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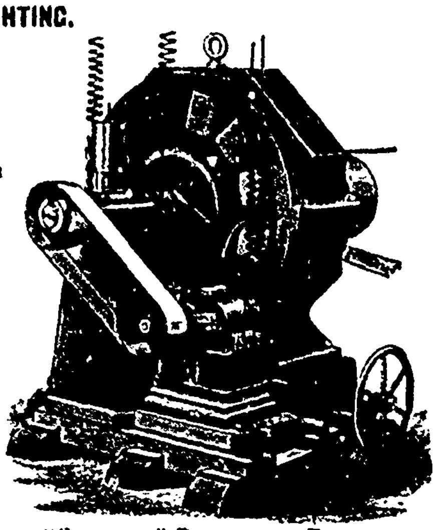

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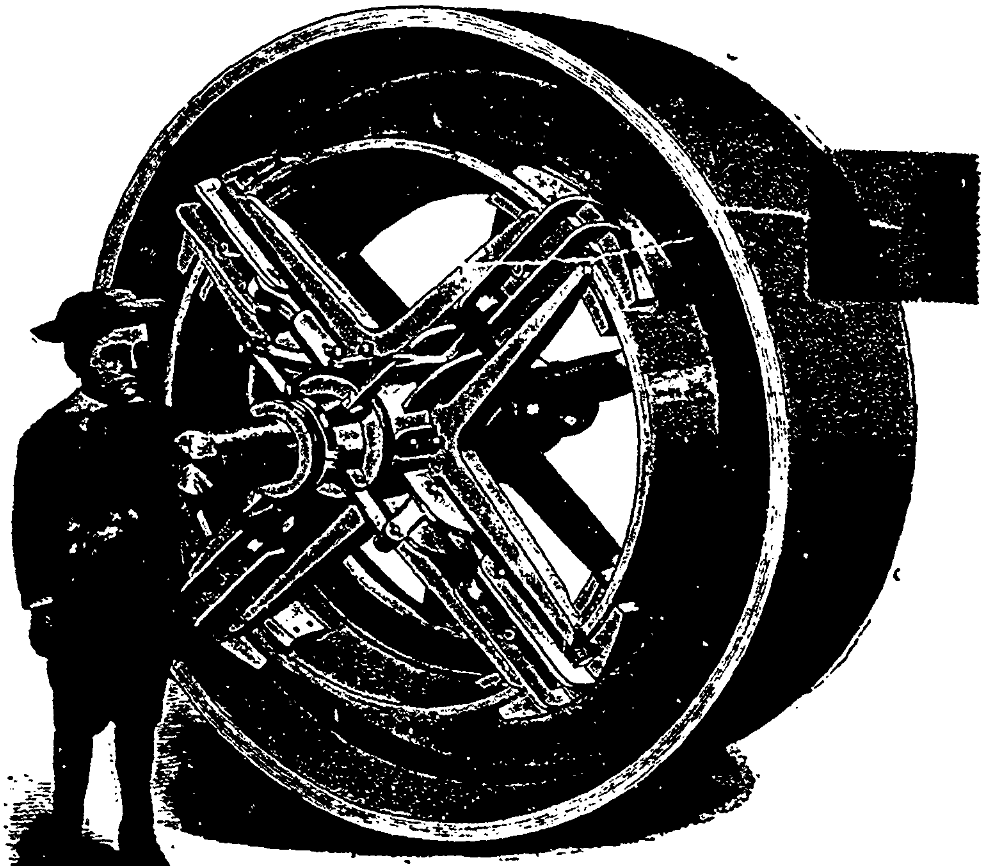

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OFFICE OF

THOMSON-HOUSTON INTERNATIONAL ELECTRIC COMPANY,

BOSTON, MASS.

BOSTON, November 2, 1891.

DEAR SIR:

We beg to inform you that we have appointed the **TORONTO CONSTRUCTION & ELECTRICAL SUPPLY COMPANY, LIMITED,** of Toronto, Ontario, our exclusive selling agents for the Dominion of Canada.

The Toronto Company have their main offices and show rooms at 63-69 Front Street, Toronto, where may be seen a specimen line of our apparatus, consisting of Dynamos for Arc Lighting of the celebrated WOOD SYSTEM, which we exclusively control for the Canadian territory, Dynamos and Transformers for Alternating-Current Lighting, Dynamos for Direct-Current Lighting, Reciprocating Rock Drills, Pumps, and other Mining Machinery, the Thomson Recording Watt Meter, now extensively used on the circuits of all Systems of Lighting and Power, and also a full line of the supply material manufactured or dealt in by this Company.

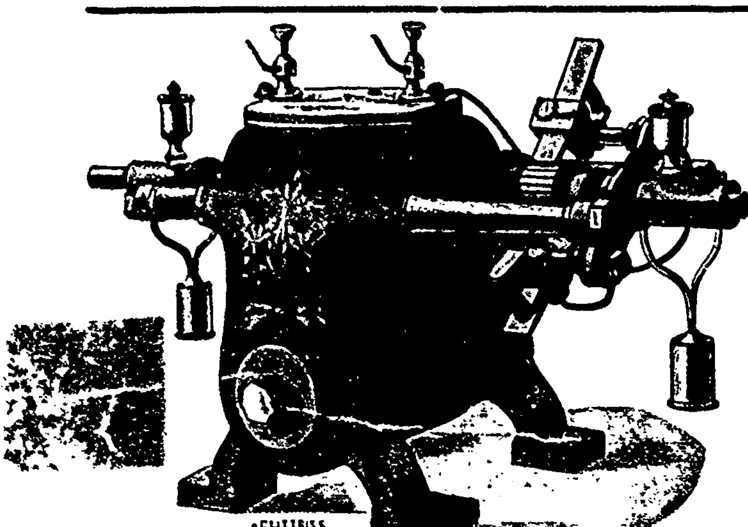
In referring you to the Toronto Company, we can assure you at their hands most courteous treatment and the fullest attention to your requirements.

They will have a competent corps of engineers in their employ thoroughly conversant with our Systems, and will be prepared to make studies and undertake engineering work for central station or isolated lighting, street railways, and mining work.

Thanking you for the courtesies we have received at your hands in the past, and bespeaking the same for our new representatives in the future, we remain,

Yours faithfully,

THOMSON-HOUSTON INTERNATIONAL ELECTRIC CO.



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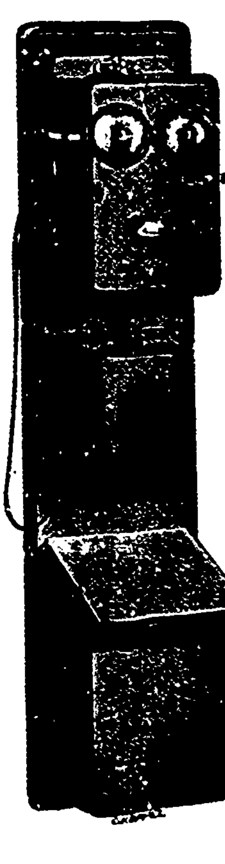

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CANADIAN

ELECTRICAL NEWS

AND

STEAM ENGINEERING JOURNAL.

VOL. I. TORONTO AND MONTREAL, CANADA, DECEMBER, 1891. No. 12.

THE WINDSOR AND SANDWICH ELECTRIC RAILWAY.

IN a recent issue of the ELECTRICAL NEWS brief reference was made to the completion of the above enterprise. By the courtesy of the manager, Mr. Willis C. Turner, we are now enabled to present to our readers a description and illustrations of the road.

The company consists of Mr. James M. Clarke, president; Carl. E. Warner, secretary-treasurer, Willis C Turner, superintendent of construction and manager.

The company was organized as above, and the construction of the Sandwich branch commenced on May 1st of the present year. On August 17th the work on this branch was completed, and a satisfactory trial trip was made.

The power house is situated on London street and adjacent to the Michigan Central Railway bridge. It is of brick and cut stone, with steel trussed supports and corrugated iron roof, erected at the cost of $12,000. Its dimensions are 147 x 50 feet, divided into two portions. The boiler room at the rear is on the level of the Michigan Central Railway, and connected therewith by a side track for the purpose of carrying coal for the use of the company. The main floor is occupied by the engines and dynamos, and is 80 x 50 feet, while the second story is used as a car storage room. This latter has four tracks 110 feet long, capable of holding ten cars. The steam plant is from the works of the Polson Iron Works Company, Toronto, Ont., and comprises two steel tubular boilers, 60 inches in diameter and 16 feet long, and one Crown automatic engine, 200 horse-power.

WINDSOR AND SANDWICH ELECTRIC RAILWAY.

The Westinghouse Electric Company, of Pittsburg, Pa., supplied the electric plant used in operating the road. The dynamo is of 100 horse-power and capable of operating twelve cars. There are also eight 20 horse-power single reduction street railway motors, the gearing of which is sealed in a heavy iron case filled with a heavy grade of oil which prevents any noise and reduces the wearing of the gear to a minimum.

The present track consists of one and a quarter miles of fifty-two pound girder rails, and four and a half miles of thirty-five pound "T" rails, the whole constructed on heavy oak ties. The girder rails are used upon the paved streets, and by agreement with the council, as fast as the streets are paved the "T" rails are to be torn up and girder rails substituted. The road in operation to-day is the Sandwich branch and the extension to Wyandotte street. The Sandwich street and Dougall avenue loop and the Wyandotte street branch to Walkerville are not yet under way, although the franchises have been obtained. These portions will be pushed to completion with all possible speed.

The difficulty experienced by many roads in maintaining the contact between the trolley and the overhead wire, has been obviated by a new wire fixture invented by Mr. Turner. All connections with the overhead wire are planned by Mr. Turner and made in Walkerville. For the overhead wire six miles of No. 0 hard drawn copper wire is used.

The rolling stock consists of six closed palace cars, two double motors, four single motors and four open cars, manufactured by the Laclede Car Company, St. Louis, and finished in natural cherry and linden. Each closed car is fitted up with cushioned seats, bevelled mirrors and electric lights. These latter are incandescent, and five in number, three being in the centre of the car and one at each end outside. There are also two oil lamps, should anything go wrong with the electric light. The company is constructing freight cars to operate between Sandwich and Windsor, and Walkerville and Windsor.

It is stated that since the new road commenced operations the traffic has doubled. The town of Amherstburg is negotiating with the company to build a similar road for that place, and connect it with the Windsor road by means of a steam railway. Another result is the formation of syndicates for the purpose of improving property along the river.

In short, the results are those which usually follow in the wake of electric traction. The company are worthy of the highest commendation for the enterprise and energy which they have displayed in connection with this undertaking. It is sincerely hoped that they will receive satisfactory reward, and that in many other towns and cities in Canada the electric street railway will be given the opportunity to prove its advantages.

TORONTO BRANCH NO. 1, C. A. S. E.

AT the last regular meeting, which was well attended, the president, Mr. A. E. Edkins, asked the members to accept his resignation owing to the fact that when he entered upon his duties with the Boiler Insurance & Inspection Co., about December 1st, he would necessarily be absent from the city much of the time. Many of them expressed a wish that the president would remain in office until the end of his present term. Finally the Association decided not to accept the resignation.

During the evening considerable discussion took place on the theory and weight of fly wheels, the number, size and strength of cylinder head studs for different diameters of cylinders, &c. A very profitable evening was spent, and when the meeting adjourned at 10.30 there were several questions in the box, which were left over until next meeting night.

Two propositions for membership were received.

EXCHANGE OF IDEAS, CERTIFICATES, ETC.

Editor CANADIAN ELECTRICAL NEWS.

DEAR SIR,—As a subscriber to the NEWS from its first issue, I take the liberty to say a few words in regard to the "Questions and Answers" column. I have seen with surprise how little it is made use of by engineers. Every day engineers meet with problems on which they require information; if they would only jot them down and send them to the NEWS, every engineer among your readers would be benefited as well as the one asking the questions. Every day engineers are looking for formulas which they cannot find. Most of us are unable to buy every book that comes out, and lack time to look around for what we need. The only way to secure it is to write to a mechanical paper such as the NEWS.

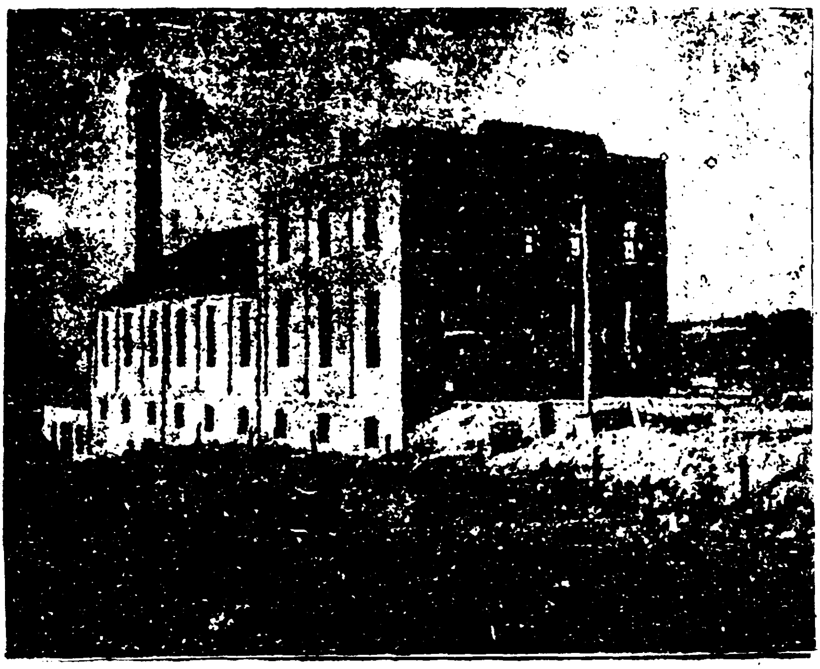
When we had no paper printed in the interest of engineering in Canada, engineers were wont to say that they did not care to write to journals on the other side, but would write if they had a paper published here. Now that we have such a paper, it is a shame that more interest is not taken in it. If every one would lend a hand to help to build up the paper, assist to make it of interest to all engineers, to widen its circulation and to fill its columns, we would have a paper that would be of inestimable value to us.

I would also like to say a few words, if I am not taking up too much of your valuable space, on the subject of certificates. The engineers have always been clamoring for a licence law, and now that we have one, and can get certificates, the men who did the most talking are the most backward in coming up for a certificate. Certainly we are not compelled to get a certificate, as the law is not compulsory, but that is all the more reason for getting one, as under such circumstances it is an honor to hold one.

I believe we will have a compulsory law in the near future. It is what we want, and what the country needs, but if we do not take advantage of the law as it stands, it will never be made compulsory. Let every engineer go up for examination and get as good a certificate as he can and as good as he deserves; it will be better for us all in the near future.

Yours, in the interest of engineers,

E. J. P.



POWER HOUSE AND CAR STATION, WINDSOR AND SANDWICH ELECTRIC RAILWAY.

RESOLUTION OF CONDOLENCE.

43 Brant St., TORONTO, Nov. 24th, 1891.

Editor ELECTRICAL NEWS.

SIR,—At a regular meeting of Toronto No. 1, C.A.S.E., held Nov. 13th, the following resolutions were unanimously adopted.

