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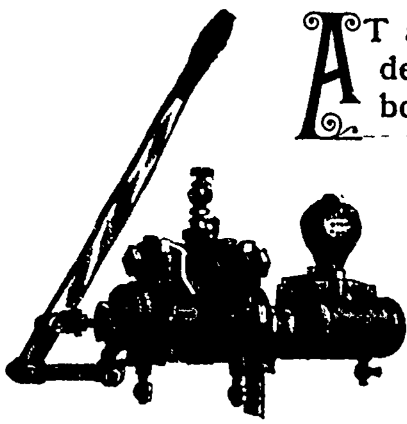

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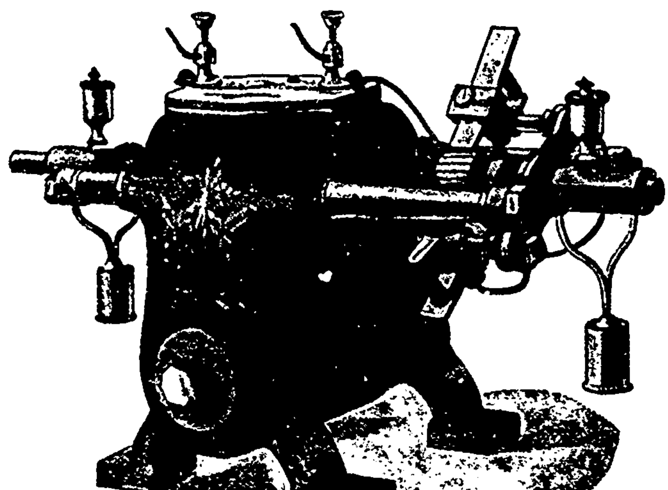

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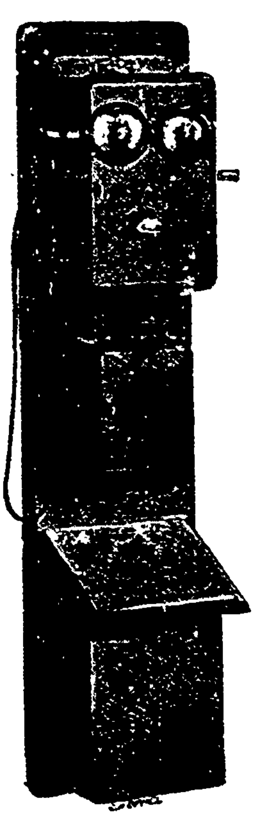

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ELECTRICAL NEWS

AND

STEAM ENGINEERING JOURNAL.

VOL. I. TORONTO AND MONTREAL, CANADA, NOVEMBER, 1891. No. 11.

OTTAWA ELECTRIC STREET RAILWAY.

WE take pleasure in presenting to our readers an illustration accompanied by a few particulars of the electric street railway recently completed and put in operation in the capital city of the Dominion.

The total length of the road is about ten miles. The guage is 4 ft. 8½ inches. The motive power is supplied by two 100 h. p. Westinghouse generators, driven by water power obtained from the Chaudiere.

The cars, sixteen in number, manufactured by Messrs. Patterson & Corbin, of St. Catharines, are each equipped with two 20 h.p. Westinghouse single reduction motors, and are lighted by incandescent lamps. T rails are used, and the roadbed and tracks are of the most substantial character. In fact, the construction of the road in every particular is in accordance with the most modern practice. The work was done under the direction of Messrs. Ahearn and Soper, of Ottawa.

The road has worked very satisfactorily, no difficulty being experienced in mounting the steep grades on certain portions of the line.

We regret to see it stated that by a curious blunder on the part of the provincial registrar's office the route of the railway is discovered to have been incorrectly laid down, engendering doubt as to the right of the company to occupy certain streets. The officers of the company, Messrs. J. W. McRae, president, Geo. P. Brophy, vice-president, Wm. Scott, treasurer, D. C. Dewar, secretary, were obliged to fight the existing horse car company for the right of way, and the enterprise which they have displayed should entitle them to be exempt from suffering further annoyance and loss on account of mistakes on the part of other people.

OTTAWA ELECTRIC STREET RAILWAY.

TREATMENT OF STEAM BOILERS.

OUR contemporary, the *Canadian Journal of Commerce*, deserves credit for its evident desire to enlighten its readers in regard to things pertaining to machinery and to steam appliances.

In a recent article on the "Treatment of Steam Boilers," it gave some sensible advice on the necessity of keeping the safety valves free, the water gauges clear, blow-off cocks, pumps, and everything about a steam boiler in proper order. All this is very good, but when one has to define what "proper order" would mean for these steam appliances, there is room for difference of opinion. Not very many years ago, when steam boilers were comparatively new things, and the pressure used in them was not more than a few pounds above that of the atmosphere, the waggon shaped boiler was one style that was very extensively adopted. James Watt used them, and in the early books of steam engineering, elaborate rules were given for the proper proportions of these boilers. They were constructed to safely carry a few pounds pressure, but from their shape were liable to injury from the internal pressure of the air should the cooling off of the boiler produce a vacuum inside. To guard against this, a safety valve was made, and arranged to open inwards, and admit the air, whenever the steam pressure fell.

The writer for the *Journal* seems to have lived in those days, or to have got hold of the cautions and directions for using these low pressure boilers, and now, in the days when 100 lbs steam pressure is common, seriously warns the public against the danger of injury to a cylindrical boiler by a "vacuum" being produced inside, and give it as one of the common causes of boiler explosions !

He does not say that the "vacuum" explodes, but that "the ring becomes indented or *swagged*," and explosion results from this. If he had said that a "vacuum" in the "engineer's" head was a frequent cause of explosion, we would cheerfully have recommended that the Stationary Engineers' Society present him with their medal.

