opposing force of the springs, which takes place when the speed of the engine increases, the auxiliary eccentric is pulled ahead, and cuts the steam off at such a point as is required to regulate the engine's speed according to the variation of load.

After the details of the governor were explained Bro. Latour at the request of the President said that the subject of his paper to be read at next regular meeting would be "The Practical Applications of the Steam Indicator." And as the application of an indicator to an engine is a scientific experiment it will be undertaken with a certain degree of precaution, for the value of a diagram depends on its correctness, and the value of the indicator is so generally recognized by engineers that we expect a full attendance at the next meeting.

Our educational work has been carried on satisfactorily so far, judging by the remarks of the majority of members. It is very encouraging to hear one saying that since he joined the Association he gained information that is worth more than all the contributions payable in twenty years; it shows that engineers are realizing that to attain a high position in their profession, and command the highest standard of wages and also to be a good, reliable, and economical engineer, it is absolutely necessary to be familiar with at least the ordinary rules of arithmetic. Sometimes engineers are very much embarrassed when confronted with the mathematics of steam engineering, but to obviate that difficulty we have adopted a course of instruction so simplified as to be within the comprehension of every one with ordinary education; and no matter how simple it may appear to those who are fortunate enough to be familiar with the higher branches of mathematics, there is always a marked interest taken, and the educational matter receives their earnest attention. It is by such good work that we will strike the point we are aiming at, and every engineer should be encouraged by thinking of the advantages at his disposal, for it is well known that any one who belongs to an association has at his back the combined ability of all the members of that particular association, and he should depend upon it at all times, for the reason that a true and broad minded engineer will never refuse to impart the benefits of his past experience to his fellow engineer. By keeping this in view we cannot fail to make the C. A. S. E. the grandest organization of Canada.

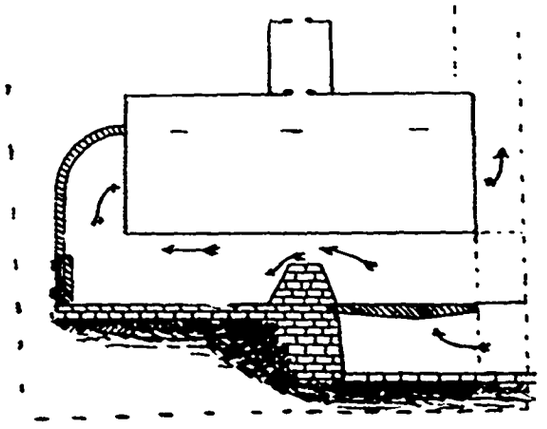
As we are entering a new year with encouraging prospects, it affords me great pleasure to extend to all the branches of the C. A. S. E., the best wishes of Ottawa No. 7.

"PROGRESS."

HAMILTON ASSOCIATION NO. 2.

At the instruction meeting held on the evening of January 19th, Bro. Joseph Langdon gave a very practical and interesting address on the subject of "Boiler Setting." He pointed out the advantages which the new type of boilers possess over the old, and opened the way for a full discussion of the subject by the brethren. The majority of opinions expressed were favorable to an open space being allowed back of bridge wall, a full 20 per cent. more area between bridge wall and bottom of boiler and following the circle of the boiler shell, and that the best results are obtainable when the grate bars are from 24 inches to 30 inches from shell of boiler.

Bro. Stott made the following sketch of the boilers of which he has charge:



The members of this Association would be pleased if other Associations would take up the discussion on this subject, and give the result of their deliberations through the ELECTRICAL NEWS.

WM. NORRIS,
Rec. Sec'y.

The following description is given of a loud speaking telephone recently devised by Mr. Graham, of the Electric Wire and Fittings Co., Westminster, B. C. He has succeeded not so much by an improvement on the existing telephones, although some modification of the apparatus has been affected, as by his method of arranging the circuit and bringing its resistance as low as possible. To this end the usual induction coil is discarded, and the two instruments, transmitter and receiver, are directly connected in circuit with the line and the battery. The transmitter of A at one end of the line is connected to the receiver of B at the other end. As this arrangement only permits of A speaking to B, and not of B replying to A without a change of the connections and a substitution of apparatus, two separate lines are employed, having a common return wire. On the second line the transmitter of B is directly connected to the receiver of A. The two correspondents can thus talk quite freely with each other, and as the receivers speak out so as to be heard in any part of a room, conversation can be carried on by each person simply speaking to his transmitter. This apparatus is attached to flexible conductors and is held in the hand. To open a conversation it is sufficient to pick up the portable transmitter and press a button in its casing so as to establish the circuit, then speak into it. The receiver at the other end acts as its own call-bell by the loudness of its voice, and the response comes equally prompt and loud. The user has, therefore, no need to listen carefully with one or two receivers held up to his head. All he has to do is to speak into his transmitter and keep his ears open.

THE PHILOSOPHY, APPLICATION, CONSTRUCTION AND IMPROVEMENT OF THE STEAM ENGINE.*

SECOND PAPER BY JOHN C. GOUGH.