"Whereas it has pleased an all wise Providence to remove from our midst, Sarah, beloved daughter of Brother F. Bills, therefore be it

"*Resolved*—that this Association tender its heartfelt sympathy to the bereaved father and mother in this their sad hour of affliction, and be it

"*Resolved*—that this resolution be spread on the minutes of this Association, and that a copy be sent to Brother and Mrs. Bills, and to the ELECTRICAL NEWS AND STEAM ENGINEERING JOURNAL.

W. G. BLACKGROVE,
J. A. WILLS,
G. MOORING.
} Committee.

A GOOD SUGGESTION.

PERHAPS the following suggestion may be of use to some who have the care of water power. It is given to the *Wood-Worker* by Mr. Gardner Morse, Eaton, N. Y., who writes:

Something more than six years ago, I was aroused about midnight, by the announcement that the creek was very high, that it was raining furiously; a dam above had given way, and it would be impossible to save my dyke and dam. I found the water rising rapidly, and that every effort to stop the break in the dyke with stones, plank and sod had proved useless. A big washout seemed inevitable, and that great damage would be done to the village below. By one of those inspirations that will sometimes come in great emergencies, I remembered the plan pursued to protect the levee of the Mississippi. I hurried a man off for all the grain bags that could be found. These were rapidly filled with sand and piled upon the break and weak places. In an hour the danger was over and no great damage done.

Again: A few weeks ago I was making some repairs in my dam, and found great difficulty in holding back the water long enough to do the work. The sandbags were once more resorted to, and they made a cheap and effective coffer dam.

These hints may help someone on a dark, stormy night, where high water has almost got the mastery, and only the most prompt and vigilant measures will avert a catastrophe.

PERSONAL.

Mr. P. G. Leigh, manager of the Kingston Locomotive & Engine Co.'s works, was married on the 28th of Oct. to Miss Maud Wilson. Mr. Leigh and his bride spent their honeymoon in Boston.

Col. C. F. Sise, of Montreal, President, and Mr. Chas. Brown, Superintendent of the Bell Telephone Co. of Canada, and Mr. W. J. Morrison, agent of the Fort Wayne Electric Co., were visitors to New York last month.

Kingston will have an All-night electric light service after January 1.

CANADIAN ELECTRICAL ASSOCIATION.

A MEETING of persons interested in the formation of a Canadian Electrical Association, to receive the report of the Committee on Organization appointed by the meeting held in September last, convened in the Auditorium building, Queen street west, Toronto, at 10.30 o'clock on Thursday, Nov. 26th.

The following persons were present:-

E. S. Edmonson, Electric Light Co., Oshawa, Ont.; W. A. Johnson, manager Ball Electric Light Co.; Frederic Nicholls, manager Toronto Incandescent E. L. Co., James Corbett, electrician, Hugh Neilson, K. J. Dunstan, Bell Telephone Co., John Galt, C.E., Hy. S. Thornberry, J. J. Wright, manager Toronto Electric Light Co., C. H. Mortimer, Toronto; T. W. Whiting, John Yule, Guelph; A. A. Wright, Renfrew; H. O. Fisk, J. W. Taylor, manager Brooks Mfg. Co., Peterboro'; D. Thomson, manager Electric Light & Power Co., Thos. H. Wadland, B. J. Throop, Bell Telephone Co., S. Douglas, Kay Electric Works, Hamilton; H. Powell, Woodstock; John Carroll, Sec.-Treas. Eugene Phillips Electrical Works, Montreal.

On motion Mr. J. J. Wright was called on to preside, and Mr. C. H. Mortimer to act as secretary.

Letters regretting their inability to be present and expressive of hearty sympathy with the objects of the meeting were read from Mr. W. G. Fraser, Petrolea; Mr. Geo. J. Thomas, local manager Bell Telephone Co., Essex, Ont.; Mr. C. E. Harris, general manager Bell Telephone Co., Halifax, N. S.; Mr. H. Brown, manager St. Thomas Gas and Electric Light Co., and Mr. W. J. Gilmour, local manager Bell Telephone Co., Brockville Ont.

The Chairman remarked that the first business would be consideration of the report of the Committee on Organization, which was accordingly read by the secretary.

The recommendations contained in the report are as follows

"That this organization shall be named the 'Canadian Electrical Association.'

"That the object of this Association shall be to foster and encourage the science of electricity and promote the interests of those engaged in any electrical enterprise.

"That the Association consist of active and associate members, the former to include all persons actively engaged in electrical business, and who shall be entitled to vote at all meetings of the Association, and the latter those interested or actively engaged in any electrical pursuit, and who shall be entitled to attend all meetings except those of the executive, and take part in all discussions, but shall not be entitled to vote or be eligible to office.

"That honorary members may be elected by a two-thirds vote of the Association.

"That the officers shall consist of a president, 2 vice-presidents, secretary-treasurer, who may be one person, and an executive committee consisting of nine members, together with the president and vice-presidents, five of whom shall form a quorum.

"That the fees shall be, for active members, $5, associate members, $2, payable in advance.

"All officers and the executive committee shall be elected by ballot at the annual meeting of the Association, and shall hold office until the close of the meeting at which their successors are elected.

"Vacancies in offices shall be filled by the executive committee to cover the term until the next annual meeting of the Association.

"Todd's Parliamentary Practice shall be the governing parliamentary law of the Association in all cases not definitely provided for by its constitution or its own rules.

"Voting by proxy shall not be allowed at any meeting of the Association or at any of its committees, except for the purposes of the election of officers.

"Amendments to this constitution shall be offered in writing and shall be referred before being voted upon to a committee to be elected by the Association. A two-thirds vote of all active members present shall be necessary for their adoption.

"No amendment shall be voted upon by the Association at the convention in which it is introduced except by a two-thirds vote of active members present.

"Ten members of this Association shall be a quorum for the transaction of business."

It was decided that the report should be considered clause by clause.

The clauses defining the name and objects of the Association were adopted without discussion. A variety of opinions were, however, expressed concerning the recommendation to divide the membership into two classes, and also regarding the qualification for active and associate members.

Mr. Thomson moved that each company be entitled to one vote.

Mr. Dunstan, Mr. Neilson and others pointed out that the result of adopting this motion would be to place the Bell Telephone Co., and the G.N.W. and C.P.R. Telegraph Companies, so far as voting power was concerned, on a level with the smallest electric light company in the country.

The feeling of the meeting was adverse to the resolution. It was decided that the voting power should be vested in individuals only.

To remove the misunderstanding which appeared to exist in the minds of some regarding the qualification for active and associate members, it was pointed out by the chairman and secretary that any person who might choose could become an active member by paying the necessary fee. It was agreed that the Executive Committee should be delegated the duty of deciding to which class applicants for membership should belong.

Mr. Carroll raised the question as to the sufficiency of the proposed fees to meet the financial requirements of the Association. It was thought best, not to increase the fees, the desire being to found the organization on lines as broad and liberal as possible, in order that no barrier might be placed in the way of persons desiring to become members.

Mr. Neillson saw an objection to the name which had been selected for the society. He thought a "Canadian Electrical Association" should be composed of electricians. He feared that in this organization the business element might in time become predominant and electrical interests a secondary consideration. He suggested that it might be well to change the name to the "Business Men's Association."

Mr. Johnston in reply pointed out that the aim should be to take in and promote the interests of the electrical business in all its branches, and that if deemed advisable, the different branches could be represented in the Association by sections, as in the case of the Society of Civil Engineers and other institutions of similar character.

This view was concurred in by the majority of those present, who were of opinion that the Association would only be likely to prosper in proportion as it was designed to subserve and harmonize the various electrical interests.

The report of the Committee on Organization, with slight amendment, was adopted.

A code of by-laws was also adopted.

The election of officers was next proceeded with.

Mr. Nicholls moved that Mr. J. J. Wright be the president.

The chairman suggested the name of Mr. S. R. Parker, of Owen Sound, as being a person well adapted for the position. The opinion of the meeting was, however, that the interests of the Association would be best served for the present by the election of a resident of Toronto. The election of Mr. Wright was therefore made unanimous.

On motion of Mr. Carroll, Mr. Dunstan was elected first vice-president.

On motion of Mr. Thornberry, Mr. Carroll was elected second vice-president.

On motion of Mr. Dunstan, C. H. Mortimer was elected secretary-treasurer.

The following gentlemen were elected to compose the Executive Committee: Messrs. Wright, (Renfrew); Yule, Edmonson, Parker, A. B. Smith, Thomson, Johnson, Fisk, Waddell.

On motion of Mr. Dunstan, seconded by Mr. Carroll, it was resolved that all fees paid before 1st June, 1892, shall be in full to 31st May, 1893.

It was resolved on motion of Mr. Carroll, seconded by Mr. Thomson, that the first annual meeting of the Association shall be held in the city of Hamilton on the second Tuesday in June, the time and place to be fixed by the Executive Committee.

The meeting then adjourned.

The Executive Committee subsequently met, and disposed of some preliminary business.

Mr. N. W. Rolt, local manager of the Edison company at Winnipeg, Man., has been transferred to the Toronto offices.

The Edmonton Electric Lighting & Power Co., Ltd., has been incorporated by letters patent to furnish the incandescent light at Edmonton, N.W.T. Capital stock, $10,000, all subscribed. The company has contracted with the Royal Electric Co., of Montreal, to put in a [illegible] plant, the lights to be turned on Nov. 30th.

SAFE ELECTRIC WIRING.

The following recommendations are contained in a report presented at the recent electrical convention in Montreal by the Committee appointed to consider safe methods of wiring and operation of electric light apparatus :

ARC (SERIES) SYSTEMS.

INTERIOR CONDUCTORS.

ALL INTERIOR CONDUCTORS—Must be :

1. Where they enter buildings from outside terminal insulators to and through the walls covered with waterproof insulation, and must have drip loops outside, preferably slanting upward toward the inside and bushed with waterproof and non-combustible insulating tube.

2. Arranged to enter and leave the building through a double contact service switch, which will effectually close the main circuit and disconnect the interior wires when it is turned "off." The switch must be so constructed that it shall be automatic in its action, not stopping between points when started, and prevent an arc between the points under all circumstances ; it must indicate on inspection whether the current be "on" or "off," and be mounted on a non-combustible base in a position where it can be kept free from moisture, and easy of access to police or firemen.

3. Always in plain sight, never covered, except in special cases where an armored tube may be necessary.

4. Covered in all cases with a waterproof non-combustible material that will adhere to the wire, not fray by friction, and bear a temperature of 150 degrees F. without softening.

5. *In dry places, kept rigidly apart* at least ten inches, except when covered (in addition to insulation) by a waterproof, non-conducting and *non-inflammable* tubing which must be strong enough to protect the insulating covering from injury. Conductors thus placed may be run not less than three inches apart, and be fastened with staples, under which are placed mechanically rigid insulating strips or saddles of greater width than the metal of the staple, by which *possibility of injury to the tube may be prevented.*

6. In damp places, attached to glass or porcelain insulators and separated ten inches or more.

7. When passing through walls, floors, timbers or partitions treated as in central stations under like conditions.

LAMPS AND OTHER DEVICES.

ARC LAMPS—Must be in every case :

1. Carefully isolated from inflammable material.

2. Provided at all times with a glass globe surrounding the arc, securely fastened upon a closed base. No broken or cracked globes may be used.

3. *Provided with a hand switch, also an automatic switch,* that will shunt the current around the carbons should they fail to feed properly.

4. *Provided with reliable stops to prevent carbons from falling out in case the clamps become loose.*

5. Carefully insulated from the circuit in all their exposed parts.

6. Where inflammable material is near or under the lamps, provided with a wire netting around the globe and a spark-arrester *above, to prevent* escape of sparks, melted copper or carbon.

Incandescent lamps in series circuits having a maximum potential of 350 volts or over, must be governed by the same rules as for arc lights, and each series lamp provided with a hand switch and automatic cut-out switch; when lights are in multiple series, such switches and cut-outs must not control less than a single group of lights. Electromagnetic devices for switches are not approved.

Under no circumstances will incandescent lamps on series circuits be allowed to be attached to gas fixtures.

INCANDESCENT (LOW PRESSURE) SYSTEMS.

300 volts or less.

OVERHEAD CONDUCTORS.

OUTSIDE OVERHEAD CONDUCTORS—Must be :

1. Erected in accordance with general rules for arc (series) circuit conductors.

2. Separated not less than six inches, where they enter buildings as service conductors, and be provided with a double pole fusible cut-out, as near as possible to the point of entrance to the building, and outside the walls when practicable.

UNDERGROUND CONDUCTORS.

UNDERGROUND CONDUCTORS—Must be :

1. Provided with suitable protecting devices at the ends of tube or conduit services inside the walls of buildings, as a guard against moisture and injury.

2. Terminated at a properly placed double pole house cut-out.

3. Of specially insulated conductors after leaving the tube or conduit, and separated by at least 10 inches, until the double pole cut-out is reached.

INSIDE WIRING.

Wire should be so placed that in the event of the failure or deterioration of their insulating covering the conductors will still remain insulated.

At the entrance of every building there shall be a double pole switch placed in the service conductors, whereby the current may be entirely cut off.

CONDUCTORS—Must not be :

1. Of sizes smaller than No. 16 B. & S., No. 18 B.W.G., or No. 3 E.S.G.

2. Lead or paraffine covered.

3. Covered with soft rubber tube.

4. Laid in moldings of any kind in damp places.

5. Laid in moldings with open grooves against the wall or ceiling.

6. Laid in moldings where less than half an inch of solid insulation is between parallel wire, and between wires and walls or ceilings.

CLEATWORK is not desirable, and cleats must *not* be used unless—

1. In a very dry place.

2. In a place perfectly open for inspection at any time.

3. They are of porcelain, or well seasoned wood, filled, to prevent absorption of moisture.

4. They are so arranged that *wires of opposite polarity, with a difference of potential of 150 volts or less,* will be kept at least two and one-half inches apart, and that where a higher voltage is used, this distance be increased proportionately.

5. There is a backing provided of wood at least half an inch thick, well seasoned and filled to prevent absorption of moisture.

METAL STAPLES must never be used to fasten conductors unless

1. Provided with an insulating sleeve or saddle rigidly attached to the metal of the staple, and having such strength and surface as to prevent mechanical injury to the insulation of the conductor.

2. Under conditions in which cleatwork would be acceptable or where driven into a molding specially adapted for open work.

SPECIAL WIRING.

Wherever conductors cross gas, water, or other metallic pipes, or any other conductors or conducting material (except arc light wires), they should be separated therefrom by some continuous non-conductor at least one inch. In crossing arc light wires the low-tension conductors must be placed at a distance of at least six inches. In wet places an air space must be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run *over* all pipes upon which condensed moisture is likely to gather, or which by leakage might cause trouble on a circuit.

In breweries, stables, dye-houses, paper and pulp mills, or other buildings specially liable to moisture, all conductors, except where used for pendants, must be :

1. Separated at least six inches.

2. Carefully put up.

3. Supported by porcelain or glass insulators.

Moisture proof and non-inflammable tubing may be accepted in lieu of such construction.

No switches or fusible cut-outs will be allowed in such places.

INTERIOR CONDUITS—Must not be :

1. Combustible.

2. Of such material as will be injured or destroyed by plaster or cement, or of such material as will injure the insulation of the conductor, or construction that the insulation of the conductor will ultimately be injured or destroyed by the elements of the composition.

3. So constructed or placed that difficulty will be experienced in removing or replacing the conductors.

4. Subject to mechanical injury by saws, chisels or nails.

5. Supplied with a twin conductor in a single tube where a current of more than 10 ampères is expected.

6. Depended upon for insulation. The conductors must be covered with moisture proof material.

The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury and as far as possible from moisture.