The putting of a new plate into an old boiler is, according to this article, another cause of boiler explosions the reasons assigned being that the new does not agree with the old. In ancient times, when leather bottles were used, we have good authority for saying that new wine put into old bottles produced something like an explosion, but where, outside of this article, will be found any authority for the statement that the way to make a boiler explode is to put new plates in the bottom of it?

The means suggested for the prevention of explosions are almost as dangerous as those given as being the causes of explosion. It is not enough to keep a vacuum out of a boiler, and never to put a new plate in the bottom, but every boiler after it is two years old, according to this article, should once every six months be "tested with cold water." The problem is solved: Keep the cold water in ALL THE TIME, and never let it become hot, and there will never be another explosion! We give this last suggestion as our addition to the *Journal's* plan, and hope that when systematic compulsory boiler inspection becomes the law of the land, men who are not liable to a vacuum in the head will be appointed inspectors.

QUESTIONS AND ANSWERS.

JAS. OGLE, Brantford, Ont., writes: We have a fan to suck shavings from wood working machinery, and we have experienced considerable trouble with the belts breaking, owing to their having to be kept exceptionally tight to act on the pulley without slipping, which I claim is the fault of the pulley being too small in diameter. The fan is calculated to run 1750 revolutions per minute, our line shaft runs 148 revolutions per minute, with a 40 in. pulley leading to a 15 in. pulley on counter shaft, and with a 35½ in. pulley on countershaft leading to 8¾ in. pulley on fan. A person would hardly realize the difference with the off in making steam very nearly the difference of one boiler. I therefore consider it working to a great disadvantage. I would like to have you pass your opinion, and give us a method to overcome this difficulty.

ANSWER. The sizes of pulleys mentioned will not give a speed of 1750 revolutions per minute to the fan, even if there be no slip whatever. With the first shaft at 148 revolutions per minute the fan would make 1601 revolutions, and not 1750. The probability is that owing to the great tension on the belt, some parts of the shafting are bent, and consequently power is wasted. Better results would be obtained by putting a leather cover on a pulley 10 inches in diameter on the fan, and driving it by a pulley 45 inches in diameter. The 15 inch pulley might also be covered by leather, as by so doing the belts could be run with very much less tension. Nothing is said about the width of belting used, and it is impossible to calculate the power used without knowing the width.

H MARTINSON, Listowel, Ont., writes. Your answer to my question as to whether a "compound engine, one in which the steam is exhausted from one cylinder into the other, is more economical than a single engine whose cylinder is of as great capacity as the two combined," is unsatisfactory to me.

In your reply you say "it is *generally considered* that a compound engine is more economical than a single cylinder." A thing being "generally considered" does not make it so.

You say "it is possible to get a greater ratio of expansion with two cylinders than can be got with one?" How do you prove that? You say again "The loss from internal condensation is very much less with the compound." Why should the condensation be less in two cylinders than in one? I should arrive at the opposite conclusion.

Again you say: "Using an automatic cut-off engine, an indicated diagram taken with 65 lbs. steam initial pressure, and cut-off at 20 per cent. stroke, should give a result of about 28 lbs. of water per h. p. per hour. The water consumption in a compound engine, figured from the indicated card in the same way, would give us at 20 per cent. cut-off and same initial pressure, about 15 lbs. of water per h. p. per hour." All you have proved in the above example is, that more steam went through the single engine than through the double one—in that case, everything else being equal, the single engine developed more power than the double.

I may be wrong, but in my opinion there is only so much power in steam, and it is cheaper to develop that power through a single engine than through a compound one. My objections to the compound are: the first cost is greater, they cost more to run, and more to keep in repair. If the compound engine is superior to the single engine, it ought to be easy to demonstrate its superiority.

ANSWER.—It is sometimes very difficult to get our correspondents to understand our efforts to enlighten them in regard to the points involved in the questions asked and answered. If a blind man were to write and ask why a rose was a more beautiful flower than a dandelion, all our efforts would probably fail if the man had previously made up his mind that the dandelion was superior to the rose, but it would not follow that our want of success was due to our defective taste, and not to the blindness of our correspondent. We are led thus to take comfort to ourselves by the criticism of our efforts to explain why a compound steam engine was better than a single engine. Our friend says "a thing being generally considered does not make it so." This remark strongly resembles the ancient question "How many legs will a calf have if you call the tail one?" the answer to which is, that the juvenile bovine creature has but four legs, and that calling the tail a leg will not make it one. But when the subject is not legs and tails, but *power*, and cost of making it and using it, we think that the opinion of those who have tried the matter, and have paid for their knowledge by actual experience, is entitled to some consideration. The result of the actual experience is, that when properly proportioned for the power to be developed, and for the pressure of steam to be used, the compound engine is more economical than the single cylinder engine. The following reasons have proved to be the correct explanation of this economy. 1st. The change of temperature in each cylinder between the temperature of the live steam and that of the exhaust is less in the compound engine, and consequently less condensation of the live steam takes place in its admission to the cylinder. 2nd. The steam condensed into water in the first cylinder is to a large extent re-evaporated during the exhaust, and passing as steam into the next cylinder, performs work at the lower pressure carried in that cylinder. There are other points of advantage in the working of a compound engine, but these cover the reasons why it is more economical in fuel. The machinery used in the steamboats crossing the Atlantic is the most perfect that skill can devise, and the objects aimed at are, to carry the heaviest load, at the greatest speed, with the least expense. Our friend says that in his opinion compound engines cost more to make, more to run and more to keep in repair. If he is correct, then all the owners and builders of these steamboats are acting very foolishly, as they all use compound engines. The progress during the last twenty years is remarkable, but none have proposed to return to the single cylinder engines. In 1872 the steam-pressure used was from 45 lbs. to 60 lbs. per sq. inch, and with compound engines the average consumption of coal was 2 1-10 pounds per horse power per hour. At the present time, steam of 160 lbs. per sq. inch is used, and the consumption of coal is less than 1½ pounds per horse power per hour. As some of these steamers use over 15,000 horse power, it is evident that a small fraction of a pound saved on each horse power per hour will amount to a number of tons on each voyage. Can our friend produce any examples of single cylinders doing such work as is found to be done by the compound engines on the Atlantic?