I have much pleasure in reading before your club, to-night, the continuation of our paper on the above subject. We have already endeavored to partly trace that incalculable store of potential energy (the heat and light of the sun), upon which the human race is so dependent, until it is partly expended in doing work through its medium the steam engine, and it may be well that we dwell upon this subject until we are quite familiar with it, as it will be of the greatest assistance to us in laying claim to discuss and explain the construction and improvement of that great prime-mover in which we are so much interested to-day. It will, no doubt, make it much easier for us to discover what principles are comprehended in its philosophy, to learn what are known facts bearing upon its operation, and to determine what are the directions in which improvement must take place, what are the limits beyond which improvement cannot possibly be carried, and in some directions, to determine what is the proper course to pursue in effecting improvements. The general direction of change in the past, as well as at present, is easily seen. We may therefore form an idea, based upon experience of the probable direction in which to look for improvement in the near future.

Reviewing the operations which go on in this prime mover, the steam engine, during the process of transformation of energy which has been outlined, and studying it more in detail, we may deduce the principles which govern its design and construction, guide us in its management and determine its efficiency. I will, however, finish the heat question in boiler and furnace pit. In the furnace of the boiler, the quantity of the heat developed in available form is proportional to the amount of fuel burned. It is available in proportion to the temperature attained by the products of combustion; were this temperature no higher than the temperature of the boiler, the heat would all pass off unutilized. But the temperature produced by a given quantity of heat, measured in heat units, is greater as the volume of gas heated is less. It follows therefore, that at this point, the fuel should be consumed with the least possible air supply, and the least possible abstraction of heat before combustion is complete. High temperature of furnace is also favorable to complete combustion, (hence the great saving in fuel where mechanical stokers are in use.)

We might therefore conclude that, in the steam boiler furnace fuel should be burned in a chamber having non-conducting walls, and with the smallest air supply compatible with thorough combustion, and further, that the air should be free from moisture, that greatest of all absorbents of heat, and that the products of combustion should be removed from the furnace before beginning to drain their heat into the boiler. A fire-brick furnace, a large combustion chamber with thorough intermixture of gases within it, and a restricted and carefully distributed supply of air, are the conditions which meet these requisites best. The heat generated by combustion traverses the plates which separate the gases of the furnace from the steam and water confined within the boiler, and is then taken up by those fluids, raising their temperature from that of the entering feed water to that due the steam pressure, and expanding the liquid into steam occupying a greatly increased volume, thus doing a certain amount of work, besides increasing temperature. The extent to which heat may be thus usefully withdrawn from the furnace gases depends upon the conductivity of the boiler plates, the rate at which the water will take the heat from the metal, and the difference of temperature on the two sides of the metal. Extended heating surface, a metal of high conducting power, and a maximum difference of temperature on the two sides of the separating plate, are the essential conditions of economy.

The heating surface is sometimes made of so great an area that the temperature of the escaping gases is too low to give good chimney draught, and a mechanical draught is resorted to such as fan blowers and steam-blowers (the latter, however, I cannot say that I would recommend), being ordinarily used for its production. In my experience, I must say I have found it an economical method to adopt. The steam boiler, nowadays, is generally constructed of steel, sometimes, but rarely, of iron; the steel, however, is found to be the better in consequence of its greater strength, its homogeneousness of structure, and its better conductivity.

The maximum conductivity of flow of heat for any given material is secured by so designing the boiler as to secure rapid, steady and complete circulation of the water within it. The maximum rapidity of transfer throughout the whole area of heating surface is secured, usually, by taking the feed-water into the boiler as nearly as possible at the point where the gases are discharged into the chimney flue, withdrawing the steam near the point of maximum temperature of flues, and securing opposite directions of flow for the gases on the one side and the water on the other. Losses of heat from the boiler, by conduction and radiation to surrounding bodies, should be checked as much as possible. Of the coal burned in a steam boiler, it rarely happens that more than three-fourths is utilized in making steam the remainder being in ashes, clinkers and moisture, therefore the engine does not get the number of foot pounds per pound of coal burned in the steam boiler as the casual observer might be led to suppose.

Now, the steam in the engine first drives the piston some distance before the induction or steam port is closed, and it then expands, doing work, and condensing in proportion to the work done as the expansion proceeds, until it is finally released by the opening of the exhaust or eduction port. Saturated steam is modified in its action by a process to which we referred in our last paper, condensing at the beginning and re-evaporating during expansion and at the end of the stroke, thus carrying into the condenser considerable quantities of heat, which should have been utilized in the development of power. Whether this operation takes place in one cylinder or in several is only of importance in so far as it modifies the losses due to conduction and radiation of heat, to condensation and re-evaporation of steam, and to the friction of the parts of the engine.

This re-evaporation is counteracted to an extent by steam jacketing, and I believe was one of James Watt's improvements (?). It is a casing around the cylinder, this being filled with steam, and in communication with the boiler, which supplies, as it were, a reservoir of heat which would, by raising the temperature of the expanding steam in the cylinder, retard the condensation therein due to the loss of heat consequent on expansion; but in parting with heat thus to the steam within the cylinder a portion of that in the steam jacket is condensed, hence it is very questionable if any economy of fuel ultimately results from the adoption of the steam jacket. In all cases, however, the cylinder whether jacketed or not, should be surrounded by lagging, viz., a layer of some material which is a very slow conductor of heat, until something more suitable can be adopted, to prevent loss by radiation, etc.