Twin tube conductors must not be separated from each other by rubber or similar material, but by cotton or other readily carbonizable substance.

Conductors passing through walls or ceilings must be encased in a suitable tubing, which must extend at least one inch beyond the finished surface until the mortar or other similar material be entirely dry, when the projection may be reduced to half an inch.

DOUBLE POLE SAFETY CUT-OUTS—Must be :

1. Placed where the overhead or underground conductors enter a building and join the inside wires.

2. Placed at every point where a change is made in the size of the wire *(unless the cut-out in the larger wire will protect the smaller).* This includes all flexible conductors. All such junctions must be in plain sight.

3. Constructed with bases of non-combustible and moisture proof material.

4. So constructed and placed that an arc cannot be maintained between the terminals by the fusing of the metal.

5. So placed that on any combination fixture, no group of lamps requiring a current of six ampères or more shall be ultimately dependent upon one cut-out.

6. Wherever used for more than six ampères (or where the plug or equivalent device is not used) equipped with fusible strips or wires provided with contact surfaces or tips of harder metal soldered or otherwise having perfect electrical connection with the fusible part of the strip.

SAFETY FUSES must be so proportioned to the conductors they are intended to protect that they will melt before the maximum safe carrying capacity of the wire is exceeded.

All fuses, where possible, must be stamped or otherwise marked with the number of ampères equal to the safe carrying capacity of the wire they protect.

All cut-out blocks when installed must be similarly marked.

The safe carrying capacity of a wire changes under different circumstances, being about 40 per cent. less when the wire is closed in a tube or piece of molding than where bare and exposed to the air, when the heat is rapidly radiated. It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects, and not upon the amount of current to be used on the circuit. Below is a table showing the safe carrying capacity of conductors of different sizes in Birmingham, Brown & Sharpe, and Edison gauges, which must be followed in the placing of interior conductors.

—Brown & Sharpe.—		——Birmingham.——		—Edison Standard.—	
Gauge No.	Ampères	Gauge No.	Ampères.	Gauge No.	Ampères.
0000	175	0000	175	200	175
000	145	000	150	180	160
00	120	00	130	140	135
0	100	0	110	110	110
1	95	1	95	90	95
2	70	2	85	80	85
3	60	3	75	65	75
4	50	4	65	55	65
5	45	5	60	50	60
6	35	6	50	40	50
7	30	7	45	30	40
8	24	8	35	25	35
10	20	10	30	20	30
12	15	12	20	12	20
14	10	14	15	8	15
16	5	16	10	5	10
		18	5	3	5

SWITCHES—Must :

1. Be mounted on moisture proof and incombustible bases, such as slate or porcelain.

2. Be double pole when the circuits which they control are connected to fixtures attached to gas pipes, and when six ampères or more are to pass through them.

3. Have a firm and secure contact, must make and break readily, and not stick when motion has once been imparted by the handle.

4. Have carrying capacity sufficient to prevent heating above the surrounding atmosphere.

5. Be placed in dry accessible places, and be grouped as far as possible, being mounted, when practicable, upon slate or equally indestructible back boards.

MOTORS.—In wiring for motive power, the same precautions must be taken as with the current of the same volume and potential for lighting. The motor and resistance box must be protected by a double pole cut-out and controlled by a double pole switch.

ARC LIGHTS ON LOW POTENTIAL CIRCUITS—Must be :

1. Supplied by branch conductors not smaller than No. 12 B. & S. gauge.

2. Connected with main conductors only through double pole cut outs.

3. Only furnished with such resistances or regulators as are enclosed in non-combustible material, such resistances being treated as sources of heat.

4. Supplied with globes protected as in the case of arc lights on high potential circuits.

FIXTURE WORK.

1. In all cases where conductors are concealed within or attached to

fixtures, the latter must be insulated from the gas pipe system of the building.

2. When wired outside, the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings, or motion of the fixtures.

3. All conductors for fixture work must have a waterproof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 16 B. & S., No. 18 B.W.G., or No. 3 E.S.G.

4. All burrs or fins must be removed before the conductors are drawn into a fixture.

5. The tendency to condensation within the pipes must be guarded against by sealing the upper end of the fixture.

6. No combination fixture in which the conductors are concealed in a space less than one-fourth inch between the inside pipe and the outside casing will be approved.

7. Each fixture must be tested for possible "contacts" between conductor and fixture, and for "short circuits," before the fixture is connected to its supply conductors.

8. The ceiling blocks of fixtures should be made of insulating material.

ELECTRIC GASLIGHTING.

Where electric gaslighting is to be used on the same fixture with the electric light:

1. No part of the gas piping or fixture shall be in electrical connection with the gaslighting circuit.

2. The wires used with the fixture must have a non-inflammable insulation or where concealed between the pipe and shell of the fixture the insulation must be such as is required for fixture wiring for the electric light.

3. The whole installation must test free from "grounds."

4. The two installations must test perfectly free of connection with each other.

PENDANTS AND SOCKETS.

No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

CORD PENDANTS.—Must be:

1. Made of conductors, each of which is composed of several strands insulated from the other conductor by a mechanical separator of carbonizable material, and both surrounded in damp places with a moisture proof and a non-inflammable layer.

2. Protected by insulated bushings where the cord enters the socket.

3. So suspended that the entire weight of the socket and lamp will be borne by knots above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws. All sockets used for wire or cord pendants should have openings at least equal to one-quarter inch gas pipe size.

4. Allowed to sustain nothing heavier than a four-light cluster, and in such a case special provision should be made by an extra heavy cord or wir as a mechanical reinforcement.

5. Equipped with keyless sockets as far as practicable, controlled by wall switches. In no case may a lamp giving more than fifty (50) candle power be placed in a key socket on a flexible pendant.

PRIMARY CONDUCTORS.

In those cases where it may not be possible to exclude the transformers and primary wires entirely from the building, the following precautions must be strictly observed:

1. The transformer must be located at a point as near as possible to that at which the primary wires enter the building.

2. Between these points the conductors must be heavily insulated with a coating of moisture proof material, and, in addition, must be so covered and protected that mechanical injury to them or contact with them shall be practically impossible.

3. The primary conductors, if within a building, must be furnished with a double pole switch, and also with an automatic double pole cut-out where the wires enter the building, or where they leave the main line, on the pole or in the conduit. These switches should, if possible, be enclosed in secure and fireproof boxes outside the building.

4. The primary conductors, when inside a building, must be kept apart at least 10 inches, and at the same distance from all other conducting bodies.

SECONDARY CONDUCTORS.

The conductors from the secondary coil of the transformer to the lamps or other translating devices must be installed according to the rules for "inside wiring" for "low potential systems."

MISCELLANEOUS.

1. The wiring in any building must test free from "grounds" before the current is turned on. This test may be made with a magnet bell that will ring through a resistance of 20,000 ohms, where currents of less than 250 volts are used.

5. No ground wires for lightning arresters may be attached to gas pipes within the building.

3. All conductors connecting with telephone, district messenger, burglar alarm, watch clock, electric time and other similar instruments must, if in any portion of their length they are liable to become crossed with circuits carrying currents for light or power, be provided near the point of entrance with some protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire hazard if crossed with another conductor through which it may become charged with a relatively high pressure.

PUBLICATIONS.

We are indebted to Mr. C. C. Shelley, publisher, 10 and 12 College Place, New York City, for a copy of a work entitled "Central Station Management and Finance," by H. A. Foster. The book is one which should prove of advantage to owners and superintendents of central stations.

We are advised that the tenth edition of "The Electrician" Electrical Trades Directory, corrected to January, 1892, is in course of preparation, and will be published early in the new year. Judging by previous editions, this directory will be one of great value. The Electrician Publishing Co., Salisbury Court, Fleet St., London, E.C., are the publishers.

The Auburn Woolen Co., of Peterboro', Ont., recently purchased from the Edison General Electric Co. a No. 8 direct current dynamo and other necessary appliances for supplying current to 275 sixteen c.p. lamps distributed throughout its mill. The lighting plant occupies a building 38 x 20 feet in size separated from the mill.

SPARKS.

St. Dunstan's Cathedral, Charlottetown, P. E. I., is now lighted with the incandescent light.

The Walkerville Malleable Iron Works have recently contracted for an Edison incandescent plant.

The electric street cars in process of construction for Port Arthur, Ont., will be warmed by electricity.

Incandescents are a comparatively modern invention, but arklights were in use at the time of the flood.—*Westborough Tribune.*

The magneto motive force equals the products of the number of spirals and the number of amperes of current multiplied by 1 257.

The Sherbrooke Gas and Water Co. have lately made arrangements to supply 300 incandescent lights to Bishop's College, Lennoxville.

A 100 h. p. engine and 50 light dynamo are being added to the plant of the Brandon Electric Light Co., making the capacity of the station 2,000 lights.

An ingenious device for protecting carbons and carbon rods from the effect of sleet and snow is made of galvanized sheet iron and japanned, and is strong enough to withstand a great deal of hard usage. At the bottom is an extension feature that permits the protector to be adjusted to almost any size of lamp.

In a note in the *Comptes Rendus* of September 14th, M. Paquelin describes an incandescent platinum light devised by him. The apparatus consists of a strip of platinum coiled on itself and placed in a platinum bowl with a hollow stem. A gaseous mixture of air and some hydrocarbon vapor is then introduced under pressure in suitable proportions. The mixture is set alight, the flame disappears, and the platinum strip incandences, the incandescence being the more intense the greater the pressure. With moderate pressures the light is comparable with that emitted by an electric lamp. The whole apparatus can be plunged into water without the light being extinguished.

The electric current has been used since 1889 at the small arms factory at Saint Etienne for annealing the steel wire of which the hammer springs of the rifle, 1886 pattern, are made. These springs are manufactured of steel wire, 7 milimetres thick, cut in lengths of 3.20 metres, the wire is rolled spirally and a current of 23 amperes is passed through it. Heating is rapidly effected; when it is judged sufficient, the circuit is opened, and the hammer-spring into a water tank. One man can anneal 20 springs in three minutes, equivalent to about 2,400 per day. Electric annealing being clean in operation, and cheap, will, no doubt, soon be applied in numerous cases analogous to the one indicated.

Albert Moyse, of Montmorency cotton mill, tells of a remarkable experience he recently had with a live electric wire. He was called one evening from the machine shop to the mill to look after some machinery which was out of order. He took a couple of men with him. "After I had been working a short time," he said, "it grew dark and I had to start the electric arc light. The light was nine feet from the floor and I stood on an iron machine to reach it. Before I touched it I asked one of the men if the motor power had been turned off He replied that it had. I then reached out my hand to catch hold of one of the conducting wires to steady myself. The weather at the time was very wet. As soon as I touched the wire with my right hand I felt myself drawn up with remarkable rapidity. Blue flames shot from my eyes. It was intensely blue, yet brilliant. I felt a sensation such as I never experienced before. As far as I could realize the feeling was pleasureable. I felt that my time had come, and I lost consciousness. I afterwards learned that this experience had not taken more than two seconds. Those who saw the accident said that as soon as my hand touched the wire I was dragged up like a flash, dashed bodily against the ceiling, four feet above the wire, and then thrown to the floor where I laid for over an hour unconscious. At the time I got the shock the power was running through the wire at the rate of 1,100 volts. The motor had not been turned off. When I came to my senses I was lying at the bottom of a cart and was being driven home. For over ten minutes I could not remember anything. The man who was driving was one of the mill hands, but I could not remember who he was. He said he spoke to me as did others in the cart, and that I answered back in a most foolish way. They thought I had lost my reason. I was taken to my home in this strange condition and for some time could not recognize my own wife and family. When I fully regained my senses, I began to suffer for the first time. All over my body came tingling, pricking sensations, which were very agonizing. Sparks would at intervals shoot from my eyes. My body was so sore that I could not bear my clothing, while my hair actually seemed to be electrified and to be raised from my scalp. I looked into a mirror and did not know myself, for my face was swollen to twice its natural size, while the skin had swollen so much on my forehead that it hung like a bag over my eyelids, almost preventing me from seeing. I was suffering very keenly One of the men had gone to get Mr. Strachan, of the electric light company, to see if he could do anything for me. As soon as he saw me he took off my boots and socks and brought me into the yard, where he walked me barefooted over the damp earth. It was such a comfort as soon as my feet touched the earth. I could feel the electric fluid running through my body to my feet, and then into the earth. The cure was a speedy one and I soon felt relieved. I was sore for days after, though. The accident would not have taken place had I not been standing on an iron machine, which made a circuit through me. They said it was a miracle I had not been instantly killed."

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SEND in your application for membership in the Canadian Electrical Association.

WITH the present number the ELECTRICAL NEWS closes its first volume. A properly classified index to the contents of this volume is herewith presented.

THE Commissioner of Patents recently made the statement that no action had been taken with the view of extending the life of the Bell telephone patents in Canada.

AS the festive season will have passed before the NEWS again reaches its readers, we embrace the present opportunity of wishing one and all a Merry Christmas and Happy New Year.

THE commendable recommendation is made by the Electric Commission for the District of Columbia that all high tension electric wires which may be regarded as dangerous to life, shall be painted red.

THE remarks of a correspondent printed in another column, on the value to engineers of an exchange of ideas through the Question and Answer department of this paper, are timely, and worthy of earnest consideration by the class to whom they are addressed.

THE outlook in electrical industries has never been so bright as at present. The large manufacturing concerns in Canada, such as the Edison and the Royal, are overwhelmed with orders, and are working night and day. They are still months behind. The demand for motors has been such that it is difficult to obtain them, and they have to be imported at increased cost from the other side. Engine builders also are very busy with orders for the supply of engines for electric installations. The business promises to be very brisk for some time to come.

THE *Evening News*, of Toronto, has recently been printing a series of articles advocating a closer trade relationship with the people of the mother country. They point out with considerable ability that unless we wish to drift into some undesirable position we must make our destiny ourselves. There is no doubt that by admitting English goods in return for a preference in their markets for our produce, we should encourage the influx of the most desirable class of immigration, the agricultural, and the Dominion be made independent of the markets now closed against us by the great American ———.

IT appears that a receiver has been appointed for the St. Catharines and Thorold Electric Railway. The action was taken on behalf of the bondholders, as it is claimed the railway has been running at a loss for the past six months. It is unfortunate that this should be the outcome of the enterprise of its projectors, as it was one of the first railroads in Canada to be continuously operated by electricity. As water power is used, it would seem strange that running between towns like St. Catharines, Merritton and Thorold, it could not be made to pay. The explanation, however, is, that being one of the pioneer electric roads on the continent, the apparatus used was of a more or less crude and imperfect construction and design, so that interruptions to traffic would be too frequent to be consistent with successful business. There is no doubt that if the road could be equipped with the modern motor and appliances it could be made a paying and profitable investment.

THE scheme for bringing water for Toronto use from Lake Simcoe will probably die the death of its aldermanic sponsors, and will be interred with their bones on the ides of January next. Apart from the fact that the quality of the water is much inferior to that at our doors--simply to be had for the pumping—the cost of the enterprise would considerably outweight its possible advantages. It is stated that the revenue for power supplied to manufacturers would be enormous. We have shown in a previous issue that the idea is fallacious. If the power is to be distributed hydrostatically to the different factories, new mains of immense size would have to be laid all over the city—if electrically, the loss in transmission, cost of maintenance of apparatus, and the *smallness of the available power* would put revenue out of the question. Especially would this be the case were the whole arrangement under municipal control. Then it is stated it would do away with the necessity for a trunk sewer, probably by using the present suction pipe as an outlet. Even if it were large enough it must be remembered that it could only be reached by means of a trunk sewer intercepting all the others. The power to be developed by the city water supply from Lake Simcoe, which would have to be developed miles outside the city in any event, is purely a figment of the imagination, and it is well that the citizens should have this fact impressed upon them before they determine to spend fifteen or twenty million dollars to get bad water.