The council of an Ontario town recently sent inquiries to nearly all the cities and towns of Canada as to the yearly cost of each electric lamp in use for street lighting. The lights are paid for from 200 to 365 nights per year. The figures are: Montreal, $146; Toronto, $108.59; Hamilton, $102.10; Ottawa, $80; Halifax, $79; London, $94.05; Kingston, $65.80, St. Catharines, $77.10; Brantford, $105; St. Thomas, $102.20; Windsor, $80.30, Peterborough, $60, Stratford, $66, Belleville, $105; Woodstock, $56.50, Brockville, $101.50, Berlin, $60, Galt, $66, Cornwall, $17, Cobourg, $62.50, Truro, $85, Lindsay, $48, Barrie, $70, Yarmouth, N.S., $80, Ingersoll, $60, Bowmanville, $65.05, St. Marys, $39, Orangeville, $57; Paris, $58.50, Whitby, $45, Brampton, $64, Simcoe, $50, Kincardine, $52.80; Mount Forest, $75; Newmarket, $45; Wingham, $60, Palmerston, $45, Markham, $36. The figures are interesting, but are very incomplete. Many of these plants are run by water power. Data is wanting also as to the number of lights, length of lighting hours, and candle power of lamps.—*Electrical Engineer.*

THE DYNAMO.

DYNAMO and magneto-electric machines consist essentially of a coil of wire—"the armature"—rotating between the poles of a large magnet, the poles being bent round so as to approach each other and have the armature between them. This magnet may be either a permanent magnet of hard steel, or an electro-magnet consisting of wire coiled round a soft iron core, a current of electricity being made to circle round the wire coil, and thus magnetizing the iron core while it lasts. A magnet produces an influence in the neighborhood around it, and this surrounding neighborhood is known as the "field of force" of the magnet; *i.e.*, the sphere in which its influence can be felt.

A magnetic needle or a bit of iron filing placed in this field sets itself to point along the "lines of force" of this field, that is, the lines along which the magnetic force acts, and which form curves around the magnet, running out, as it where, from pole to pole, curving from one to the other. When a coil of wire, or armature, is made to revolve rapidly in the strong field of force which occupies the space between the poles of a powerful electro-magnet, currents are produced in the coil. These currents alter their direction through the coil every time the latter changes its position with reference to the poles of the magnet. The side of the coil which was opposite the north pole is, after half a revolution, opposite the south pole, and the influence of the south pole tends to produce an opposite current to that of the north pole. Here we have an "alternative current" dynamo machine. As the coil, or armature, rotates with great speed some hundreds of revolutions per minute these currents in alternating directions, succeed each other very rapidly, and if an electric arc lamp is placed on the circuit it will be lit up. In this case it is not necessary that the current be sent around the circuit in one direction only, but although the terminals of the lamp are constantly changing their polarity that is, the north pole, where the current enters, the next instant becomes the south pole, where the current leaves yet, as this occurs many times in one second, the effect produced is the same as if the current was in one uniform direction.

In a "continuous current" dynamo, which is necessary for some purposes, such as electro-plating, where the effect desired could not be produced if the direction of the current was continually altering, the electric current is made to pass always one way round the external circuit. This result is got by using the ingenious device of a commutator, which automatically deflects the current so as always to send it in an unvarying direction. This commutator consists simply of a split tube, which is attached to the revolving armature, and may be seen in any dynamo working on the continuous system. This tube revolves with the revolving armature, and it is divided by an insulating substance into two parts. Each half is alternately on the left and right of the space between the poles of the magnet and the "brushes" which collect the current from the armature; *i.e.*, the bundles of copper wire spread out like a brush, which form each end of the outer circuit, are fixed in position, and the revolving commutator attached to the armature brings alternately one of its half-tubes into contact with a brush. Thus the half of the commutator which receives the current changes at the same time the direction of the current through the coils of the armature is reversed; in this way the current sent out to the brush which receives the electric current from the armature is always in the same direction.—Boston *Journal of Commerce.*

DRAFT.

DRAFT, so-called, is the difference in weight between two columns of air, one hot and the other cold. The former rises by reason of its lightness, and the latter rushes in to supply its place. Hot air is lighter than common air, because, being expanded by heat, it occupies more space for the same volume. Suppose, says the *Engineer*, we have a smoke stack of certain dimensions, it contains a certain number of cubic feet of air If we build a fire at the bottom of it, we expand that air and it increases in volume, raising as it increases. Naturally this makes a column of a given number of cubic feet which is lighter than the column of the same capacity outside of the stack, and this cold air seeks to restore the balance. This is natural draft pure and simple, and as it depends upon a very slight difference in weights only, very little is needed to check it. Carrying the smoke stack or flue horizontally is a tax upon the draft proper, for the horizontal column has to be dragged by the vertical column. The horizontal column cannot rise; naturally, therefore, it has no value for increasing the velocity of the outside column of air, but has to be moved by it. All chimneys should be perfectly smooth inside, without projections of any kind; least of all should they be fouled with soot; this last is one of the greatest of obstructions. Forced or induced draft is simply compressed air driven into a furnace by means of fans, and has an artificial velocity imparted to it by them.

THE WORLD'S FAIR POWER PLANT.