The loss due to condensation, however, on the cooled interior surface of the cylinder at the commencement of the stroke and the subsequent re-evaporation as expansion progresses, is least when the cylinder is kept hot by its steam jacket, and when least time is given during the stroke for this transfer of heat between the metal and the vapor.

It may be said that, all things considered, therefore, losses of heat in the steam cylinder are least when the steam enters dry, and I venture to say, moderately superheated, where the interior surfaces are kept hottest by the steam jacket, and the piston speed moderately high.

The mechanical power which has now been communicated to the machinery of the engine by the transfer of the kinetic energy of the hot steam to the piston is finally usefully applied to whatever mechanism of transmission forms the connection with the machinery driven by the engine. In this transfer, we find, there is some loss in the engine itself by the friction of its rotative and reciprocative parts. This is a variable amount, nowadays, and can be made very small by skilful design and good workmanship and management. It may be taken at ½ lb. per sq. inch of piston for engines of good design and workmanship, of say, 100 h. p. and upward, but is often several pounds in very small engines. It is least where the rubbing surfaces are of different materials, but both of smooth, hard, close grained metal, well lubricated with the best lubricants, and where advantage is taken of any arrangement of parts which permits the equilibration of pressure, as on the shaft-bearings of double, triple and quadruple expansion engines, or in other words an equal distribution of the strains on those different parts.

A complete balancing of the reciprocating parts is also a matter of very great importance, and is sometimes the cause of many mystified accidents to engines, both on locomotives, stationary and marine engines, when treated lightly. The friction of a steam engine of large size and good design is usually between 5% and 7% of its total power. It increases rapidly as the size of the engine decreases.

Having now somewhat outlined the growth and philosophy of the steam engine, though in intermittent, yet plain language, and made ourselves acquainted with that incalculable dormant energy and its transformation into useful and available kinetic energy, through that familiar process of combustion until we find ourselves devising ways and means of controlling it so as to use it to the very best advantage and with as little cost as possible, we are now prepared to study the conditions which control our intelligent designers, and to endeavor to learn what are the lessons taught us by science and by experience in regard to the essential requisites of efficient working of steam and economy in the consumption of fuel. We may venture to point out the direction in which improvement is now progressing as indicated by a study of these requisites, and may be able to see the natural limits to such progress; and we may conjecture, too, what must be the character of that change of type which can only take the engineer beyond the limit set to his advance, so long as he is confined to the construction of the present type of engine.

(The common slide valve on improved principles, the steam and exhaust ports, their arenas and formula for calculating size of same for different piston speeds, will come under the heading of "Design and Construction," in our next paper.)

*Paper read before the Montreal Electric Club.

An interesting engine test was recently conducted at the School of Practical Science, Toronto, by a joint committee of students, and members of Toronto No. 1, C. A. S. E. We hope to be able to furnish our readers at an early date with some particulars of these tests.

ELECTRIC RAILWAY DEPARTMENT.

NEW POWER STATION OF THE MONTREAL STREET RAILWAY.

Following is a brief description of the equipment of the Montreal Street Railway Company's new power station :—

The engine house is two hundred and thirty-five feet long by eighty-nine feet wide, containing six 600 h. p. (nominal) engines built by Laurie Bros., of Montreal. They are horizontal cross-compound, condensing engines, with Corliss valves. Cylinders 24 inches and 48 inches, by 48-inch stroke, speeded to run 68 revolutions per minute, and guaranteed to develope above horse power at the most economical point of the cut-off, with a boiler pressure of 125 pounds. The drive wheel is 24 feet in diameter, with 54-inch face, double crowned, so as to drive two belts. Each engine will drive two 200 kilowatt generators. The gross weight of the fly wheel is 40 tons. Total weight of engines about 85 tons. The foundations on which the engines are built are of brick, cement and concrete. The depth of the foundations is about fifteen feet below floor level, and the weight fully six and a half times as much as that of the engines. The foundation bolts of the engines can be reached by a tunnel in the foundations. The engines are raised 7 feet above the street level, so as to keep them clear of possible floods in the spring-time; and this accounts for the great depth of foundation. In the basement below the engines there are Worthington and Northey condensers, and the water for condensing and steam purposes is drawn from the Lachine canal in a 20 inch pipe. Connection is also made with the city mains, so as to supply water for steam purposes from that source, should the canal be run off at any time. The boiler house, adjoining the engine house, is 117 feet long by 93 feet 6 inches at the back, and 118 ft. in front. There are 12 Lancashire boilers, made by Daniel Adamson & Co., of Dukinfield, Manchester; size, 28 feet long by 7 feet diameter, working pressure 125 lbs. Each boiler is capable of giving over 300 h. p. The shells are in 8 courses or rings of one plate each, 5-8 in. thick. Green's economisers are built in the flue, and through them the feed water passes to each battery of boilers. The fire floor is raised in like manner to the engine floor, so as to avoid possible floods. The chimney stack is 186 feet above the level, 9 feet internal diameter. The main steam pipe is 18 inches in diameter. All the steam pipe has been supplied by McDougall Bros., of Montreal.