THE manufacture of carbons has become an important branch of the electric light industry. It was not long ago that it was a little understood process, and the prices obtained were high, but of late years and owing to the largely increased demand, the number of factories has multiplied. An attempt was made a year or two ago to form a combine and raise the price to a fancy figure, but like all movements of the kind which are overdone, it collapsed, after bringing into existence a new factory started by a large manufacturing electric light company. The same process is in course of repetition again, but warned by former experience, it is being done quietly and carefully, so as not to alarm the consumer unduly. The price at present has not materially advanced and probably will not until the combine controls the whole of the factories. We have in Canada a thriving business of this kind upon which the "trust" have cast an envious and a longing eye. In fact, they make no secret of their intention to either buy or starve it out of existence. The remedy is plain, however, and is in the hands of the consumers themselves. They must stand by a Canadian institution, but if it fails, there are enough carbons used by two or three of the largest plants in Canada to amply justifiy the establishment of a co-operative factory to manufacture for their own use. Carbons have been made in Toronto years ago, and can be made again —in fact, some of the machinery used still remains intact, and could be brought into use on short notice. The moral of all this is, that if the combine tries for too much, like the dog in the fable, it will probably lose all.

IT is certain that we are upon the eve of great discoveries in the field of electrical science. The perfection to which electric lighting has attained, great as it is, is but the threshold as it were of the possibilities yet to be realized. When it is considered that of the amount of energy expended not one-tenth appears as light, leaving the larger proportion to take the form of heat, it is at once seen that absolute perfection is yet a long way off. Light without heat is the dream of the scientific explorer in the realm of nature, and when it is successfully achieved our present wasteful methods will appear crude indeed. We are burning up our stoves as well as our fuel. We are like the Chinaman who invented cooked pig—we burn down our house to get roast pork. The experiments of Tesla with currents of high frequency are upon this line, and may yet take practical shape. If a medium of sufficient tenuity could be found capable of transmitting the almost inconceivably rapid vibrations of light as set in motion and maintained by the subtle force of electricity, the grosser form of caloric would be passed and left behind, and the cold and brilliant aurora glow of heatless light would be attained. But where is this medium to be found? The molecules of ordinary metals are incapable of being attuned to the rapidity required. Copper, our best conductor, would probably be too inert to transmit the vibratory force, and be dead as so much wood. But if it is accomplished, it will have this peculiarity—the electricity capable of producing a heatless light would have no effect upon the human organism. If a metal will oppose resistance to the rapidity of its vibrations, so in a much greater degree would the tissues of the human frame, and the possibility of injury be a thing of the past. Although the electric current may be weighed and measured with precision and appears to follow certain fixed laws, but little is known of its actual constitution, and in what manner it is transmitted along the most favorable path. But there are immense possibilities in it, and before long we may look for further discoveries in its application to the production of light.

WE have great pleasure in being able to record a most successful inaugural meeting of the Canadian Electrical Association. Representatives of every branch of electrical science and from all parts of the Province were present, while from the most distant parts of the Dominion came letters of good will and hearty accord with the objects of the Association. Organization and the formulation and adoption of the necessary constitution and by-laws necessarily took up a large part of the time together with the appointment of officers and executive to act until the first annual meeting to be held in Hamilton next June. The adoption of our neighbor city as the place of congress we look upon as being particularly felicitous. It is as accessible as any from all points of the compass, and has a special reputation for doing up affairs of this kind in the most approved and hospitable manner. From the well-known characteristics of its representatives on the Executive we have the most unbounded faith, amounting to a certainty, that this well-earned reputation will in no wise be allowed to suffer. There will be important questions to be discussed from commercial as well as scientific standpoints with probably a dash of the legislative thrown in, and possibly the relation of electrical interests to the municipalities with whom they all, more or less, hold close relationship. From a technical standpoint the development of electrical art is so rapid that between now and the date arranged there may be a good deal that is new to bring forward. It is also our idea that it might be a feasible plan to arrange or appoint a Board of Arbitration to whom disputed questions or questions of interference might be referred for amicable settlement. In short the sphere of usefulness of the newly inaugurated Association appears to us to be almost boundless, and we predict that, under wise and skilful management, it will assume a position both of importance and influence. Let the Association be national in character as well as in name, and while maintaining feelings of the utmost friendliness to the nation to the south of us, demonstrate that, favored as we are by nature, by position, and by connection with that greatest of empires on some part of which the sun forever shines, for skill, enterprise, invention and manufactures, we are able to hold our own without dependence and even attain supremacy among the nations of the earth.

THERE is a demand arising for a better class of work in the installation of wiring and machinery by electric light companies. The business has passed very largely beyond the experimental stage, and when electric light apparatus is put in it is intended to be a permanency. In the early days of the art, before the necessity of thorough insulation was understood, work more or less crude was done, but this has been largely replaced. Impatience has also been largely responsible for temporary and slip-shod work. An electric plant has been decided on for a town or a factory after much delay and figuring, and then the contractor is hurried to get at least some of the lights in operation at the earliest moment. Wires are strung in a faulty manner, not sufficiently fastened, or care taken to insulate from the ground, with the intention of coming back to it to make it right. But it is neglected or forgotten, until a forcible reminder in the way of an incipient fire brings it home in an unpleasant manner. Wiring work for electric lights should be done with the greatest care and in a permanent manner, and should be so done that where near pipes or other ground a contact is impossible; and furthermore, the wiring should be secured against any possible injury from contact with men and tools that are continually on the move about a factory or workshop. Also, instead of it being the ambition of the wireman to get his loop to a predetermined spot with as little trouble to himself as possible as long as he gets there, it should be run in a mechanical manner in mathematically straight lines and thoroughly secured—no kinks or curls or loose bights of wire such as have to be twisted around the nearest nail or tied up with twine to keep them out of the way. With regard to pole lines and outside construction, it is often the case that a municipality will not give a contract for lights except for a short time, so that the contractor is not justified in doing permanent work, and in cases where there is no contract there is so much talk of compelling electric light companies to take their wires down and go underground, that first-class permanent work is an impossibility. If it was understood that the lines were not to be interfered with by legislative action, there would be such a class of neat, permanent and safe work done that legislative action would be unnecessary. The time for slip-shod, careless and slovenly work has at any rate gone by, and the individual or company who care to conserve their own interests will see that the best class of workmanship only is employed.

BELL TELEPHONE CO.'S IMPROVEMENTS.

THE Bell Telephone Company's new building on Temperance St., Toronto, is nearing completion. It will cost $50,000, and is designed when furnished to be one of the most complete exchanges on the continent. A representative of the company is now visiting the leading exchanges of the United States for the purpose of obtaining the information which will enable them to decide upon the best style of switchboard to adopt. After this important matter is decided, six months or so will be required for manufacturing and placing the switch-board in position, so that the removal to the new building will probably not take place for nearly a year. Provision will be made in the new exchange for 5,000 subscribers.

A large tunnel some seven or eight feet in depth, perfectly waterproof, and lighted by electricity, is being constructed on Temperance St. In this tunnel 125 ducts will enter, 60 from the west, and 66 from the east. Each of these ducts holds a cable two inches in diameter, and each cable has 100 wires, representing 50 subscribers.

NEWSPAPER ELECTRICAL MARVELS.

THE love of the marvelous which is ingrained in our poor human nature has been well fed in recent years by actual achievements in electricity, itself the greatest marvel of all, since we seem to be as far off as we ever were from comprehending the real nature of the "fluid." It has therefore become a most useful field for the wonder-mongers of the daily press to work in, since they have but scant sense of responsibility for the truth of their statements, while they have a strong and chronic desire to get a column or two of highly spiced food for the jaded palate of the Sunday reader. If only they can mix in a little truth and a little news with their marvels, so much the better, but the marvels must be had anyway, and there is hardly a week in which new ones, which only need to be true to be highly important, are spread at length before the public.—*Engineering News.*

The Boiler Inspection and Insurance Co. of Canada, gives notice of its intention to apply at the next session of the Parliament of Canada for an act to add to the powers of the company the right to insure against loss of human life or injury to person or property arising from the use of elevators, hoists or lifts or machinery connected therewith, and machinery used for the production of electricity as a motive power or illuminating agent, and otherwise enlarging the character of the risks which the company may undertake, and for such other powers as may be necessary in the premises.

THE ELECTRIC TRANSMISSION OF POWER.*

By Gisbert Kapp

The transmission of power, in whatever way it may be effected, is one of the most important problems in applied mechanics. Strictly speaking, it enters into and is, indeed, precedent to the application of power to all industrial operations. The power developed in a Lancashire mill-engine only becomes of value to the spinner or weaver after it has been transmitted to the mules or looms by the agency of ropes, belts, pulleys, and other gear. Without such gear affecting the transmission, the power developed by the local steam-engine would be as useless to the mill owner as the power which may be contained in a waterfall miles away. In either case transmission must precede the application of power, but whilst in the former case the problem of transmission is simple, and has to be attacked rather from the point of view of convenient subdivision, than with particular regard to efficiency (this being naturally high with properly designed gear), in the latter case the problem is of a much more difficult character, and efficiency, combined with moderate capital outlay, small working expenses, reliability, and safety become matters of first consideration.

We have thus to distinguish between two kinds of power transmission, the one taking place over distances reckoned by feet or yards, and the other over distances reckoned by thousands of feet, or even by miles. When we speak of the electric transmission of power, we tacitly assume that it belongs to the latter class, and refers to distances beyond the reach of the ordinary gear, such as shafting, cog-wheels, pulleys and belts, employed for the subdivision and distribution of power within the walls of a factory, and it is in this generally accepted sense that I propose to bring the subject mainly before you. There are, however, cases where the application of electromotors to special tools is either the most convenient or only possible method of applying mechanical power to the performance of certain operations, and it will, therefore, be necessary, at least briefly, to glance at that part of our subject which is not usually comprised within the title of these lectures, namely, the transmission of power over very short distances by means of electric currents. We thus distinguish between "long distance" and "short distance" transmission, the fundamental distinction between the two being that, in the former, the transfer or transmission of power from one point to another, so to speak, in bulk, is our main object, whilst in the latter we rather aim at the subdivision and convenient application of power, in small quantities, at various points, and for particular purposes. I propose to consider long distance transmission first.

Broadly speaking, there are two ways in which we can transmit mechanical energy from one place to another. Let us assume, by way of example, that the primary source of energy is coal, and that the power derivable from this coal is required, not at the pit's mouth, but at a mill a certain number of miles away. In such a case, the obvious, and also the most economical way of transmitting power is to carry the coal to the mill, and burn it under the boiler of the mill-engine. Even if the distance between the pit and the mill is short, this method will be the best, provided there are no difficulties of transport. Suppose, however, that, although the distance is short, local conditions, such as great difference of level, bad roads, or total absence of roads, render the carriage of coal difficult or impossible, then we would establish our boiler and engine at the pit, generate the power there, and transmit it by wire rope, or in some other way, to the mill. In both cases we have transmission of power, but the methods are essentially different. In the first case we have transmitted, not mechanical energy itself, but the thing from which mechanical energy can be obtained, namely, the coal, each ton of which represents so many stored horse-power hours. In the second case we have transmitted the energy itself in its kinetic or potential form. In popular language we might describe the process as the transmission of "live" power, as distinguished from the transmission of "stored" power, which takes place when we carry coal from the pit's mouth to the mill.

The most important sources of power in nature are corn, coal, and falling water. Under the term "corn" I comprise all vegetable food stuffs suitable for conversion into mechanical energy, by means of horses and other animal engines, whilst the term "coal" naturally includes all kinds of fuel suitable for conversion into mechanical energy by some form of heat-engine. The power derived from corn and coal is generally transmitted in the stored form, that derived from falling water in the live form, since the conveyance of water at a high level, or under considerable pressure, to great distances, necessitates the erection of very costly works. To prevent misunderstanding, I must here point out that I use the term "stored energy," as applied to water, merely in its colloquial sense. We speak of the energy stored in the water of a mill pond, but, in reality, the energy does not reside in the water at all, but is an effect of its elevated position, and is, therefore, not comparable with the energy which is chemically stored in coal. Leaving, however, such distinctions on one side at present, we may regard water, which is being carried along horizontally, at a certain elevation, from one place to another, as the vehicle of so much stored energy, which we can obtain, in its live form, at any point at which we establish a water engine, through which the water passes in its descent to a lower level. If we carry water along in this way, it is not with the object of bringing the stored power to the point of application, but merely to secure the largest possible fall, and, therefore, a maximum of power with a given quantity of water. If it be necessary to transmit the power farther, the transmission is generally effected in the live form. Now let us see what position electricity occupies in relation to these primary sources of power in nature, namely, corn, coal, and falling water.

In the first place it will be obvious that, where electricity is the transmitting agent, we can effect the transmission both in the stored and in the live form. To see this clearly, we need only for a moment revert to our example of the coal pit and the mill. Instead of sending the coal to the mill to be converted into power there, we could burn it at the pit, and thereby generate steam to be used for driving a steam dynamo. The current from the dynamo we could utilize in charging a storage battery, and send this to the mill, where it would drive an electromotor, thus taking the place of the local steam engine. Here we have a system of transmitting energy in the stored form. On the other hand, if we do away with the batteries as a vehicle of energy, and connect the dynamo at the pit with the motor at the mill by a pair of insulated wires, we have a system of electric transmission of power in the live form. The latter system is that generally understood under the term "electric transmission of power," and therefore forms the principal subject of these lectures, but before entering upon it, I propose briefly to investigate the capabilities of electric transmission of power in the stored form.