As might naturally be expected, there will be required a very large power plant to drive the machinery at the World's Fair But few, however, realize how much power it will require. Compared with the power plants of former expositions this will be tremendous. It took a 2,456 horse power engine to drive the machinery at the Centennial Exhibition in Philadelphia. At the Paris fair 6,000 horse power was sufficient. The World's Fair at Chicago will require six times as much, or 24 000 horse power, according to present estimates. The following interesting facts in this connection are furnished by the Construction Department:

In the Machinery Hall the machines on exhibition will be driven by six lines of shafting carrying the required pulleys, each line running lengthwise with the building, or about 800 feet. Each of these six lines will be driven into four sections of a length of 200 feet, and each section will be driven by an engine. This necessitates the use for power in Machinery Hall of 24 engines with a capacity of 125 to 200 horse power These sections of shafting will be provided with friction couplings on on their ends, so that in case of accident or the disabling of any engine its section may be driven by the engine on the other side of it. Lengthwise in the Machinery Hall will travel three electric cranes of 20 tons capacity, each having a maximum speed of 400 feet per minute. During the installation of and the removal of these exhibits, these cranes will be used for transporting goods, but during the exposition they will be used to carry passengers through the halls.

At the east end of the Machinery Hall will be located the exhibit of pumping and hydraulic machines in operation. These pumps will supply water for all the grand fountains on the grounds, and for other purposes. Here will be a pumping plant almost equal in capacity to any of the plants of the water works of Chicago. There will be pumps working with a capacity of 40,000,000 gallons per day.

In the Machinery Annex will be located the electric energy plant, where a number of engines of various types will furnish the 16,000 horse power necessary to operate the generators for electricity for light and power. These engines will be located so as to form a compact central station. This plant is elastic in its proposed capacity, and its power can be extended indefinitely. The estimated necessary 16,000 horse power will probably be increased rather than diminished. In the building near the annex will be located the steam plant for furnishing steam power for this electric station.

South of Machinery Hall and opposite the centre of the building will be located the boiler house supplying the steam used in the building. This plant will be a model, and will have a capacity of 8,000 horse power. Only in Machinery Hall will steam power be used. Electric power will be used in all of the other buildings, and will be transmitted by wires from the central electric plant. It is estimated that in Machinery Hall and its annex there will be about 3½ miles of shafting.

It is not yet determined whether crude petroleum or coal will be used for fuel. To run this big plant during the exposition will require at least 75,000 tons of coal or 225,000 barrels of crude petroleum. It will require at least 250 engineers, firemen and attendants to man this plant. To keep it bright and clean during exposition will require 90,000 pounds of waste, and it is estimated that $6,060 worth of lubricating oil will be poured on its innumerable bearings.

In all heating systems designed to use exhaust steam, says the Boston *Journal of Commerce*, care should be taken to have the pipes large enough to allow the passage of the steam with the least back pressure It is a poorly designed system that requires a back pressure of five pounds.

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

By William Barnet le Van.

(Continued from October number.)

Having given the inside diameter D, and the required effective area Æ, the lift or height h to which the valve must be lifted, is as follows:

$$h \pi D \cos v = Æ - \tfrac{1}{2} h \sin 2v \, \pi h \cos v$$

$$h \pi D \cos v = Æ - h^2 \tfrac{1}{2} \sin 2v \, \pi \cos v$$

$$h^2 \tfrac{1}{2} \sin 2v \, \pi \cos v + h \pi D \cos v = Æ$$

$$h^2 + h\left\{\frac{2 \pi D \cos v}{\sin 2v \, \pi \cos v}\right\} = \frac{Æ}{\sin 2v \, \pi \cos v}$$

Half the square of the coefficient for h is

$$\left\{\frac{D}{\sin 2v}\right\}$$

Add this on both sides of the = signs.

$$h^2 + h\left\{\frac{2D}{\sin 2v}\right\} + \left\{\frac{D}{\sin 2v}\right\}^2 = \frac{2Æ}{\sin 2v \, \pi \cos v} + \left\{\frac{D}{\sin 2v}\right\}^2$$

The square root of this formula will be

$$h + \frac{D}{\sin 2v} = \sqrt{\frac{2Æ}{\sin 2v \, \pi \cos v} + \left\{\frac{D}{\sin 2v}\right\}^2}$$

Then

$$\text{Height } h = \sqrt{\frac{2Æ}{\sin 2v \, \pi \cos v} + \left\{\frac{D}{\sin 2v}\right\}^2} - \frac{D}{\sin 2v} \quad \ldots 22$$

Example 20. A safety valve has a diameter D = 2 inches, and the valve sit has a bevel or angle v = 25 degrees. What is the effective area Æ, if the annular opening for a lift h = ¼ or 0.25 of an inch?

$$\text{Formula 16} \quad Æ = \pi h \cos v \,(D + \tfrac{1}{2} h \sin 2v)$$

$$\text{Effective area } Æ = 3.1416 \times 0.25 \times 0.906 \left\{2 + \frac{0.25}{2} \times 0.766\right\} = 1.493 \text{ square inches.}$$

The diameter D, in example 18, can be found by using the other dimension by

$$\text{Formula 21.} \quad D = \frac{Æ}{\pi h \cos v} - \tfrac{1}{2} h \sin 2v$$

$$\text{Diameter } D = \frac{1.493}{3.1416 \times 0.25 \times 0.906} = 2.15 - \frac{0.25}{2} \times 0.766 \cdot 909 = 2.054 \text{ inches.}$$

And the lift h as follows

$$\text{Formula 22} \quad h = \sqrt{\frac{2Æ}{\sin 2v \, \pi \cos v} + \left\{\frac{D}{\sin 2v}\right\}^2} - \frac{D}{\sin 2v}$$

$$\text{Lift } h = \sqrt{\frac{2.986}{0.766 \times 3.1416 \times 0.906} + \left\{\frac{2}{0.766}\right\}^2} - \frac{2}{0.766} = 0.2503$$

or as follows

The sine of $2v$ = 25 × 2 = 50		0.766
Multiplied by π		3.1416
		2.4064656
Multiplied by cosine v = 25		0.906
First product		2.1802578336
Divide 2 Æ = 1.493 × 2 =	2.986	1.36956
By the first product	2.1802578336	
Then divide diameter D	2	2.611
By the sine $2v$ = 25 × 2 = 50 = 0.766		
Square this quotient 2.611 × 2.611 =		6.8172
To this add the first quotient		1.36956
		8.18676
The square root of this sum $\sqrt{8.18676}$ = 2.8613		
Now divide diameter D = 2	= 2.611	
By the sine $2v$ = 25 × 2 = 50 = 0.766		
Subtract this latter quotient from the root of the above, and the remainder will be the lift h = ...	0.2503 inches.	