LEGAL DECISIONS.

STREET RAILWAY COMPANY V. CARRIERE, MONTREAL.—In this case the action was one of damages for injuries received while standing on the outside board of an open car. The action was for $50,000, and a judgment was delivered by the court in 1890, dismissing the action. On appeal by the plaintiff to the Court of the Queen's Bench, the judgment of the Queen's Bench 1893, reversed the judgment of the Superior Court, and allowed $600 damages to the plaintiff. Upon an appeal to the Supreme Court by the Montreal Street Railway Company, the appeal was quashed without costs, on the ground that the amount in dispute was under $2,000, the statute 54-55 Vic. ch. 25, not applying to the cases pending, following the decision of this court in Cowans v. Goans, decided last June.

JOYCE V. HALIFAX STREET RAILWAY COMPANY.—The charter of a street railway company required the road between, and for two feet outside of the rails, to be kept constantly in good repair and level with the rails. A horse crossing the track stepped on a grooved rail, and the caulk of his shoe caught in the groove and he was injured. In an action against the company by the owner, it appeared that the rail at the place where the accident occurred, was above the level of the roadway. *Held*, by the Supreme Court of Canada, affirming the judgment of the Supreme Court of Nova Scotia, that as the rail was above the road level, contrary to the requirements of the charter, it was a street obstruction unauthorized by statute, and therefore a nuisance, and the company was liable for the injury to the horse caused thereby.

LONDON STREET RAILWAY CO. V. CITY OF LONDON.—Judgment on appeal by the defendants from the judgment of Falconbridge, J., the trial judge, in favor of the plaintiffs in the action for an injunction to restain interference by the defendants with the construction of a track on a portion of the street railway line operated by the plaintiffs on Dundas street, west of Richmond street, in the city of London, Ont. Appeal allowed, judgment of trial judge set aside, and action dismissed with costs. The court held that the plaintiffs had no right to meddle with the roadway in question, except in so far as they are authorized by the by-law of the defendants, and the agreements ratifying its terms. Under the second clause of the by-law they are entitled to lay a single track at the point in question. Whether they are entitled along with this single track to lay "necessary side tracks, switches, and turnouts" is a matter in dispute which the court does not find it necessary to determine. Having a right to lay a single track and not a double track, they are obliged under the sixth clause of the by-law to lay it in the centre of the street, and as the gauge is fixed at four feet eight and a half inches, each rail of the single track should be two feet four and and a quarter inches, from the centre line of the street. Supposing them entitled to lay down a side track or switch, they must lay it on one side or other of their track, so that, for example, if they lay it down on the north side of their track, the whole south half of the roadway, excepting only two feet four and a half inches adjoining the centre line of the street, will be entirely unobstructed. The plaintiffs, instead of doing this, have laid down double tracks, the inner rail of each track being two feet from the center line of the street, with the result they occupy on each side of the center line of the street a space of at least six feet four and a half inches, besides the width of the rails, and the projecting portion of the ties. It is plain therefore that the plaintiffs, upon their own construction of the by-law, are interfering on one side or the other of the centre line of the street with a strip of the street upward of four feet in width, without any shadow of right. They, in fact, being forbidden to lay down a double track, insist upon their right to proceed to lay down what they call a single track and siding in a form and manner which cannot be distinguished from a double track, and in a form and manner forbidden in the case of a single track and siding. In so proceeding they were wholly without justification, and the defendants, being responsible by law for the condition of the highway, were well within their rights in interfering with the plaintiffs' work, and in restoring the highway to its proper condition.

SPARKS.

An electric railway connecting the villages of Pakenham and Kilburn, Ont., is talked of.

There is said to be under consideration a project for the construction of an electric railway between Belleville and Trenton.

The city of Hamilton received last year in percentage and mileage from the Hamilton Street Railway Company the sum of $12,504.67.

The Winnipeg Electric Street Railway Company is being requested to extend its lines to the thickly settled portions of the adjoining municipalities.

The name of the National Electric Tramway and Lighting Company, of Victoria, B. C., has been changed to the Victoria Electric Railway and Lighting Company.

Mr H. E. Andrews has been appointed president of the Cleveland Street Railway Company as successor to Mr. H. A. Everett, who held the position for two years previously.

The newly elected council of the village of Grimsby is said to be more favorably disposed towards the Hamilton, Grimsby and Beamsville Railway than the Council of 1893

An electric railway agitation is on foot at Cornwall, and it is reported that plans are being prepared with a view of utilizing for this purpose the power from the Moul nette dam.

It is stated to be the intention of the Ruthbun Company, of Deseronto, who are the owners of the Thousand Island Railway between Gananoque and the G. T. R. main line, to operate the road by electricity.

A successful trial trip was made a few days ago over the Park and Island Railway line at Montreal. The tracks are laid on a solid stone foundation, T rails being employed. The St. Jean Baptiste Electric Company furnished the power for the operation of the road Cars considerably larger in size than the ordinary city electric street cars are to be used. It is expected that at the end of the present year forty miles of track will have been constructed.