As you all know, a sack of coal contains more stored power than a secondary battery of equal weight, and its carriage, whether by rail or road, is cheaper, easier, and requires less precautions than that of the battery. It is, therefore, quite obvious that, if the primary source of power is coal, and if there is no objection to the establishment of a steam-engine at the place where the power is wanted, it will be more economical to carry the power there in the form of coal than in the form of batteries, not only because of the saving in carriage, but also on account of the smaller capital outlay, the smaller depreciation, and the avoidance of the loss of energy in the battery itself. But let us assume that the primary source of energy is falling water, then it is not so obvious at the first glance that its electric transmission in the stored form should be uneconomical. We cannot produce coal out of the energy of falling water, but we can charge batteries with it, and electricity would thus seem to offer a means of utilizing a power of nature which would otherwise be lost. It might, perhaps, here be objected that electricity does not form the only means for utilizing such a power, since there are various other ways in which power may be stored, a familiar example being compressed air. We might, therefore, also utilize the power of the waterfall for working an air compressor, and store the air under pressure in steel reservoirs, to be used afterwards for working air-engines constructed similarly to ordinary steam-engines. Many such engines are actually in use in Paris on the Popp system, though there the air is conveyed to them by pipes under pressure, and not in storage vessels, as would be the case in our example. There can thus be no doubt that the transmission of power by stored air is practicable, but the question is, at what cost will it be effected, and can it compete with transmission by batteries? The answer to these questions depends on two factors, namely, the storage efficiency and the cost of transport. By storage efficiency, I mean the ratio of the power put into and taken out of the apparatus which serves as the vehicle for the power. Batteries may now be obtained in which this ratio is about 80 per cent.; that is to say, for every 100 h. p. hours put into the battery, 80 h. p. hours can be taken out. The storage efficiency of compressed air is very much smaller. The most reliable data under this head are to be obtained from the Paper which Prof. Kennedy read before the British Association in 1889, when he gave an account of experiments carried out at Paris on the Popp system. He found that the indicated efficiency with cold air was 39 per cent.; that is to say, for every 100 h. p. indicated by the compressing-engine, 39 h. p. were indicated in the engine driven by compressed air as it came from the mains. If the air before being admitted to the engine was heated to 320° F., the apparent indicated efficiency rose to 54 per cent., but as the heat energy thus supplied to the air requires the expenditure of fuel at the point where the power is wanted, the use of hot air really involves two methods of transmission—namely, that of power in the shape of air under pressure flowing through the mains, and that of power in the stored form contained in the fuel. To make the comparison with electric transmission of stored power a fair one, I must therefore take the efficiency of the Popp system when the air is not heated. A correction must, however, be made for loss of power in the mains. In the Popp system the power is transmitted in the live form by air flowing through pipes, and there is necessarily a certain loss on account of friction in the pipes and valves. As far as the friction in the pipes is concerned, this would not occur if the transmission were effected in the stored form by means of air carried under pressure in a reservoir, but, on the other hand, the loss by friction through valves would be greater, because it would be necessary to insert between the reservoir and the air engine a reducing valve, which would regulate the supply of air as the pressure falls. The loss of power due to this circumstance will probably be greater than the cor

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responding loss in the Popp system, where the pressure is constant; but as I have no experimental data to determine this point, I take the same loss as found by Prof. Kennedy, namely, 2 per cent., which makes the indicated efficiency nearly 40 per cent. The efficiency of the air engine he found to be, with cold air, 67 per cent., making the total efficiency of the system 26.7 per cent. By adopting air storage we could, therefore, obtain 26¾ h. p. hours for every 100 h. p. hours indicated in the engine. Now let us see how the case stands with electrical storage. The efficiency of the steam dynamo, that is, the ratio of the electrical output to the indicated power, may be taken as 83 per cent., that of the batteries 80 per cent., and that of the motor at least 85 per cent., so that the total efficiency works out to quite 56 per cent., or more than twice that of the rival system. I have here assumed that the dynamo is steam-driven, simply because the only reliable figures I could obtain about compressed air referred to steam-driven compressors, but it is obvious that the comparison of the storage efficiencies of the two systems cannot be materially affected by the source of power, and will practically be the same in the case under consideration, where the power is supposed to be derived from falling water. We see that in efficiency, at least, air storage is far behind electrical storage. Let us now inquire whether it is any better off in the other essential feature I have mentioned—namely, in the cost of carriage. The information available under this head is tolerably reliable as regards batteries, but this is not the case as regards air stored under pressure. I know of no experiments made to determine accurately the weight of air reservoirs, and, in the absence of such data, I cannot do better than adopt the calculated figure given by Prof. Osborne Reynolds in one of his Cantor lectures delivered in 1888. According to this authority, the weight of the steel reservoir and air contained would amount to 300 lb. for every horse-power hour so stored. Now the weight of a secondary battery filled with liquid, and provided with a tray and connections, all complete, does not exceed 100 lb. per horse-power hour stored, that is, only one-third the weight of an equivalent air reservoir. We see, therefore, that as regards efficiency air storage is twice as bad, and as regards weight it is three times as bad as electric storage. Competition with it is, under these circumstances, obviously impossible, and we may therefore say that if the transmission of power from the waterfall to a distant point has to be made in the stored form, electricity is the only agent which may be considered.

Whether it would pay to transmit power is a question which cannot be answered off-hand. As compared with the direct transmission of live power by means of a pair of wires, the cartage of batteries up and down the country will no doubt appear to be a clumsy device, but when we are investigating the different possible solutions of an important problem we must not allow any preconceived opinions of what is elegant or clumsy to influence our judgment; we must, in fact, judge each case on its own merits, and I propose to deal with the electric transmission of stored energy in the same sense. The system of power transmission by storage batteries is actually in use, not, indeed, for long distance transmission pure and simple, as above defined, but still for transmission over distances reckoned by miles. I allude to the electric tram-cars worked by storage batteries, which are charged at a central depot, and run for many miles before they require to be again charged. The object is not to carry a certain amount of power in bulk from one point to another, but to dispense whatever power is required for the propulsion of the car during the journey. We might, however, imagine the tram-car, instead of being occupied by passengers, to be loaded with storage cells in addition to those it carries for its own propulsion. Whilst the latter would gradually lose their charge in transit between the two terminuses, the former would arrive fully charged, and could be made to give up part of the power stored in them at the starting point. Here we have transmission of power in the stored form, but let us return to our example of the waterfall and the mill, and see how such a system might be put into operation.

At the waterfall we establish the necessary hydraulic works, and an electric station where the batteries can be conveniently charged. We further build a tram line or railway, joining the charging station with the mill where the power is wanted, and we design the rolling stock with special regard to the safe and convenient carriage of the batteries to and fro. The train is fitted with electromotors, so as to make it self-propelling. A train load of charged cells is thus taken to the mill, and left there to work the electromotor which supplies power to the mill. During this process the batteries become gradually exhausted, and must be disconnected from the motor before they are quite exhausted, because we must allow a sufficient margin of power for taking the train back to the charging station. The economy of the whole system will evidently be the greater the less power is spent in the outward and home journey; and we might call "efficiency of transmission" the ratio of the power actually delivered to the motor, and that which might be so delivered if the battery were used for working a motor at the charging station itself; in other words, if the distance of transmission were nought. Say, for instance, that a total of 1,000 h. p. hours could be obtained from the battery, if it were discharged immediately, and that the power spent in the outward journey amounts to 50 h. p. hours, then a further 50 h. p. hours will have to be spent in the return journey, and the power obtainable at the mill will only amount to 900 h. p. hours. The efficiency of transmission will in this case be 90 per cent. *If we double the* distance between the waterfall and the mill, the efficiency of transmission would be reduced to 80 per cent.; if we treble the distance, the efficiency would only be 70 per cent., and so on. The efficiency must naturally depend on the kind of road over which the transmission takes place; it will be small on a common carriage road, larger on a tramway, larger still on a railway, and largest on a canal. We can, for every arrangement, express the value of the system, as far as economy of power is concerned, in one of two ways. We can, if the distance is fixed, give the efficiency in the usual way as a percentage, or we can fix a standard percentage of efficiency, and ascertain the distance over which this standard is attainable in any particular case. I shall adopt the latter way of reckoning, as the more convenient for comparison with other methods for transmitting power, whether in the stored or live form.

First, as to the transmission of stored power otherwise than by batteries. The only two methods we need consider are the carriage of corn and the carriage of coal, each combined with the use of a proper engine for converting the stored into live power at the other terminus of the line of transmission. In the case of corn, the starting point of this line is the field where the corn is grown. We there load it into suitable vehicles, and send it to the mill where the power is wanted. Since we are dealing now entirely with animal power, we must suppose the cartage to be effected by draft animals, say horses, and the conversion of corn into live power at the mill also by such animals. I need hardly say that, at the present time, no English mill owner would dream of working his mill in this fashion by animal power, since coal is yet abundant, and a single steam-engine is a far cheaper and handier instrument for producing and controlling a large amount of power than an equivalent number of horses. On the other hand, if power is required in small quantities, and in particular ways, then the horse will produce this power better, more cheaply, and more conveniently than the steam engine. It may seem absurd to work a large cotton mill by horse gear, but substitute for the mill a farm, and you see at once that the transmission of stored power to it, in the shape of corn, is a necessary part of the agricultural operations. Now, the horses, in bringing the corn to the place where the power is required, perform work, and must consume an equivalent amount of food. They also perform work in bringing the empty carts back again to the field to be re-charged. The ratio between the amount of corn delivered at the mill and the amount taken out of the field would therefore represent the *efficiency of transmission*. If this is to be 90 per cent., as in the case of electric transmission, we may take it that, for every 100 sacks of corn taken away from the field, the horses would eat on the outward journey (when the carts are heavily laden) 6½ sacks, and on the homeward journey (when they are empty) 3½ sacks, *leaving* 90 sacks of corn to be converted into live power at the mill. The distance to which we can thus carry stored power with a standard efficiency of transmission is a measure of the merit of the system, as far as economy of power is concerned.

The transmission of stored power in the shape of fuel is a parallel case. We load the coal at the pit's mouth into waggons, and haul them by means of locomotive engines to the places where the power is wanted. Part of the coal is consumed on the outward and homeward journey of the train, leaving the rest for the production of live power at the mill. If this amounts to 90 tons out of every 100 tons put on the train at the pit's mouth, we have again an efficiency of transmission of 90 per cent.

I have already mentioned that the exact distance to which we can carry power by either of the three agents here mentioned (namely, batteries, corn, and coal), depends very much on the kind of road over which the transmission takes place. We might assume an almost infinite variety of cases, but, as our object is to obtain a rough general comparison of the different systems rather than exact figures for any one of them, I have assumed merely three kinds of roads, namely, a common carriage road, a tramway, and railway, and have calculated the distance to which power can be transmitted in each case with a loss of 10 per cent. The results of these calculations are given in the following table:

TRANSMISSION OF STORED POWER.

Source of power	Distance in miles attainable with 90 per cent. efficiency of transmission over:—		
	Road.	Tram.	Rail.
Coal and steam engine .	115	270	1,300
Corn and horse. . . .	52	170	440
Storage battery and electromotor . . .	4	10	26

The speed of transmission has been assumed at four, six, and twenty miles of road, tram, and rail respectively, when coal or batteries are the transmitting agents; and at four miles on all kinds of road where corn is the transmitting agent. In all cases I have assumed that the road is the best of its kind, perfectly free from gradients or curves, and that the traffic can be worked at the speeds mentioned without interruption. In reality, these conditions will of course not be fulfilled; we have to make allowance for waste of power on gradients, curves, bad places in the roads, for running at variable speed, and for stopping and starting. The distances given in the table are, therefore, throughout too large; but, as our purpose is merely the comparison of the different systems, we may take the figures in the table as a rough indication of the merits of each.

You will see, from this table, that as regards efficiency, the electric transmission of stored power cannot compete with the other two methods. A horse and cart carrying corn over an ordinary carriage road works with twice the efficiency of the electric locomotive taking batteries over a railway. The discrepancy is still greater if we compare the electric locomotive hauling batteries with the steam locomotive hauling coal. The latter can transmit power over a distance fifty times that over which the former can transmit power with an equal efficiency. On a tram line the distance over which we can transmit power with an efficiency of 90 per cent. is, according to the table, 10 miles; that is to say, if the whole load of the car is composed of batteries, we can run it 10 miles out and 10 miles home at an expenditure of 10 per cent. of the total charge of the batteries. Now let us see how this compares with the storage cars in use on passenger tram lines. The total weight of a full-sized car is about 10 tons, made up somewhat as follows: Car and propelling gear, 4 tons; batteries, 2½ tons; passengers, 3½ tons. If the 3½ tons represented by the passengers were utilized for additional storage cells, the car could run 20 miles with the loss of 10 per cent. of its charge; or it could run 200 miles if losing the whole of its charge. As there are, however, only 2½ tons of batteries instead of 6 tons, it can only run 86 miles. This is according to the table, and more than attainable in practice, for the reasons already stated. Experience has shown that storage cars can only run from 30 to 60 miles with one set of batteries, or half the distance stated in the table. If we apply the same reduction to all the methods of transmission, we find that the distances to which power can be carried electrically in the stored form, with an efficiency of 90 per cent., are two, five, and 18 miles over a carriage road, tramway, and railway respectively.

The efficiency of transmission is, however, not the only or even the most important consideration in the problem of transmitting power to a distance. The owner of a transmission plant cares nothing for any theoretical perfection in the way of high efficiency. All he cares for is the cost at which the power is delivered to him. All other things being equal, high efficiency will naturally reduce this cost, and, in so far, is an advantage, but in practice all other things are not equal, and to aim at high efficiency regardless of other considerations is the reverse of good engineering. It is no doubt gratifying to the engineer if he can point to a transmission plant designed by him to give some extraordinarily high efficiency, but if the result has been maintained by means of an exorbitant capital outlay and excessive working expenses, it will not be equally gratifying to his employer, the owner of the installation, who has to pay for its erection and working. It therefore becomes the duty of the engineer so to plan the installation that the cost of the power delivered shall be a minimum under any given circumstances.

We have seen that, as judged by the efficiency standard alone, electric transmission of power in the stored form is hopelessly behind the other two methods which we compared with it. Let us now see whether this is or is not the case if we judge the system by the more practical and, indeed, the only reliable test of cost. It is, of course, understood that, in estimating the annual cost at so many pounds per horse power delivered, we take into account not only the cost of coal burnt throughout the year, if we obtain the power by steam, or the rent for water if we use a turbine, but also all other expenses which may properly be charged to the power account, such as wages for the attendants, petty stores, interest, repairs, and depreciation of plant. Estimated in this way the cost of water power will be found to vary between £2 and £8 per annum, the exact figure depending, of course, on the total amount of power available, the quantity of water, its fall and local conditions, which must largely influence the cost of the hydraulic works. The cases where water-power can be had at so low a price as £2 a year are exceptional; on the other hand, if we have to pay as much as £8 a year for water-power, it will seldom be worth while to transmit it electrically, or in any other way; and I shall, therefore, assume £3 and £6 as the limits of cost for water-power intended for electric transmission. The cost of steam power, if produced by large economical engines, is generally taken at £10 per year; if produced by small, and therefore less economical engines, it may rise to £20, and even £40 per year. I shall further assume that in all cases the power is required for 3,000 hours during the year, that is, 300 working days of 10 hours. At the outset, it is clear that if we wish to transmit large parcels of power—say 100 h. p. and upwards—by storage batteries, we must be able to deliver the power at a cost higher, it would obviously pay better to establish a local steam-engine. I have already mentioned that a system of battery transmission can be made to yield 56 per cent. efficiency, if we allow 10 per cent. for the transmission itself. To deliver 100 h. p. we must, therefore, charge with 178 h. p. during the time equal to that during which the power is required. If, therefore, at the generating station the annual horse-power costs £3, the charge for power alone will be £5 6s. at the receiving station. To this must be added the cost of labor and the interest and depreciation of plant, which, in this case, consists of the generating dynamo, motor batteries, and line of transmission, with its equipment of locomotives and waggons. The small storage cells, as now made, for lighting and power purposes, cost about £40 per horse-power; but let us assume that the larger cells, such as we would require, could be had for £30 per horse power, then a battery to work a 100 h. p. would cost £3,330. In order to economize carriage, and to reduce the wear and tear of cells, it would be advantageous to have two batteries, one being charged while the other is at work. We have thus an initial outlay of £6,660 for batteries alone. The interest and depreciation on these will certainly not be less than 15 per cent., or £10 per horse-power. Add to this, the cost of power at the generating station, that of labor and interest and depreciation on the electric machinery and the line, and you will see that it is quite impossible to compete with battery transmission against a local steam-engine, if the power produced by the latter costs £10 per annum. But how does the case stand, if the amount of power required is so small that it cannot be produced at this low figure? If we want only 5 h. p., and if we produce it by a local steam or gas engine, we shall have to pay for each horse power £20 to £40 per annum. Will it, in this case, pay to transmit by means of batteries, the power produced by a large and economical steam-engine at some central station? If we have to build a tramway or railway for this purpose specially, it will certainly not pay; but let us assume that a tramway already exists, and let us investigate whether the company, which we suppose is working the line by storage cars, could afford to sell to a customer on the line power at a cheaper rate than he could produce by a local engine. Let us assume, by way of example, that the customer requires 5 h. p. for 10 hours daily. The battery to work a 5 h. p. motor will weigh about 2½ tons, and cost £170. The charging dynamo, motor, and regulating gear will cost about £150, so that the whole capital outlay, if we provide two batteries, will amount to £490.