TO FIND THE ANGLE OF A VALVE SIT.

From the largest diameter subtract the smallest diameter, and divide half this difference by the depth of bevel of the valve sit, and the quotient is the tangent of the angle v.

The algebraic expression is as follows:

Let D = largest diameter of valve sit in inches.
d = smallest diameter of valve sit in inches.
k = depth of valve sit in inches.
v = angle, or bevel.

$$\text{Tangent } v = \frac{D - d}{2k} \quad \ldots\ldots 23$$

Example 16.—The largest and smallest diameters of a valve sit are D = 3½ and d = 2½ inches respectively, and the depth k = ½ or 0.5 inch. What will be the angle of the valve sit?

$$\text{Formula 23} \quad \text{Tangent } v = \frac{3.5 - 2.5}{0.5 \times 2} = 1, \text{ the tangent of the angle of the valve sit.}$$

Or, largest diameter D = 3.5
Smallest diameter d = 2.5

1.0

0.5 × 2 = 1.0

Tangent v = 1

The angle corresponding to this tangent by table is 45 degrees.

SAFETY VALVE AREAS.

The writer, in 1867, had the honor of being appointed by the president, one of a committee of four members of the Franklin Institute, to which was referred the consideration of the legal requirements which should be made for safety valves and pressure gauges upon steam boilers erected in the city of Philadelphia, in accordance with acts of the Assembly of the State of Pennsylvania, approved May 7th, 1864. The following report was approved by ordinance of councils of the city of Philadelphia, July 13th, 1868:

The committee did not in American or English practice of engineers or boiler-makers find any general rule of dimensions of safety valves, that had been acknowledged, relating to other dimensions of boilers, or to the pressure of steam or to the rates of combustion of fuel, although such relationship is admitted by the assumption and practice of different constructors without any definite rule.

Neither have those writers in our language, whose works are regarded as authoritive upon the subject of steam and the steam engine, nor has American or English legislation, established or stated suitable proportions and requirements for the various conditions. On the other hand, the laws of France, Prussia, and other continental nations, have been framed with an evident appreciation of the essential demands, and established areas of valve openings for all sizes of, and pressures of steam in, boilers, so that it had only remained for the committee to translate into English measures, to modify the ratios by using, as the surface of comparison with the safety valve area, the grate surface in place of that adopted by the French—boiler surface, and to make a further correction by embracing in the rule the differing rates of combustion upon the grate surface.

The committee have not found, nor have they sought very carefully, the reasoning upon which the French rule, or formula, has been based, and will say that they reached the same conclusion independently, and were not a little surprised by the coincidence after their own investigation.

We proceed to give, as briefly as possible, those considerations which control or influence this question of area of safety valves:

A safety valve is a loaded valve covering an orifice opening outwards from a boiler, which valve is intended to lift whenever the pressure of steam within the boiler rises above that to which the valve has been loaded; and the opening thus produced ought to discharge the steam of the boiler in such quantities that the pressure within shall not exceed, to any considerable degree, or beyond some fixed limit, the defined pressure at which the valve opened.

Upon this proposition, it is evident that a safety valve may sometimes be required to discharge all the steam which, under the most favorable conditions, may be formed by evaporation in any given time. As the rapidity of the evaporation of water is evidently the result of rapidity of combustion of fuel, which itself refers to extent of grate surface and strength of draught or blast (supply of air), we take the grate surface, or area, as that element of a steam boiler presenting the most readily-measured surface for comparison with the required area of the opening or least section of the aperture or channel of discharge of an opened safety valve. We can assume that the draught or supply of air to the fuel being burned under any given steam boiler, is, on the average, that existing in ordinary stationary steam boilers with chimney draught, and afterwards correct our proportions for forced draught or blast, and more active combustion. In like manner, we can modify the results, based on this assumption, to suit the conditions of boilers which are heated by the waste heat or by the burning of gases unconsumed in manufacturing processes. As it is the object of investigation to determine that area of safety valve needed to insure safety, it is proper to give so great an excess above the absolute demand for the sectional area of the vein of steam escaping from a boiler under any given pressure as will be sure to cover the emergency of extraordinary rapidity of combustion during any short period of time, and also to include the coefficient of resistance to discharge through a passage offering as much resistance as the one formed by lifting a disk valve of the ordinary construction from a flat seat.

We here notice that there may be so large an excess of area that the opening of the valve may, by its sudden relief of pressure and discharge of steam, especially in boilers with limited water surface for the elimination of the steam from the water, dangerously disturb the equilibrium of circulation of water within the boiler, and also that the safety valve may be so badly formed, in regard to shape of disk and seat, that after lifting a little without any change of load upon the valve, the pressure within the boiler may dangerously increase, while a small quantity of steam only is discharged. In both of these points of difficulty we will refer to the practice of engineers, only saying here that the ratio of excess which we assume, when applied to the case of the gradual rising of temperature and pressure which occurs in a boiler containing a mass of water, and only admitting the gradual opening of the valve, is much below any dangerous condition, and our assumed excess is really additional safety. The assumption of considerable excess also allows us, when in our theoretical examination we find considerations of obviously very small value, to reach, in a practical form, a perfectly satisfactory general result. Proceeding on these grounds, therefore, let us take the average combustion of a well-set or arranged boiler at 8 pounds of coal (or fuel equivalent) per square foot of grate per hour, and that the maximum combustion, when the fire is in the best condition, and is evolving heat most rapidly can be taken at three times that of the average. That is, for a portion of time we must assume that the rate of burning will be 24 pounds of coal per square foot of grate per hour. We can estimate with the slow rate of average combustion assumed, and with adequate heating surface to the boiler, which surface shall be in good working order, both within and without, that there will be evaporated 9 pounds of water to each pound of coal consumed. This gives a maximum rate of evaporation of 216 pounds of water per square foot of grate per hour, or 0.06 pound of water per square foot of grate per second.