The Ontario Legislature will be asked to incorporate the Toronto and Suburban Railway Company, with power to acquire the assets and privileges of the City and Suburban Railway Company, Ltd , and the Davenport Street Railway Company, Ltd , and to use paid up stock in payment thereof, to assume the liabilities of these companies, and to have power to acquire other franchises. The capital stock of the company will be $250,000.

Messrs. A. E Carpenter and R. R. Waddell, of Hamilton, who claim to hold a franchise from the Saltfleet Township Council, have taken possession of the only available route upon which an electric railway can be constructed to Hamilton Beach, and have commenced grading operations. In this action they appear to have forestalled the Hamilton, Grimsby and Beamsville Railway Company and the Hamilton Street Railway Company, both of whom had expressed their intention of running a trolley line to the Beach next summer.

At the annual meeting of the shareholders of the London Street Railway Company, held on January 18th, the following gentlemen were elected directors for the ensuing year: H. A Everett, T. H. Smallman, Greene Pack, E. W. Moore, S R. Break. The following officers were also elected H. A. Everett, President; E W Moore, Vice President, S. R. Break, Secretary-Treasurer and General Manager. The annual report for 1893 showed gross earnings to be $52,244 60, being an increase of $13,702 22 over the year 1892. The operating expenses for the same period were $40,696 93, leaving the net revenue $11,557.67, being an increase of $4,175.25 over 1892.

The Toronto Street Railway Company have been experimenting for some time past with the transportation of scavenging material from the city streets to Ashbridge's Bay, special cars being constructed and used for the purpose. The experiment has resulted successfully, and the company have offered to enter into an agreement with the city to carry garbage from any point within the limits of the city at the price of $1.50 per car per round trip, it being provided that the car shall not contain more than 10 tons of material. There are also provisions requiring the city to bear a share of the cost of switches and additional tracks required, and the company are not to be liable for the payment to the city of any percentage on the quoted price or mileage on track extensions. It is proposed that the agreement shall cover a period of ten years with option of renewal.

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.

By Nikola Tesla.

(Continued.)

It is possible that the outer conducting air strata or free space contains an opposite charge and that, together with the earth, they form a condenser of very large capacity. In such case the period of vibration may be very low and an alternating dynamo machine might serve for the purpose of the experiment. I would then transform the current to a potential as high as it would be found possible and connect the ends of the high tension secondary to the ground and to the insulated body. By varying the frequency of the currents and carefully observing the potential of the insulated body and watching for the disturbance at the various neighboring points of the earth's surface resonance might be detected. Should as the majority of scientific men in all probability believe, the period be extremely small, then a dynamo machine would not do, and a proper electrical oscillator would have to be produced, and perhaps it might not to be possible to obtain such rapid vibrations. But whether this be possible or not, and whether the earth contains a charge or not, and whatever may be its period of vibration, it certainly is possible—for of this we have daily evidence—to produce some electrical disturbance sufficiently powerful to be perceptible by suitable instruments at any point of the earth's surface.

Assume that a source of alternating currents S be connected, as in Fig. 21, with one of its terminals to earth (conveniently to the water mains) and with the other to a body of large surface P. When the electric oscillation is set up there will be a movement of electricity in and out of P, and alternating currents will pass through the earth, converging to, or diverging from, the point C where the ground connection is made. In this manner neighboring points on the earth's surface within a certain radius will be disturbed. But the disturbance will diminish with the distance, and the distance at which the effect will still be perceptible will depend on the quantity of electricity set in motion. Since the body P is insulated, in order to displace a considerable quantity the potential of the source must be excessive, since there would limitations as to the surface of P. The conditions might be adjusted so that the generator or source S will set up the same electrical movement as though its circuit were closed. Thus it is certainly practicable to impress an electric vibration at least of a certain low period upon the earth, by means of proper machinery. At what distance such a vibration might be made perceptible can only be conjectured. I have on another occasion considered the question how the earth might behave to electric disturbances. There is no doubt that, since in such an experiment the electrical density at the surface could be but extremely small considering the size of the earth, the air would not act as a very disturbing factor and there would be not much energy lost through the action of the air, which would be the case if the density were great. Theoretically, then, it could not require a great amount of energy to produce a disturbance perceptible at great distance, or even all over the surface of the globe. Now it is quite certain that at any point within a certain radius of the source S a properly adjusted self-induction and capacity device can be set in action by resonance. But not only can this be done, but another source S', Fig. 21 similar to S, or any number of such sources can be set to work in synchronism with the latter and the vibration thus intensified and spread over a large area, or a flow of electricity produced to or from the source S' if the same be of opposite phase to the source S. I think that beyond doubt it is possible to operate electrical devices in a city through the ground or pipe system by resonance from an electrical oscillator located at a central point. But the practical solution of this problem would be of incomparably smaller benefit to man than the realization of the scheme of transmitting intelligence or perhaps power to any distance through the earth or environing medium. If this is at all possible, distance does not mean anything. Proper apparatus must first be produced by means of which the problem can be attacked, and I have devoted much thought to this subject. I am firmly convinced that it can be done and hope that we shall live to see it done.