(To be Continued.)

THE ENGINEER OF THE FUTURE.

SINCE the introduction of electricity into common, matter of fact, every day life, says W. D. Tomlin, in *Practical Electricity*, the demands for economical power have pressed hard on the brain of the constructing engineer. Some men have boasted that steam as a motive power is doomed and its days are numbered, that electricity is the coming power. Perhaps it is, but the recent developments tend toward the employment of stupendous steam power to produce electricity; simply because electricity can be distributed at a far less percentage of loss than any other motor. You cannot carry steam 200 feet without considerable condensation, but you can distribute electricity nearly 200 miles, and at the point of distribution your amperes will be almost initial. You cannot transmit h. p. by gearing, rope, belting or otherwise without a loss of power by slippage, friction or kindred causes; but you can distribute electricity through ten miles of lines and give to each renter his pound of electricity through a small dynamo just in proportion as his contract calls for. Young men, I can assure you of one thing,—go into the city and ask for employment as engineer; about the first thing you are asked, is: "Do you know anything about taking care of a dynamo or electric plant?" "No;" "Well, we don't want you. Good morning!" It has become almost a necessity that an engineer should know something of electricity if he expects to secure employment. But on the different motor lines, the effect, to an engineer whose earlier experience has been with slide valve, is almost paralyzing. Some form of Corliss valve gear, but the steam expanded through three cylinders and then condensed. The apparent complexity becomes simplicity itself when in the hands of a single man who operates the engine for expansion results, with cylinders 16½", 28", and 42" by 60" stroke at 65 rev., in 150 pounds initial pressure, giving 1,400 h. p. Look through any prominent engineering journal, and you will find from a dozen to fifteen valve gear motions. An adjunct of the Corliss engine is the indicator,—and the time is rapidly coming to us when an engineer's education will be incomplete who cannot use an indicator and adjust the valves of his engine. What the stethoscope is to the doctor, the indicator is to the engineer. Both the professions are thus enabled to examine the breathing organs of the patient. The use of an indicator, while reflecting credit on the engineer who can use it, is a possible benefit to the steam user and owner; because thereby the coal pile is considered. The owner gets the full benefit of every pound of fuel saved, the saving being a bona-fide transaction often affecting the balance of a set of books from a debt to the credit account.

The time is close at hand when an indicator will be a part of the engine room outfit, and a daily engine log be as carefully kept as the double entry set of books in the general office.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

THE fifth annual dinner of the above Society was held at the Richardson House, Toronto, on the evening of the 11th of November. There was a good attendance of members and invited guests, and as on former occasions, the evening throughout was one of pleasure and profit.

Mr. W. Lewis occupied the chair, and in his introductory remarks said:—"We always look forward to our anniversary dinner with pleasure, and I wish to say for the information of the gentlemen present to-night who are not members, that our Association is progressing favorably. Of course we have not as many members as we should have, but the Association is steadily gaining ground, and as far as engineering is concerned, I know it is a good thing for any man. I ask all present to respond to the toast of "Her Majesty the Queen" by singing heartily the national anthem.

Mr. Geo. Grant followed with a song, receiving a hearty encore.

Mr. J. A. Wills responded to "Canada Our Home," and said: "Brethren, as a true Canadian, words cannot express my feelings towards this gathering tonight; regarding this country I wish to say that as long as her sons stand, it cannot be shaken. We have in this young land a steamship line, and a railroad second to none. Our manufacturers can turn out engines and machinery equal to any other country, and Canadians in general can take their place with the people of any other nation."

Mr. Blackgrove followed with a song.

Prof. Galbraith, of the School of Practical Science, said that this was the fifth dinner he had had the pleasure of attending under the auspices of the Association, and he trusted it would not be the last. He hoped to have the pleasure of inviting them all up some evening to try their skill in running the engines, and he would give them a good fair test. He continued: You know we are making endeavors to promote education in this city, not only for those who can give up their whole time, but for others who can come in the evenings. Men entering this line of work require a certain amount of education and a certain amount of mathematics. The evening school was mainly for the benefit of the city, as young men coming from other places would be under expense and would want to devote their whole time to the instruction given them. These schools should be under the Minister of Education. I notice here your motto, "Knowledge is Power," and it struck me that there are different kinds of knowledge that make power. One kind of knowledge is gained by a man's own experience; another kind we call instinctive knowledge—that you feel in your bones and cannot impart to others—and others that I will not now attempt to explain. I thank you for your kind attention, and hope in the future as in the past, the society will increase in membership and go on in this good work.

Mr. John Inglis said he was very glad to see so much interest manifested, and thought the society deserved a great deal of credit. As a manufacturing city, he thought Toronto stood at the head in Canada. He came here ten years ago, and had never regretted doing so. He observed in that period a vast growth in all the different branches of industry. In referring to past years he remarked how many young men had had to go out into the world without any education at all, and poor people could not think of attending a technical school. Now it is different, and he was glad that Toronto had taken it in hand to help young men to get a higher education. He was very much pleased to be present and hoped it would not be the last time, as the occasion had proved a very happy one to him.

Mr. Brown, of Galt, Ont., was pleased to be present. He could not say it was the first time he had enjoyed the hospitality of this Association, as he had a very enjoyable time at the picnic in July last. It was difficult to imagine the good the Association had done and is doing. There was a good class of men looking after the work. It was the duty of each one to help his fellow. By instructing their brethren they would also be helping themselves.

Mr. Dixon was glad to note the progress that steam engineering had made. He remembered when a boy the question being asked at school, "What is steam?" and that one boy answered that it was "hot water under a very heavy perspiration." No matter how low the perspiration was, it required special attention. The society had made a step in the right direction in seeking to place men in this calling at the head of their profession. The society being both benevolent and educational, there was not a doubt but that it would prosper.

Mr. Watts wished the society every success, as he knew the grand work it was doing to promote engineering knowledge.

Mr. Robb, of Hamilton, remarked that the branch of the society in that city was advancing rapidly, and now has 40 members in good standing. He was glad that such an Association had been started in our country, and thought that any man desirous of learning would receive benefit from its meetings. He trusted that this would not be his last time with them.

Messrs. Kenney, Oliver, Orr, Montgomery, and others expressed their desire that the society should continue to advance.

Mr. Wickens returned thanks for the many kind words spoken of the Canadian Association of Stationary Engineers. This was a meeting very near to his heart. While a good deal had been said, there had not been anything said about the work of the Association. The members met together every two weeks for social and beneficial instruction. Different subjects of a technical character were discussed, all being interested and benefitted. The branches of the society now extended from Montreal to Brandon, Man. Referring to the time that is to come, he remarked that a few years ago an engineer was little thought of. It was now different, and the time was coming when an engineer would occupy a much higher position in public estimation than at present. In conclusion, if the engineers would band themselves together, there was not a doubt but that they would be able to "keep up with the procession."

ABOUT STEAM PUMPS.

THE distance that a pump will lift or draw water, as it is termed, is about 33 feet, because water of one-inch area 33 feet weighs 14.7 pounds; but pumps must be in good order to lift 33 feet, and all pipes must be air-tight. Pumps will give better satisfaction lifting from 22 to 25 feet. There are many things to be considered in locating steam pumps, such as the source from which the water is obtained, the point of delivery, and the quantity required in a given time; whether the water is to be lifted or flowed to the pump; whether it is to be forced directly into the boiler, or raised into a tank 25, 50 or 100 feet above the pump.

When purchasing a steam pump to supply a steam boiler, one should be selected capable of delivering one cubic foot of water per horse power per hour.

No pump, however good, will lift hot water, because as soon as the air is expelled from the barrel of the pump the vapor occupies the space, destroys the vacuum, and interferes with the supply of water. As a result of this the pump knocks. When it becomes necessary to pump hot water, the pump should be placed below the supply, so that the water may flow into the valve chamber.

The most necessary condition to the satisfactory working of the steam pump is a full and steady supply of water. The pipe connections should, in no case, be smaller than the openings in the pump. The suction lift and delivery pipes should be as straight and smooth on the inside as possible.

When the water contains chips, shavings or sawdust, a strainer should be placed on the lower end of the pipe.

When the lift is high, or the suction long, a foot valve should be placed on the end of the suction pipe, and the area of the foot valve should exceed the area of the pipe.

A suction air chamber is a great advantage to the pump when the lift is high.

The area of the steam and exhaust pipes should in all cases be fully as large as the nipples in the pump to which they are attached.

The cylinders of steam pumps should in all cases be oiled before starting in the morning or stopping at night.

Stuffing boxes on the piston and valve rods should in all cases be kept with soft, moist packing, as, if the packing is allowed to become hard and dry, it will flute the rods, inducing leakage, and necessitating repairs.

The air vessel on the delivery pipe of the steam pump should never be less than five times the area of the water cylinder.

When pumps are standing still, idle or out of service in cold weather, all the drain, drip and pet-cocks should be left open.

OHM'S LAW.

No exact ideas are possible about the action of electricity without a thorough understanding of Ohm's Law. This is as necessary to the electrician as correct ideas about the strength of materials are to the engineer. An electrical engineer has to deal quantitatively not only with electrical currents, but also with the pressure or potential at which they are supplied. The power of a river to turn a waterwheel is dependent both on the magnitude of the current of water and on the amount of the fall which the water suffers. The most important thing an engineer has to deal with is power, or rate of doing work, and this is measured both with electricity and with water by the product of the current and the difference of pressure or head. Instruments can be made to measure both quantities, but an engineer must not rely on subsequent measurements, he must be able to calculate in advance, and it is in this connection that Ohm's law is so important, for it states the relation between current and potential, and its value is all the greater because the relation is a simple one.

No relation such as Ohm's Law can be established until a general agreement is arrived at as to the way in which currents and potentials are to be measured. We have seen in Primer No. 1 that an electric current produces effects of various kinds, and each one of these may be taken as a basis of measurement. They are, however, not all equally suitable. Thus the strength of a current might be regarded as proportional to the excess of temperature of the conductor heated by the current above that of the atmosphere; but this would be a very bad definition, for the excess in question would be dependent on many circumstances over which the current would have no influence; it would be a very inconvenient definition of current strength, it would not fit in with any other, and it would be impossible to make measuring instruments agree among themselves. There are, however, two effects of an electric current which are found to be strictly proportional to each other. The magnetic force exerted by a current is found to be accurately proportional to the rate of decomposition of an electrolyte placed in circuit. If several voltameters or electrolytic resistances are placed one after the other in the same circuit, the rates of decomposition bear a constant ratio to each other; so that if one is doubled all the others are doubled, even though the electrolytes are quite different in the various voltameters. The magnetic and electrolytic definitions of current strength thus lead to the same result; and, chiefly for this reason, the magnetic definition is adopted, and current meters are graduated in accordance with it. Similar reasons determine the way in which potential is measured, the definition adopted depending on the force of attraction exerted between two electrically charged parallel plates whose linear dimensions are large compared with their distance apart.

Ohm's Law states that the difference of electric pressure, or potential, required to drive a current through a given conductor is strictly proportional to the magnitude of the current while the physical state of the conductor remains the same. The ratio of the two is defined to be the resistance of the conductor. This definition of resistance implies that the current (measured in amperes) flowing through a conductor is obtained by dividing the electric pressure or difference of potential (in volts) at its terminals by the resistance of the conductor measured in ohms. The law of Ohm implies more than this, however, for it states that a conductor whose resistance is one ohm has always a resistance of one ohm whatever the current flowing through it may be, provided only that no external influence, or indirect action of the current itself, conspires to alter the physical state of the conductor. The resistance of a conductor is thus a physical property of the substance itself, and is not dependent on the current flowing through it. If the resistance of a material varied with the current flowing, it would be very much harder to make calculations about conductors than it is by using Ohm's Law. To take an illustration from mechanics, if we are told that a given material will stand a pull of two tons per square inch we know that a bar whose section is four square inches will stand a pull of eight tons, because we are aware that, so long as the physical state of the material is not altered by heating or any other means, the strength of a bar is proportional to its section. This law, which corresponds with Ohm's Law, is very convenient for calculation, because, by means of one constant for a given material, we can calculate the strength of a bar of that substance, no matter what its section may be, by simply multiplying the section by the constant. In the above instance the constant 2 tons per square inch would be of little use to us if we were told it only applied to bars whose section was 4 square inches, and that for bars of any other section the constant would be different. Ohm's Law enables us to calculate from the dimensions of the conductor and a single constant of the material, called the specific resistance, what the resistance of the conductor is. We have no need to take the current into account, because it makes no difference.

The resistance of a conductor is proportional to its length; for if we take two similar conductors of resistance one ohm and join them in series, so that the end of one is connected with the beginning of the other, each will require one volt difference of potential to send an ampere through it, and hence the difference of potential of the unjoined ends when the current flowing is one ampere will be two volts. The resistance of the combined conductors, being by definition the ratio of the volts to the amperes, will therefore be two ohms, or twice the resistance of each. We may see similarly that the resistance of a conductor is inversely proportional to its section, for, if we connect the above-mentioned conductors in parallel, so that they are joined together at each end, and send a current through the combination, a difference of potential of one volt maintained at the ends will drive a current of one ampere through each conductor, and the total current transmitted by the compound conductor will be two amperes. The resistance will thus by definition be half an ohm, or half the resistance of the single conductor, while the section is double. To obtain the resistance of a conductor we thus multiply the specific resistance of the material by the length of the conductor and divide by the section. The resistance of a copper wire 1 mile long and one quarter of an inch in diameter may thus be calculated as follows:

The specific resistance of copper is 1·6 microhm (millionths of an ohm) per cubic centimetre.

The length of the conductor is 1760×36 inches,

or $$1760 \times 36 \times 2{\cdot}54 = 161{,}000 \text{ centimetres.}$$

The section of the conductor is $\frac{\pi}{4}(\tfrac{1}{4})^2$ square inches,

or $$\frac{\pi}{4} \times \frac{2{\cdot}54}{4} \times \frac{2{\cdot}54}{4} = {\cdot}32 \text{ square centimetre,}$$

and the resistance of the conductor is thus,

$$\frac{161{,}000}{0{\cdot}32} \times \frac{1{\cdot}6}{1{,}000{,}000} \text{ ohms} = 0{\cdot}8 \text{ ohm.}$$

As the specific resistance of copper is 0·6 microhm per cubic inch, we might have calculated the resistance of the above conductor without introducing the factors 2·54 if we had used the constant 0·6 instead of 1·6, but whether the centimetre or the inch be used for the unit of length it is always necessary to reduce the dimensions to the particular unit chosen.