On the grounds stated in a preceding paragraph, we may neglect the increase of heat demanded for the evaporation of water at higher temperatures than 212 degrees, and assume, within our limits of 20 to 120 pounds above the atmosphere, the weight of water evaporated or quantity of steam produced by the combustion of a given quantity of fuel to be constant.

Whatever error there is, from taking a larger quantity of steam at the higher pressures than is actually produced by the result, only adds to the dimensions of the safety valve of such higher pressures, and is an error in a safe direction, as well as a very small one.

When we come to the discussion of how great an allowance of excess of size over absolute requirement is to be made, we take first the coefficient of friction, as found by experiment on the flow of liquids through apertures and passages of a character similar to the passage of a safety valve Æ = 1.5 *a* where Æ is the area of absolute requirement sought, and *a* the sectional area of the vein or tube of fluid, supposing no resistance from the mouth of discharge to exist. *And secondly, the practical coefficient employed to give* adequate excess of area of valve for all contingencies. This last has been taken at eight times the area of absolute requirement, or A = 8 Æ = 12 *a*, where A is the area of the valve sought, and *a*, as before, the values of Æ, A and *a*, being taken in square inches.

The most simple equation expressing the relation of volumes of steam to water, applicable to our purpose, is that given as the result of experiment by Fairbairn and Tate:

$$Wp = \frac{389}{p + 15.052} + 0.41$$

Where Wp = the volume of one pound of steam in cubic feet, under any nominal pressure p per square inch above the atmosphere. Whence we have:

$$W = 0.06\left\{\frac{389}{p + 15.052} + 0.41\right\} = \text{cubic feet of steam formed, under our supposition, per second.}$$

The height of column to effect the discharge of steam under any pressure p (per square inch), is evidently equal to the volume of p pounds of steam multiplied by 144.

$$h = 144\,p\left\{\frac{389}{p + 15.052} + 0.41\right\}$$

and the theoretical velocity of discharge in feet per second $= v = 8.025\sqrt{h}$.

$$v = 8.025\sqrt{144\,p\left\{\frac{389}{p + 15.052} + 0.41\right\}}$$

The size of the vein a (in square feet), which will convey the volume W at he velocity v per second, is:

$$a_1 = \frac{W}{v} = \frac{0.06}{12 \times 8.025}\;\frac{\frac{389}{p + 15.052} + 0.41}{\sqrt{p\left(\frac{389}{p + 15.052} + 0.41\right)}}$$

but $144\,a_1 = a$, and $12\,a = A$. ∴ $A = 1728\,a_1$

$$\therefore A = \frac{1728}{12} \times \frac{0.06}{8.025}\sqrt{\frac{\left\{\frac{389}{p + 15.052} + 0.41\right\}^2}{p\left\{\frac{389}{p + 15.052} + 0.41\right\}}}$$

Taking the above facts into consideration, the committee arrived at the following formula:

$$A = 21.23\sqrt{\frac{1}{A}\left\{\frac{1}{p + 15.052} + 0.00195\right\}} \quad \ldots\ldots\ldots\ldots 24$$

We will now compare this with the legal formula of France, which reads:

$$A\ (\text{in centimeters}) = 0.00053\,\frac{s\ (\text{in meters})}{n - 0.412}$$

where

A = area of safety valve.

s = heating surface of boiler in square meters.

n = absolute pressure of steam in atmospheres.

We can safely take the French practice in construction of their boilers at 20 units of boiler surface to each unit of grate surface, as the boilers in general use in France assimilate in these ratios to those of our long cylinder or two-flued forms, when the proportions generally correspond. Substituting this value, and taking 14.7 pounds for the atmospheric pressure, deducting one atmosphere of constant pressure, and reducing the whole to American weights and measures, we have:

$$A = \frac{22.5\,G}{p + 8.62} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 25$$

where

A = area in square inches of safety valve per square foot of grate surface.

(To be Continued.)

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

Editor ELECTRICAL NEWS.

DEAR SIR, – The annual meeting of Montreal No. 1, C.A.S.E., was held in Mechanics Hall, on Thursday evening, Oct., 1st, when the following officers were elected for the ensuing year:

Thomas Nadin, President; Edmund Hay, Vice-President; Henry Nuttall, 2nd Vice President; J. G. Robertson, Recording-Secretary; J. E. Huntington, Financial-Secretary; Thomas Ryan, Treasurer, Henry Rollins, Conductor, A. Nuttall, Door Keeper; Jas. Dooner, Hugh Tipping and Geo. Redpath, Trustees.

Yours truly,

JOS. G. ROBERTSON,
Secretary.

PISTON SPEED NEEDED.

THE table here given shows the piston speed in feet per minute required to produce one gross horse power, with various mean effective pressures per square inch, and with various piston diameters and areas.

For other horse powers the speeds needed will be exactly proportionate; that is, 100 gross horse power will require 100 times the speed needed for one. With other mean effective pressures, and with other areas, the speeds required will be inversely proportionate, that is, 11½ pounds mean effective pressure per square inch will take double the speed needed with 32½; 100 square inches will take double the speed needed with two hundred.

PISTON SPEED NEEDED TO PRODUCE ONE GROSS HORSE POWER.