ON THE LIGHT PHENOMENA PRODUCED BY HIGH-FREQUENCY CURRENTS OF HIGH POTENTIAL, AND GENERAL REMARKS RELATING TO THE SUBJECT.

Returning now to the light effects which it has been the chief object to investigate, it is thought proper to divide these effects into four classes: 1. Incandescence of a solid, 2. Phosphorescence. 3. Incandescence or phosphorescence of a rarefied gas, and 4. Luminosity produced in a gas at ordinary pressure. The first question is, How are these luminous effects produced? In order to answer this question as satisfactorily as I am able to do in the light of accepted views and with the experience acquired, and to add some interest to this demonstration, I shall dwell here upon a feature which I consider of great importance, inasmuch as it promises, besides, to throw a better light upon the nature of most of the phenomena produced by high-frequency electric currents. I have on other occasions pointed out the great importance of the presence of the rarefied gas, or atomic medium in general, around the conductor through which alternate currents of high frequency are passed, as regards the heating of the conductor by the currents. My experiments described some time ago have shown that the higher the frequency and potential difference of the currents, the more important becomes the rarefied gas in which the conductor is immersed, as a factor of the heating. The potential difference, however, is, as I then pointed out, a more important element than the frequency. When both of these are sufficiently high, the heating may be almost entirely due to the presence of the rarefied gas. The experiments to follow will show the importance of the rarefied gas, or generally of gas at ordinary or other pressure as regards the incandescence or other luminous effects produced by currents of this kind.

I take two ordinary 50-volt 16-c. p. lamps which are in every respect alike, with the exception that one has been opened at the top and the air has filled the bulb, while the other is at the ordinary degree of exhaustion of commercial lamps. When I attach the lamp, which is exhausted, to terminal of the secondary of the coil, which I have already used as in experiments illustrated in Fig. 15*a* for instance, and turn on the current, the filament, as you have before seen, comes to high incandescence. When I attach before the second lamp, which is filled with air, instead of the former, the filament still glows, but much less brightly. This experiment illustrates only in part the truth of the statements before made. The importance of the filament's being immersed in rarefied gas is plainly noticeable, but not to such a degree as might be desirable. The reason is that the secondary of this coil is wound for the low tension, having only 150 turns, and the potential difference at the terminals of the lamp is therefore small. Were I to take another coil with many more turns in the secondary, the effect would be increased, since it depends partly on the potential difference, as before remarked. But since the effect likewise depends on the frequency, it may be properly stated that it depends on the time rate of the vibration

Fig. 33

Carbon Deposit in Tube in a Magnetic Field.

of the potential difference. The greater this vibration, the more important becomes the gas as an element of heating. I can produce a much greater rate of vibration in another way, which besides has the advantage of doing away with the objections which might be made in the experiment just shown, even if both the lamps were connected in series or multiple arc to the coil, namely, that in consequence of the reactions existing between the primary and secondary coil the conclusions are rendered uncertain. This result I secure by charging from an ordinary transformer, which is fed from the alternating currents supply station, a battery of condensers, and discharging the latter directly through a circuit of small self- induction, as before illustrated in Figs, 19a, 19b, 19c.

In Fig. 22a, 22b and 22c the heavy copper bars B, B1 are connected to the opposite coating of a battery of condensers, or generally in such a way that the high frequency or sudden discharges are made to traverse them. I connect first an ordinary 50-volt incandescent lamp to the bars by means of the clamps c, c. The discharges being passed through the lamp, the filament is rendered incandescent, though the current through it is very small, and would not be nearly sufficient to produce a visible effect under the conditions of ordinary use of the lamp. Instead of this I now attach to the bars another lamp exactly like the first, but with the seal broken off, the bulb being therefore filled with air at ordinary pressure. When the discharges are directed through the filament, as before, it does not become incandescent. But the result might still be attributed to one of the many possible reactions. I therefore connect both the lamps in multiple arc as illustrated in Fig. 22a. Passing the discharges through both the lamps, again the filament in the exhausted lamp I glows very brightly, while that in the non-exhausted lamp I1 remains dark, as previously. But it should not be thought that the latter lamp is taking only a small fraction of the energy supplied to both the lamps; on the contrary it may consume a considerable portion of the energy, and it may become even hotter than the one which burns brightly.

(To be Continued.)

TRADE NOTES.

The Canada Vinegar Works have just placed in their factory a Kay dynamo.

The Worsted and Braid Co., Toronto Junction, have installed a Kay dynamo.

A. R. Woodyat & Co., of Guelph, have placed in their plating rooms a Kay electric plating machine.

Wm. Buck, stove founder, Brantford, has just installed in his plating room a new Kay electric plating machine.

The Kay Electric Works have just installed a 400 light incandescent plant for Thos Eagen, of Tottenham.

The Kay Electric Works have installed an electric plant in J Hooper's blacksmith and machine shop in Guelph.

The reader who wishes to enjoy a good laugh should turn to the advertisement in this issue of the Packard Lamp Co

The Acme Silver Company, of Toronto, have added to their extensive plant a Kay electro plating machine of large capacity

The towns of Dundas, Ont., and East Toronto, Ont., have awarded contracts for fire alarm systems to Messrs. T. W. Ness & Co., of Montreal and Toronto.