Having calculated the resistance R of the conductor in ohms, we can find the number of volts V required to send a current C amperes through it by means of the formula,

$$V = CR;$$

and if a battery of electromotive force E and internal resistance r have its terminals connected with the ends of the conductor in question, the current flowing, which is obtained by dividing the electromotive force of the circuit by the *total* resistance, will be given by the formula,

$$C = \frac{E}{r+R}$$

The volts needed to drive this current through the battery will, in accordance with what we have said, be

$$v = Cr$$

The volts at the terminals of the wire—that is, the difference of potential at the terminals of the battery—is $V = CR$, so that by addition we have

$$V + v = CR + Cr = C\,(R + r),$$

or, by comparison with the equation giving the value of C,

$$V + v = E.$$

So that the electromotive force E of the battery, which is a constant, is spent, partly in driving a current through the battery itself, and partly in sending the current through the wire; and the potential difference at the terminals of a cell differs from its fixed electromotive force by the number of volts necessary to drive the current through the battery. Although the electromotive force of a battery is constant, the useful part of it, that available for external purposes, varies with the current sent, unless the internal resistance of the cell is inappreciable.

The value of V is not always less than E.

When a current is sent through the battery in the opposite direction to that which the cell would naturally produce, V exceeds E by the product of Cr.—"*The Electrician*" *Primers.*

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

BY WILLIAM BARNET LE VAN

(Continued from November Number.)

The results of the two formulas are given below:

Formula 24, as calculated: $A=21.23\sqrt{\frac{1}{p}\left\{\frac{1}{p+15.052}+0.0195\right\}}$

Pressure in pounds per square inch.	10	20	30	40	50	60	70	80	100	120
Area of safety valve per square foot of grate (sq. inches).	1.33	0.815	0.589	0.465	0.384	0.328	0.287	0.257	0.209	0.178

Formula 25, as given in French law: $A=\frac{225\ G}{p+8.62}$

Pressure in pounds per square inch.	10	20	30	40	50	60	70	80	100	120
Area of safety valve per square foot of grate (sq. inches).	1.21	0.786	0.583	0.461	0.384	0.328	0.286	0.254	0.207	0.125

This coincidence of results could only have existed from having the same basis, and the difference of form of the two second terms can only have arisen from the using of some other and more tractable empirical formula for the volume of steam by those who originated the French rule.

The divergence below 20 pounds we do not consider essential, whether the calculated formula gives too large values or the French one gives too small, and we would recommend for adoption the more simple formula

$$A=\frac{22.5\ G}{p+8.62}\ \ldots\ldots\ldots\ldots\ 26$$

It next remains to show the results of this formula when applied to practical cases, so as to see how nearly it is corroborated by the use of our American stationary boiler-makers.

We give tables of two pressures—50 pounds and 80 pounds per square inch—and for areas of grates from 4 to 25 square feet of grate as follows

Areas for Safety Valves for Boilers with 80 pounds Pressure (A=0.254), and with Grates of different Dimensions.

Surface of grate in square feet....	4	6	9	12	16	20	52
Estimated area of safety valve....	1	1.5	2.25	3	4	5	6.25
Estimated diameter of safety valve in nearest whole numbers of quarters of inches....	1¼	1½	1¾	2	2¼	2½	3

Areas for Safety Valves for Boilers with 50 pounds Pressure (A=0.384), and with Grates of different Dimensions.

Surface of grate in square feet....	4	6	9	12	16	20	25
Estimated area of safety valve....	1.52	2.28	3.42	4.56	6.08	7.60	8.50
Estimated diameter of safety valve in nearest whole number of quarters of inch	1½	1¾	2¼	2½	2¾	3¼	3½

We think these dimensions correspond very nearly to the practice of all experienced constructors, and exhibit at once the usual size of safety valve, and that of the main steam pipe, generally employed.

If we adopt the formula as expressing the proper areas of safety valves for stationary boilers, which are not prepared to burn upon their grates more than eight pounds of coal per hour on the average, we have next to show how it can be applied to other conditions. With natural draught, the rapidity of combustion depends, in a great measure, upon the intensity of the fire, and a maximum rate of 24 pounds may, and probably does, accompany an average rate of 8 pounds of coal per square foot of grate per hour, while with artificial draught, or blast, this rapidity of combustion is nearly independent of the condition of the fuel, and a maximum rate of 24 pounds will hardly be exceeded with an average one of 16 pounds. We think it safe to take this quantity of 16 pounds average combustion per hour, with or by the aid of induced or produced supply of air to the fuel (as with jets or by fans), as an equivalent to the one square foot of grate surface which he had taken as the unit of comparison with the area of the safety valve. That is, the area of one square foot of grate, *without* artificially accelerated draught, may be assumed to require the same area of safety valve, as the burning of 16 pounds of coal per hour, *with* such draught properly demands.

As regards those boilers which are heated by the waste heat of furnaces, or by the combustion of waste gases from some process of manufacture, the circumstances are too variable to admit of statement in any law, and only the judgment of competent mechanics upon the performance of such boilers or steam generators can determine the proper area of safety valves for them.

If the area given by the formula be applied to the opening of the seat of the safety valve, it is obvious that the vertical lift of the valve must be at least one-fourth the diameter, to have the same sectional area when open.

Hence, should any valve be so constructed that the range of motion will not admit, when fully raised, a lift equal to one-fourth the diameter of the opening of the seat of the valve, the sectional area actually given between the raised valve and the edge of the valve seat should be taken as that to which the rule applies.

And while the formula gives areas abundantly large to meet the general resistance to discharge, which proceeds from the necessary form of a disk resting upon, or placed in proximity to, a seat, we think we ought here to state that it is always advisable that the under sides of safety valve disks should have a globular or pointed form (whether with or without guide-wings), and not made flat, as they sometimes are, and that the disks be beveled-edged, resting upon a very narrow bevelled seat, and do not have a flat bearing. It may be well to state, also, that, as ordinarily constructed, a safety valve, after lifting and allowing a flow of steam all around the disk, does not continue to raise and allow all the steam, as formed, to escape at the constant pressure, but admits some elevation of pressure before opening wide. With the areas given by the formula, and where the disks have been shaped as we have before described, this increase of pressure will not exceed 10 per cent. of the initial load on the valve, and the additional resistance to opening is a safeguard against the too sudden relief of steam, to the derangement of the water circulation of the boiler.

The committee will only add, as regards further consideration of the form or description of safety valves, and as to legal requirements beyond the adequacy of the openings, that the subject becomes too extensive for them to consider.

As originally made in the days of Watt—almost as planned by Papin—the essential parts of the safety valve have substantially remained until this time. No patent covers its simplicity or improves its certainty, although there have been made and used a thousand kinds, and there are a hundred existing patents.

It can only be imperfect by palpable misconstruction, or unsafe by vicious intent, and we can only recommend the defects to competent inspection, with power to remedy, and the misuse to the punishment of the law. There is very little likelihood that a safety valve, properly constructed, and in proper hands, would get out of order or fail to act at the needed moment. But, on the supposition that such a catastrophe might occur, it has been thought by the committee, after much deliberation, that, in order to divide the small chance for failure, it may be as well to make it a legal requirement, that in place of one safety valve, each and every boiler shall have at least two, the aggregate area of which should be that established by the formula.

These valves ought to be loaded with the same load, and blow off indiscriminately, so that either or both may be in action at once. This plan would call for, and insure, more care in graduating the loads on safety valves than is at present employed. The committee feel justified in observing that there are now in use more safety valves improperly graduated or marked than there are those imperfectly or unsuitably constructed. Lock-up safety valves afford but little protection from fraud or over-pressure and less security, unless frequently tested; and their use is decidedly discountenanced by the committee. We conclude our discussion of this branch of the subject committed to us, by recommending for the approval of the Institute the following

SCHEDULE,

giving the least aggregate area of safety valves (being the least sectional area for the discharge of steam) to be placed upon all stationary boilers with natural or chimney draft. This area may be expressed by the formula:

$$A=\frac{22.5\ G}{p+8.62}$$

in which

A=area of combined safety valve in square inches.

G=surface of grate in square feet.

p=pressure of steam in pounds per square inch to be carried in the boiler above the atmosphere, as shown by the steam guage.

The following table gives the results of the formula for one square foot of grate, as applied to boilers used at different pressures:

Pressure in lbs per sq. inch.	10	20	30	40	50	60	70	80	90	100	120
Area in sq. ins. corresponding to each square foot of grate.	1.21	0.79	0.58	0.46	0.38	0.33	0.29	0.25	0.23	0.21	0.17

We give one example of the application of the figures given by the table

Suppose the boiler to be worked under 60 pounds pressure, then each square foot of grate surface should have an area of safety valve, by the table, of } = 0.33 square inch.

Suppose the boiler to have 18½ square feet of grate surface } = 18.5

18.5 × 0.33 = 6.105 square inches area for the safety valve.

This would call for two safety valves, each having an area of 3.05 square inches, or a diameter of 2 inches. Where boilers have a forced or artificial draft, the combustion of 16 pounds of coal per hour should be taken as equivalent to the one square foot of grate surface=G in the above formula and table.

Where boilers are heated by the waste heat of furnaces, or otherwise than by fire upon grates, the value to be taken for G must be estimated by some competent person, based upon the comparative performance of boilers with others heated in the usual way.

And the committee would report on the second branch of the subject referred to them the legal requirements which ought to be made as to pressure gauges that the time allotted to them has not permitted a complete investigation The great advantage which any of these instruments possess is found in their indicating the pressure of steam within a boiler, so as to allow a fireman to regulate his supply of fuel with economy. There are many kinds and forms of gauges, almost every one of which has some characteristic superiority over all, or most other kinds and forms, but we do not wish to say that any of them are perfectly or permanently reliable.

And your committee would ask to be relieved from further consideration of the subjects referred to them.

ROBERT BRIGGS,
COLEMAN SELLERS,
J. VAUGHAN MERRICK,
WM. BARNET LE VAN.

Steam pressure p as per Steam Gauge.	AREAS OF VALVES AS RECOMMENDED BY THE FOLLOWING COUNTRIES.			
	British	Scottish.	Prussian.	America. Franklin Institute.
	$A = \frac{G}{2}$	$A = \frac{G\ 18}{p+15} 2$	$A = \frac{1.2}{p+15} \square$	$A = \frac{G\ 22.5}{p+8.62}$
5	10	36	36	33
10	10	28.8	28.8	23.11
15	10	24	24	19
20	10	20.4	20.4	15.7
25	10	18	18	13.38
30	10	16	15.6	11.6
35	10	14.4	14.4	10.3
40	10	13	12.6	9.25
45	10	12	12	8.4
50	10	11	10.8	7.6
55	10	10.28	10.2	7
60	10	9.6	9.6	6.5
65	10	9	9	6
70	10	8.46	8.4	5.7
75	10	8	7.8	5.3
80	10	7.58	7.5	5
85	10	7.2	7.2	4.8
90	10	6.84	6.84	4.5
95	10	6.54	6.54	4.34
100	10	6.26	6.24	4.14

It will hereafter be shown by the experiments of James Brownlee, of the Institution of Engineers and Ship-Builders, in Scotland, that the Franklin Institute formula, although giving the smallest area of valve, is, at all steam pressures above 25 pounds per square inch, when full open (one-quarter the diameter of valve outlet), five times that requisite to discharge all the steam generated, the Scottish and Prussian rule, nine times; while by the British formula it is four and a half times at 25 pounds steam pressure, and eighteen times more than is required at 130 pounds pressure; and this, after allowing for an evaporation of 3 pounds of water per minute per square foot of fire grate, which is considerably more than is usually realized in practice.

So that with properly constructed safety valves, which will rise one-fourth of their diameter by an increase of 1 to 5 pounds above the load, there is no necessity for the area being much (if any) more than one-fifth of that called for by the Franklin Institute formula.

But as boilers are made of iron and steel—and as these materials, like men, wear out—the Franklin Institute formula gives ample margin for reduction of the steam pressure as the boiler deteriorates with age, so by the time the area becomes too small the boiler will have to be renewed.

In 1874, a most interesting series of experiments on safety valves was made by a committee of the Institution of Engineers and Ship-Builders of Scotland A discussion had arisen among the Scottish and English engineers relative to the proper construction of a safety valve, and the rules of the English Board of Trade as to the areas required and the mode of loading the valves.

In this trial two safety valves only were tested those approved by the English Board of Trade—the united areas of which were one-half of a square inch area to each square foot of grate surface. The boiler used in this experiment was of the tubular kind, and the grate surface was 25 feet, the heating surface, 746 square feet. The safety valves were each 2⅞ inches diameter. The safety valves were loaded with weights direct.

(To be Continued.)

Charles Myles proposes to establish an electric railway between Hamilton and Grimsby.

The electric light has temporarily at least made its exit from the town of Richmond, Que. A correspondent writes "We did not properly appreciate the benefits of the light till we lost it."

The corporation of the town of Orillia, Ont., have seemingly ceased to regard electric lighting by the municipality in the light of a bonanza, and have sold their plant and given a contract for lighting to Mr. Byone.

SPARKS.

Edmonton, N.W.T., has a telephone exchange of thirty-one instruments, or one telephone for every twenty-two inhabitants.

The town council of Woodstock, Ont., is said to have refused to grant to the Edison Co. a franchise to install and operate an incandescent plant.

A pleasant event in social circles at Stratford, recently, was the marriage of Minnie, second daughter of Mr. John Reid, manager of the Stratford Gas and Electric Light Co., to Dr. E. H. Eidt.

The electric street car traffic in New Westminster is said to be fairly good, and the demand for seats or even standing room on the inter-city electric tram cars is about double the present supply.

Mr. W. C. McDonald has presented to McGill College a library of 295 volumes, in English, French and German, comprising the leading works on electrical science and its application to industrial uses. There are also a number of works on mechanical and other scientific subjects.

One of the cars of the Ottawa electric street railway collided with a lumber train at a crossing the other evening, owing to the motorneer not seeing the railway signal man's light. The motorneer reversed so as to save part of the shock. The five passengers were badly shaken, but nobody was seriously hurt. The car was wrecked.

At a meeting of the Committee on Electricity, Electrical and Pneumatic Appliances, of the World's Columbian Exposition, held Oct. 26th, the following names were decided upon as those of eminent electricians not now living, to be placed over the electricity building at the exposition, namely:—Franklin, Galvani, Ampere, Faraday, Ohm, Sturgeon, Morse, Siemens, Davy, Volta, Henry, Oersted, Coulomb, Ronald, Page, Weber, Gilbert, Davenport, Soemmering, Don Silva, Arago, Daniell, Wheatstone, Jacobi, Gauss, Vail, Bain, De la Rive, Joule, Saussure, Cooke, Steinheil, Varley, Guericke, La Place, Channing, Pries ley, Maxwell, Coxe, Thales, Cavendish.

The North American Mill Building Co., of Stratford, Ont., gives notice of its intention to apply to have its corporate powers extended so that it will have (*a*) Authority to construct, maintain and operate works for the production, sale and distribution of electricity for the purposes of light, heat, and power; (*b*) Authority to enter into any contract for the supplying of electric or steam power to any person, firm or corporation, and (*c*) Authority to take and hold stock in any company now or hereafter to be incorporated for the purpose of constructing, maintaining and operating works for the production, sale and distribution of electricity for the purposes of light, heat and power.