PISTON.		MEAN EFFECTIVE PRESSURES, POUNDS PER SQUARE INCH.								
Diam. In.	Area Sq. In.	10	12½	15	17½	20	22½	25	27½	30
4	12.57	262.5 ft.	210. ft.	175. ft.	150. ft.	131.3 ft.	116.6 ft.	105. ft.	95.5 ft.	87.5 ft.
6	28.27	116.7	93.4	77.8	66.7	88.4	51.9	46.7	42.4	38.9
8	50.26	69.7	52.5	43.8	37.5	32.8	29.2	26.3	23.9	21.9
10	78.54	42.	33.6	28.	24.	21.	18.7	16.8	15.3	14.
12	113.09	29.2	23.3	19.5	16.7	14.6	13.	11.7	10.6	7.7
14	153.93	21.4	17.2	14.3	12.3	10.8	9.54	8.58	7.8	7.15
16	201.06	16.4	13.1	10.9	9.38	8.2	7.29	6.56	5.97	5.47
18	254.46	13.	10.4	8.65	7.41	6.48	5.76	5.19	4.72	4.32
20	314.16	10.5	8.4	7.	6.	5.25	4.67	4.2	3.82	3.5
24	452.38	7.3	5.84	4.86	4.17	3.65	3.24	2.92	2.65	2.42
30	706.85	4.67	3.74	3.11	2.67	2.33	2.75	1.87	1.69	1.56
36	1017.87	3.24	2.59	2.16	1.85	1.62	1.44	1.3	1.17	1.08
42	1385.44	2.38	1.87	1.56	1.33	1.17	1.04	.933	.848	.794
48	1809.55	1.82	1.46	1.22	1.04	.912	.811	.73	.663	.608
60	2827.43	1.17	1.33	.778	.667	.584	.519	.467	.424	.389
72	4071.5	.811	.649	.541	.463	.406	.36	.324	.295	.27

—Power and Transmission.

PERSONAL.

Mr. John Carroll, manager of the Eugene Phillips Electrical Works, Montreal, spent a couple of days in Toronto, recently. He is a friend to *the movement for the formation of a Canadian Electrical Association.*

PUBLICATIONS.

Mr. H. W. Petrie, of Toronto, has sent us a copy of a new catalogue (No. 16) of new and second-hand machinery, just issued.

It is rumored that the executive department of the Edison General Electric Co. will undergo reorganization at the annual meeting in January next.

NOTES.

Diluted muriatic acid will take the muddy deposits out of guage glasses.

Steam hammers are now being made with compound pistons, with a view to the utilization of waste of steam.

Mr Robert Macfarlane of Magog, Quebec, was recently granted a patent on a tubular water grate for steam boiler furnaces.

The Robb Engineering Co., capital $249,000, has succeeded to the business of Messrs. A. Robb & Sons at Amherst Nova Scotia.

The Thermolytic Fuel Company, of Canada, has been organized at Napanee, Ont., with a capital stock of $12,000, to acquire certain patents relating to improvements in steam boiler furnaces, and to manufacture the same.

By the explosion of a boiler in Spencer's saw mill at Walsingham Centre Ont., recently, Clark Brunson, fireman, was thrown a distance of 100 feet, and so scalded and mangled that he lived but a few minutes after the event.

A certain amount of air admitted to the furnace above the live coal is advantageous rather than otherwise, *if the supply be regulated*. The oxygen of the air thus introduced assists in the more effective combustion of the gases. *Practical Mechanic.*

The Northey Manufacturing Co., Ltd., has been organized with a capital stock of $100,000, to succeed the firm of Northey & Co., Toronto. The new company will manufacture and deal in steam pumps, engines, boilers, machinery, iron and other metals, etc.

According to Prof Rogers of Washington a single pound of good steam coal has within it dynamic power equivalent to the work of one man for one day. Three tons of the same coal represent a man's labor for a period of twenty years, and one square mile of a seam of coal having a depth of four feet only, represents as much work as one million men can perform in twenty years.

In connection with the equipment, for fire protection, of wood-working establishments, it is recommended that a gallon pail, filled with fine sand, be always placed within convenient reach of each workman employed where oiling and finishing is being done. This practice might well be followed wherever there is a possibility of fire starting in oils or oil-soaked materials. There is nothing which will squelch an oil-fed fire in its incipiency more quickly and effectually than sand and there are no afterclaps in the way of water damage, either.

Experiments made twenty years ago on the non-conducting properties of boiler scale, gave astonishing results. The effect of the scale accumulation is given as follows: 1-16 inch thick requires 15 per cent. more fuel, ¼ inch 60 per cent. more fuel, and ½ inch thick 150 per cent. more. To produce steam at 90 pounds pressure, in a clean boiler, only 355 degrees of heat are required, but with heavy scale this temperature must be increased 200 to 300 degrees. For ½ inch of scale the heat must be 700 degrees, or almost a low red heat for the iron. Professor V. B. Lewis, F.C.S., I.C., after discussing the nature of boiler deposits in a recent lecture, recommended the following means of preventing these dangerous accumulations: 1. Filtration of condenser water through a coke column. 2. Free use of the scum cocks. 3. The use of water of considerable density rather than of fresh water. 4. The use of pure mineral oil lubricants in the smallest possible quantity.

Some time ago, says *Industries*, we directed the attention of our readers to a proposal by Prof. Thurston for reducing the internal wastes of steam engines by reducing the heat-conductivity and the heat-storing power of the internal surfaces of steam engine cylinders. The same thing had been attempted many times before but without very much success. Prof. Thurston believed that he had discovered that it would be possible to form upon these surfaces a non-conducting stratum, integral with the material of which they were composed, with the metal of the cylinder itself, that should intercept the heat tending to pass away without transformation in any appreciable degree into work. This he had proposed to bring about, first, in any convenient and inexpensive way, effecting a partial solution of the superficial portion of the metal, leaving a spongy layer, then by the impregnation of this sponge with a resin or other non-conducting material produced by the painting of this surface with drying oil or with any available substance that should thus be found able to permeate and cling to the porous surface. Prof. Thurston's proposals were based only on laboratory experiments, but since they were made they have been tested on a larger scale, and he now thinks the matter fully settled.