The Curtain and Upholstery factory of Guelph have just installed a Kay motor of 15 h. p. and are going extensively into this line of manufacture.

Messrs. John T. Cassidy and Albert William Bonner have formed a partnership in Montreal to manufacture leather belting, the firm name being Cassidy, Bonner & Co.

The Eugene Phillips Electrical Works, of Montreal, have secured the order for the wire required in the construction of the Hamilton, Grimsby and Beamsville Electric Railway.

The Roman Catholic Church of Stratford have just rebuilt their organ, and are now running it by electricity, motor and attachments supplied and set up by the Kay Electric Works, of Hamilton.

The Montreal Park and Island Railway Company are operating nine miles of line between Montreal and Sault au Recollet. Three double truck cars are used, equipped with the Westinghouse system by Messrs. Ahearn & Soper, of Ottawa.

The Canadian Locomotive and Engine Company, of Kingston, have obtained the contract, in competition with American firms, for the construction of two large locomotive engines required for use on the Intercolonial Railway. Each engine will have ten driving wheels.

At the factory of T. W. Ness & Co., Montreal, they are now making a specialty of changing crystal and other gas fixtures into electric, and have recently done considerable in this line in connection with their contracts for Henry Mussen, C. G Hope, John Hope and F L. Wanklyn.

The contract for eleven cars required for the equipment of the Hamilton, Grimsby and Beamsville Electric Railway has been awarded to Messrs. Ahearn & Soper, of Ottawa. It is expected that the line will be in operation between Hamilton and Grimsby Park by the first of July next.

The Kay Electric Works, in conjunction with Leitch & Turnbull, elevator manufacturers, of Hamilton, have installed in J Hoodless & Co.'s extensive warehouse an electric elevator, its simplicity of construction, neatness of design and solidity of every part should commend it to any one needing a machine of this kind.

At the General Electric Company's workshops at Peterboro', Ont., there has just been completed an electric snow plow for the Kingston Electric Street Railway. It is 21 feet long by 6 feet wide, and propelled by two 25 h. p. single reduction motors.

Messrs. Robin & Sadler, manufacturers of leather belting, Montreal and Toronto, have sent out a card wishing their customers the compliments of the season, and stating that notwithstanding the keenest competition, they have secured an ample share of orders during the year which has just closed, while at the same time maintaining their reputation for first-class workmanship

The following letter by Mr. L. H. Reesor, proprietor of the St. Mary's Electric Light and Power Company, to the Dodge Wood Split Pulley Co., of Toronto, is a sample of many letters received by the Dodge people in praise of their new and improved dynamo pulley: "Enclosed find money order for $7.50, being amount of account for dynamo pulleys. The pulleys are giving excellent satisfaction."

Sales of Reliance motors have recently been made by T. W. Ness & Co. as follows: Messrs. P. D. Dods & Co., of the Island City Paint Works, dynamo for lighting, Waters Bros., printers, Montreal, motor; H. P. Labelle & Co., furniture manufacturers, Montreal, dynamo; G. H. Harrower, Novelty Stamp Co., Kerr & Morgan, Christian Bros., John Burns, H. H. Thurston, Montreal Show Case Co. and the Montreal Dress Stay Co., motors.

Messrs. T. W. Ness & Co., Montreal, have recently installed private telephone systems for the following firms: Messrs. W. J. Gage & Co., Warwick Sons & Rutter, and Brough & Caswell, Toronto, Grafton & Co., Dundas, the Central Prison, Toronto, Messrs. P. Green, Sons & Co. and the Sabiston Litho. Co. (using the new patented automatic switch telephone), Thompson & Co., Craig St., Montreal; Canada Life Assurance Co., Hamilton: Christie, Brown & Co., Toronto.

Messrs. T. W. Ness & Co., Montreal, have recently filled wiring contracts as follows: The new residences of Messrs. R. B Angus, Duncan McIntyre, Henry Husson, and the manager of the Bank of Montreal; also the Protestant Orphan Asylum, new Bank of Toronto building, corner St. James and McGill streets, Montreal; M. Lefebvre & Co.'s beet root sugar factory, Berthierville, Que.; the new Beard estate building on Jarvis street, Toronto; Messrs. M. Moody & Sons, of Terrebonne, Que.; St. Andrew's Church, Carleton Place, Ont.

The Vankleek Hill Electric Light Company, the capital stock of which has just been increased to $10,000, have recently completed a new power station in which has been installed a 60 h. p. engine, three large dynames and a power generator. The company has already received numerous applications for power.

The Bell Telephone Company are rapidly removing their poles and wires from the streets of Toronto and placing them underground, and at the present rate of progress it is probable that the whole of the company's system will have gone underground prior to the expiration of the time stated by its agreement with the city for the completion of the work. Three-fourths of the telephones are connected with metallic circuits. Last year there were added to the company's list of subscribers, 350 names.

SPARKS.

It is reported that next summer telephone lines are to be established throughout Manitoulin Island.

An employee of the electric light station at Harriston, Ont., named Thamas Davy, was recently killed while alone with the machinery, by being caught in the shafting.