Canadians feel justly proud of their fine telephone and telegraphic communications. The admirable telephone service enjoyed by Montreal and Toronto may be largely attributed to the fact that no one company has the monopoly of manufacturing telephones. The credit for this is greatly due to Mr. W. C. Hibbard, late of the Hibbard Electrical Manufacturing Co., of Montreal. The Bell Telephone Co. originally obtained in Canada the patents which they had previously secured in the United States, but instead of manufacturing their instruments in the country within one year, as the law demands, they brought the various parts from the States and put them together here. Mr. Hibbard grasped the situation and began to make telephones. Although the Bell Telephone Co. brought suit against him, they were defeated and the patent became invalid. Now anybody may manufacture telephones in Canada.—*Electricity.*

NOTES.

The same rule which applies to constant feed with pumps, says Robt. Grimshaw, in "Hints to Power Users," holds good where injectors are used; there should always be a stream of water going into the boiler, so long as there is a current of steam going out of it.

The proprietors of the Ridgetown, Ont., roller mills recently commenced to use natural gas as a fuel in their engine room. The gas is taken in through air mixers and through the bridge walls to the crown sheet of the boiler Sixteen burners are used, eight on each side. The results are said to be entirely satisfactory.

Mr. A. E. Edkins, for some time past in charge of the steam and electric plant at Messrs. T. Eaton & Co.'s, Toronto, has accepted a position as inspector with the Boiler Insurance and Inspection Co., and will enter upon his duties at once. Mr. Wilson Phillips has been engaged by Messrs. Eaton & Co. to succeed Mr. Edkins.

A recent departure in obtaining extra draught for furnaces on steamships without the use of blowers or other devices has been successfully tried on the Scot, of the Cape Mail line. This vessel has been furnished with smoke stacks 120 feet high above the grates. The increased draught is equivalent to a water pressure of three-fourths of an inch.

TRADE NOTES.

We have pleasure in introducing to the readers of the NEWS the Toronto Electrical Construction and Supply Co., in whose advertisement appears an important announcement by the Thomson-Houston International Electric Co., of Boston, to the effect that they have appointed this company sole agents for their apparatus in Canada.

Mr. Alonzo W Spooner, of Port Hope, Ont., whose name is familiar to our readers as the manufacturer of "Copperine" anti-friction metal, announces in this issue that he has secured the sole right to manufacture "Phenyle," a disinfectant, deodorizer and germicide, which is said to be effective in the prevention of disease in manufactories, dwellings, etc.

A PERFECT ELECTRICAL RAILWAY MOTOR.*

By H. A. Everett.

For the past eight years the writer has been very intensely interested in the perfection of electric motors. The first experiments were made in the summer of 1883, but during the previous winter we had been carefully watching the operation of an electric system in the private premises of one of the large manufacturing companies, and had seen the motor operate under all conditions of weather—though, of course, experimentally. We had come to the conclusion that it was just the thing, and had hopes that it would revolutionize travel the world over. On application to the city government we were given the right to build one-and-a-half miles of railway, with an electric conduit. The troubles and vexations we experienced with the conduit are not covered by the title of my paper, and I will endeavor to confine myself to explaining the changes that were required in the motor.

The first fundamental error made by the electricians was in the idea of increasing the voltage in proportion to the number of cars run, which of course would be impracticable in a system of any size, but we did not know that then. We got out our experimental car, and quite frequently, for a few hours, it would work magnificently, giving a speed of twenty-two miles per hour with the utmost ease, and running forward or backward with one or two loaded trailers in fine shape. We were quite well satisfied with the experiment with the one car, but insisted on having a second and third car placed on the line before adopting it generally. We finally got the second car running, and were very much dispirited to find that the speed of both cars was immediately reduced to about four miles per hour. This result was, of course, very unfortunate for us. Returning to my subject, in starting in with the motors we tried wire rope transmission from the armature to a drum on the axle, but it did not work at all satisfactorily, the ropes oftentimes stretching too much. We then tried manilla rope transmission, but that also had its weak points, and the change to friction gear also proved unsuccessful. After these various trials, the late Richard N. Allan requested us to allow him to gear it at his own expense, with a system of cog gearing which he was quite sure would prove successful. We very gladly gave him permission to put in the gearing, and (this style of gearing has been practically adopted by all the prominent electrical companies in the country) after trying to operate this line for about a year and three months, we gave the matter up for the time being, believing that it was impracticable either to operate a conduit, or to operate by the system as suggested at that time, though never losing faith in the final outcome of electrical propulsion. We examined a great many motors and travelled over a large part of the United States to observe tests made of storage batteries of various kinds, but we were not at all satisfied as to their own successful practical operation, and, until we saw the road operating at Richmond with overhead wires, we had no desire to again enter into the matter of electrical propulsion, although it must be admitted that some of our people were willing to put in a system similar to the one at Scranton, even before the Richmond system was in operation. An electrical motor of three years ago should hardly be compared with the motors manufactured at the present time, and on the other hand, a motor that is considered perfect, or nearly so now, might be considered old-fashioned and obsolete within a much shorter period. We have made several tests of storage battery systems, and have watched with great interest the many tests made in that branch, and candidly we must admit that the practical successful application of storage batteries for street railway propulsion seems as far in the future as it did five years ago. Almost all street railway men admit that the storage system, if successful, would be the ideal system, and all hope for its ultimate achievement; and in this age of progress it would be very short-sighted and bigoted to say that it will ever come.

All of the prominent companies are eager to perfect their motors in the matter of details, and have cheerfully co-operated with the practical men running electric roads to bring about the improvement of their machinery. All the well-known systems of the day have some special points of advantage, but these I will not refer to, as it is not within my province to do so.

The motors when first constructed were altogether too light both mechanically and electrically, but these difficulties being overcome very rapidly, as well as the serious difficulty of too rapid motion, which swelled the operating expenses very largely in maintaining the parts and replacing the gearing. The best motors manufactured hereafter will be the most simple in the matter of the construction of the parts, and the same time not consuming too great a quantity of electricity, so that in addition to being simple they will also be economical. The principle of winding armatures is, of course, a pretty old one now, and each company is anxious to give its patrons the most efficient and best armature. I think it would be an improvement if in all machines made, a better insulated wire were used, in both armature and fields; a more reliable and positive fuse application, one that would always burn out while still under the capacity of the motor would also be a great improvement.

A great many corporations in operating motors do not appear to be willing to give them proper attention or inspection, with the result that weak points are very soon apparent; but this is in no way the fault of the manufacturer.

The writer expects within a very few years, as the motors are perfected and their armature speed reduced, to see a line of railway from New York to Chicago, run on the basis of not more than a two hour time-table for the through trip, and giving a transportation rate considered impossible with the present motive power. A great diversity of opinion exists as to the proper size of motor cars, a good many companies holding to the principle that a very large car is desirable and practicable. From our experience in operating cars from 16 to 30 feet in length, I am of the opinion that on routes having a small patronage, where the earnings are under 20 cents per car mile run, it is unwise and undesirable to have a car exceeding 21 feet in length inside, as it is much more economical to have trail cars when the traffic is heavy, rather than to be at the continuous daily expense of hauling a very large car of great weight.

I would again reiterate the fact that motors have been wonderfully perfected within the past year, and if as much progress is made during the coming year, there can be very little to ask in perfecting a motor, although it is very desirable that the mechanical application should be more carefully looked after. I do not think it was the intention to have me criticize in any way the special weak points of any system, but simply to refer to the whole in a general way. If you will pardon a short divergence from the subject, I will relate an incident which occurred last spring. A gentleman largely interested in street railways made the remark that in the city of New York they would never permit the use of electric motor cars, if accompanied with unsightly overhead wires. I asked him if it was quite consistent that so much objection should be made to a system that required but one copper wire, not exceeding three-eighths of an inch in diameter, with posts on either side of the street, 150 feet apart, with a diameter not greater than an ordinary hitching-post, after allowing on the street that beautiful structure, the "New York Elevated Railway," with its perfect (?) odorless, smokeless, noiseless steam locomotives, and shutting out both light and air to the people on the street where the railway is operated. He candidly admitted that he did not know but that the elevated road was about as bad as the overhead wires.

To resume my subject, at the present time all of the prominent companies are devoting the time and intellects of their best men to the perfection of a gearless motor. They all now have the single reduction motor in the market, which is certainly a wonderful achievement in advance of the late countershaft machines, and which ought to make a splendid exhibit when compared in the matter of operating expenses. But I have noticed one matter which the electrical companies seemed to have entirely overlooked in the manufacture of their apparatus, and I must say that this failure is universal.

All of the prominent companies seem to have fallen into the same error, and seem to persistently and maliciously continue in their evil ways. I do not think that any one subject connected with electric propulsion has received so much attention from the railways as this one and with so little co-operation and assistance from the electric companies. I, of course, refer to the price of their equipment. It appears to me that the companies, instead of operating 4,000 motor cars, could be operating 40,000 within a very short time, if they would bring the price down to a reasonable figure, so that all companies could afford to purchase an equipment. I think it would also be desirable if the electric companies would supply all the extra parts from their shops at a price allowing a reasonable margin for profit.

Before closing this paper, I desire to extend my sincere thanks to all the gentlemen connected with street railways who have so kindly given me the benefit of their experience on this subject.

In summing up my idea of a perfect street railway motor at the present time, I would say:

Taking the trolley wheel, pole and stand, I think it is desirable to have a wheel that is capable of following the wire at any angle, with a trolley pole brittle enough to break should it become entangled in the wires, without pulling them down, and a trolley spring rigid enough to give good, steady pressure on trolley wire, and so constructed that when the car is in the car house or going under a low bridge, the pole could come very close to the roof of the car, also flexible enough to give good pressure when the trolley has to be 21 or 22 feet high at the railway crossings.

The car should have a lamp circuit, with plenty of lamps distributed properly.

The perfect motor ought to have, as hereinbefore suggested, a reliable fuse plug that will invariably blow before injury is done to the machine.

Have on each car the best lightning arrester that can be secured in the market.

In coming to the motor proper, it is desirable to use a controlling switch that is easily operated and readily reversed in case of accidents. The simpler the controlling device the better, and it should be constructed with a view to guard against any possible disarrangement of the parts, so that it will be reliable in all cases, both electrically and mechanically.

The rheostat should also be carefully looked after and properly protected to keep it from injury by reason of water, snow or dirt getting upon it. It should only be available in starting the car to avoid the lunge of a start, and should be so arranged as to be cut out as soon as the car is started, and give the entire efficiency of the motor proper.

The motor should be well protected in all its parts from any outside interference, so that in running along the street it will be impossible to pick up nails, wire, or anything that would short circuit it, at the same time observing that a motor must be properly ventilated to keep it from heating while in use. The cover should be made so as to be easily removed.

I deem it very advisable to have an armature of a large diameter, making a small number of revolutions per minute, while the bearings should be made of extreme width with proper grease-cups, and in such a condition that they can be readily re-babited when slightly worn.

The diameter of the commutator should also be large, and to have the brushes easy of access is very desirable. The winding of the armature

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ought to be of the simplest kind, and the size of the wire and insulation of same should be carefully looked after. I think the insulation of wires in armatures is at present one of the weakest points in the motor.

The armature gears should have a wide face, and run in oil. The armature shaft ought to be of ample diameter, and there is nothing gained by having the keyway too small for the securing of the commutator to the shaft. The commutator should be carefully insulated, so that there will be no grounds between it and the case. The box in which the gear runs ought to be constructed of copper, or some light material that is somewhat flexible, so that if struck from the outside it will bend rather than break. The fields should also be wound with a wire of better insulation, and of ample size to take the current. Of course, in this particular, I do not intend that the wire of either the field or armature should be great enough to take more horse power than ought to be used by the machine. To my mind it is very desirable to have the armature in such a condition that it can be readily taken out from the machine and put in again.

One of the serious disadvantages to operators of electric roads is the expensive labor necessary in winding the armatures and fields, also in regard to high priced mechanics who ought to be employed to attend to the machines. There is nothing gained in employing a cheap class of labor to handle an electric equipment either as electricians, armature or field men or mechanics. This proposition is a self evident truth, as can readily be observed in many roads now in operation.

At present I think the single reduction motor is the nearest perfection of any on the market.

I think it very desirable that the electric companies should devote some time to the perfection of an electric brake to stop the car with the same power that runs it. This could be readily done and would be a satisfactory improvement.

Electric heaters are now used in quite a number of places and I think will prove quite satisfactory.

I have noticed electric signal bells on some of the cars, and they seem to work very well.

For a dasher gong on a motor car I am in favor of a foot tread, as in testing an electric gong we found that men used it altogether too freely.

I am in favor of an oil head-light one that can be removed easily, so that in the event of a trolley being broken or anything happening to the electric part of the car, or a light is desired underneath the car, the oil head-light can be used to better advantage than the electric. There ought also to be one oil light in every car for the same purpose. There is no reason why an electric fare register cannot be made to work successfully.

The durability of the motor is a question which requires very careful attention. The single reduction motor when properly looked after, ought to last for many years. We have had one in operation for over 10 months and it appears to be in as good condition as when it first went on the road. The car should be of moderate size, constructed with all modern conveniences but without fancy decorations or any unnecessary display.

The cars should be run on frequent headway and at all hours of the day and night, at as high a rate of speed as the civic authorities will permit. The noise of the motors has been very largely done away with, and by careful attention the old counter shaft machines can be used until worn out by simply covering the gearing with an oil box, and by not attempting to run them too many miles without inspection.

A residence at Peterboro has been fitted with electric lighting apparatus.

An unprofitable warfare is being waged between the rival electric light companies in Stratford.

SPARKS.

Morrisburg will shortly have an electric light plant in operation.

The National Electric Tramway and Lighting Co., of Victoria, B. C., will light the streets of the village of Esquimault.

The Barrie Electric Light Co.'s new station is nearing completion. Its capacity will be sufficient for double the present service.

The dynamo in connection with the Hanover electric light plant was disabled by an accident recently, and the town is in darkness pending the purchase of a new one.

A new car, built by Patterson & Corbin, of St. Catharines, and fitted with the Edison Company's appliances, has recently been put in service on the Metropolitan Street Railway Co.'s tracks, North Toronto. The car is 18 feet long and can accommodate 70 passengers. It is provided with two motors of 15 horse power each, and is lighted by electricity. It will be heated by four Burton electric heaters, being the first car to be heated with electricity in Canada. The maximum rate of speed is 18 miles an hour, with ability to mount grades at a speed 10 to 12 miles an hour. By means of the controlling switch the car can be stopped within five feet if necessary, when going at full speed.

Notice is given of an application for letters patent to incorporate the Citizens' Light and Power Company, with a capital of $50,000. The headquarters are to be at Montreal. The objects of the company are to contract for, construct, operate and maintain a system or systems for the supply of electric light and power to cities, towns, villages and other municipalities, corporations and individuals in the Dominion of Canada, and to conduct such electricity by any means on, through, under or along the sides of streets, highways, bridges and public places of such cities, towns, villages and other municipalities or across or under any navigable waters in Canada, the consent of the governor-in-council having been first obtained, etc. The applicants are: Thomas Badenach, merchant; John Bronskill Clarkson, accountant; John Thomas Hagar, manufacturer; Thomas Joseph Drummond, merchant; Charles Morton, agent; Richard Wilton, accountant; Herbert Montague Linnell, electrician; Joseph Emile Vanier, engineer; David Walker McLaren, manufacturer, and William John White, advocate, of Montreal, of whom Drummond, Vanier, Hagar, White and Clarkson are to be the first or provisional directors.

Dodge Wood Split Pulley Co.