Mr. George Morgan, of Sarnia, has recently purchased the large waggon and carriage works belonging to the Lowrie estate, with the purpose, it is said, of establishing electric works.

Severe damage was done to the wires of the telegraph, telephone, and electric light companies by a wind and snow storm which passed over the city of Winnipeg on the 11th of January.

By the bursting of an armature in the electric power station at Orillia, Ont., the engineer in charge, Mr. Ritchie, narrowly escaped losing his life, while the town was temporarily shrouded in darkness.

As the result of a dispute between the Council of the city of Three Rivers and the Royal Electric Company, over the character of the plant supplied by the latter to the corporation, the company have given notice of their intention to shut down the lighting station.

A local paper states that the Royal Electric Company have submitted to the town council of Aurora, a proposition to light the streets, business places and residences (where required), at a flat rate of 2½ cents per 16 c. p. lamp per night, light to be furnished every night in the year, from dusk until midnight.

Mr. James Ross, of the Montreal Street Railway Company, accompanied by Mr. F. L. Wanklin, one of the company's engineers, lately made a visit of inspection to a number of American street railway power stations with the object of becoming acquainted with the most improved methods of equipment.

The water power which is being developed by the Keewatin and Rat Portage Power Company is stated to be the greatest on the continent. The company propose to spend a quarter of a million dollars for the utilization of this power, the purpose being to furnish power to the towns of Keewatin and Rat Portage.

Messrs. Conroy Bros. propose to utilize electric cars operated by storage batteries to draw wet lumber and refuse from their saw mills at Deschenes, Que., through the piling grounds. It is also said to be the intention of the firm to install a dynamo from which to supply current for lighting the streets of the town of Aylmer, Que.

Experiments have lately been conducted at the waterworks pumping station at Toronto Junction with the purpose of deciding the relative economy of hard coal versus screenings as fuel. It has been decided to purchase a blower and use screenings. It is claimed that by this method a saving of $2 per day can be effected.

The annual election of officers of the Canadian Marine Engineers' Association took place on January 24th, and resulted as follows: President, O. P. St. John, ex-Government Steamboat Inspector (elected by acclamation); 1st Vice-President, J. C. McFadden; 2nd Vice-President, E. O. Dell, Council, J. F. Corrin, D. L. Foley, J. D. Banks, Thos Good, J. S. Adam; Treasurer, J. H. Ellis (elected by acclamation), Secretary, F. E. Smith (elected by acclamation); Auditors, S. Gillespie J. A. Findlay; Inside Guard, J. Hopkins.

SPARKS.

Letters patent have been issued increasing the capital stock of the Vankleek Hill Electric Company, Ltd., from $3,000 to $10,000

At a recent meeting of Toronto Association No. 1, C. A. S. E., a badge and button to be worn by the members was adopted

The annual meeting of the shareholders of the Niagara Falls Park and River Railway Company will be held at the office of the company, No 18 King Street West, Toronto, on Tuesday, the 6th inst., at noon.

The company who have undertaken the development of electric power on the Canadian side of the Niagara Falls are said to have agreed to be in a position to deliver on the first of November, 1898, 25,000 horse power.

The Toronto Railway Company have been negotiating with the Siemens-Halske Company, of Chicago, with a view to the purchase of the 5,000 h. p. engine exhibited at the World's Fair, and especially designed for electric purposes.

Mr. H. G. Hunt, of St. Catharines, has in his possession a receipt for a payment of five shares of capital stock in the Toronto, Hamilton and Niagara Electric Magnetic Telegraphic Company. The receipt is dated the 18th of January, 1847.

It is said to be the intention of the executive committee of the Street Railway Men's Union of Toronto to issue a call for a convention of employees of the different street railway companies throughout Canada, with the object of establishing a federation of the various local unions, and of regulating the hours of labor and arranging a scale of wages.

THOMAS AHEARN. WARREN Y. SOPER.

Contracting Electrical Engineers

✠ ✠ ✠

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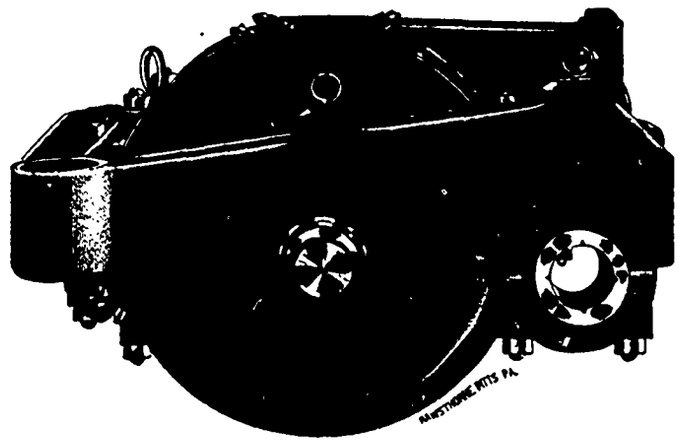

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Railway Managers who have had practical experience with our Motors and Generators pronounce them the **Best in the Market.** They embody all the requirements demanded by electric railway practice.

Efficiency, Durability, Easy Operation,

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and Perfect Mechanical and Electrical Construction.

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