For softening water by means of hydrated oxide of lead cheaply, says the *American Machinist*, it is necessary to obtain the oxide, and the following method has been devised by M. Villon. A solution of sodium nitrate is placed in a vat, divided into two compartments by a diaphragm, lead electrodes of large surface are placed in the solution and the current from a dynamo then passed through. The sodium nitrate is decomposed, caustic soda being formed in the negative compartment, and nitric acid at the positive pole, from which it dissolves a certain quantity of lead, forming lead nitrate. When the current has passed through the liquid for a certain time, the solutions are run from the two compartments into a second vat, and there mixed by means of an agitator. The soda precipitates hydrated oxide of lead and itself forms sodium nitrate, the solution is then filtered, and the nitrate solution again submitted to electrolysis. When the baryta or lead oxide are used up they are replaced by freshly prepared oxides. The purification by barytes is more perfect than that by lead oxide. According to M. Villon, the use of the filter press can be avoided by employing plumbate of sodium—a solution of lead oxide in caustic soda. The precipitate is simply allowed to settle out, and the water obtained shows a hardness of about two or three degrees.

An English naval engineer has invented a simple and ingenious system for adding to the effectiveness and life of steam boilers by doing away with the severe strain which follows the first starting of the furnaces. The remedy consists of an arrangement whereby the present furnace fronts are substituted by steel heating chambers of the same length as the boiler. These chambers, which do not in any way interfere with the grate furnace, are, at starting, filled with water from the bottom of the boiler, or from any other point in the boiler where there is no circulation. A small fire is lighted in the furnace at first, which heats up the water in the chambers, and by degrees the remainder of the water in the boiler becomes heated and the shell is also gradually warmed, a uniform temperature being obtained. As soon as the temperature has become uniform the fires are made up and steam is raised to the working pressure. The primary work of the heaters having been accomplished they are now used as feed water. The feed water instead of going into the boilers direct is diverged into the *heaters and is brought to a temperature of 220 degrees Fahrenheit.* It will thus be seen that the arrangement is that of a combined automatic circulator and feed water heater, which not only does not rob the boiler of steam but arrests and utilizes heat which would otherwise be wasted. The saving of fuel gained by this invention is said to be 7 per cent. *Railway Register.*

TRADE NOTES.

The Ball Co. report a brisk demand for their newly-designed small automatic incandescent dynamos for factory and warehouse lighting, a full line of sizes from 25 to 150 lights being carried in stock.

At the late Montreal Exhibition a very fine show of dynamo belting was made by Messrs. Robin & Sadler in the machinery hall. A 22 inch and an 18 inch made for the Royal Electric Co. were among the largest of these belts, and were a credit to the manufacturers. Some large belting made for W. W. Ogilvie's Glenora Mills and for the Montmorency Cotton Co. was also on exhibit, together with numerous other rolls of different sizes and belt leather, lace leather, &c.

The Ball Electric Light Co. have recently installed apparatus as follows: Automatic Ball dynamo for incandescent lighting in Coulter & Campbell's copper works, Toronto, a 450 light Wenstrom automatic incandescent dynamo for Z. Paquet, Quebec, 50 arc light street lighting plant for corporation of Toronto Junction, completed and awaiting the fitting up of engine house, a 2 h. p. Ball 250 volt motor for Roberts Storage Battery Co., for driving machinery.

A USEFUL FORMULA.

THE following is a simple formula for determining the insulation resistance between a dynamo circuit and its frame :—

$$R = \frac{E - \mathcal{E}}{\mathcal{E}} \times r,$$

where R = insulation resistance in ohms, E = the terminal e.m.f. of the machine, $\mathcal{E}$ = the sum of the volts observed between the positive brush and the frame, and r = the resistance of the volt meter, which must be very high.

STEAM VS. WATER POWER.

CHARLES E. Emery, Ph. D., in the *Crank*, gives the following comparative estimate of the cost of steam and of water power for a cotton mill of 25,000 spindles, requiring, say 400 horse power.

STEAM.

Interest on cost of plant, 6 per cent. on $35,680	$2,141		Per year
Sinking fund for renewal	892		"
Operating expenses	3,195		"
Fuel	7,208		"
Total	$13,436		"
Per horse power		$33.59	"

WATER.

Interest on cost of plant, 6 per cent., on $35,680	$2,141		Per year
Depreciation and repairs, 2½ per cent.	893		"
Water tender	618		"
Interest on the cost of the steam plant necessary to supply steam for heating mill, use of slashers, &c., 6 per cent on $5,796	348		"
Repairs and renewals of same	318		"
Fuel	1,900		"
Labor	618		"
Total	$6,836		"
Per horse power		$17.09	"
Difference per horse power between steam and water		$16.50	"

NOTE ON THE INTENSITY OF TELEPHONIC EFFECT.

By E. Mercadier.

The intensity of telephonic effects depends chiefly upon the the thickness of the diaphragm, its diameter, the intensity of the magnetic field, the form of this field and the induction coils.

The influence of the thickness of the diapragm has already been investigated (vide *Comptes Rendus*, April 5th and 8th, 1889), and it has been shown that for every telephone of a given magnetic field, there is a certain thickness of diaphragm which gives a maximum intensity.

This thickness having been found, it remains to be determined what diameter gives the best effect. The magnetic field of the core only produces a sensible effect within a limited region of the diaphragm, which is not increased by an increase of area. Such an increase, it is true, adds to the flexibility, and favors the vibration of the diaphragm, but, on the other hand, its mass is increased, and therefore more difficulty is encountered in producing these vibrations. Hence, the best diameter will vary with the intensity of the magnetic field, and, therefore, it is necessary to combine the proper thickness with the proper diameter, according to the intensity of the field at disposal. The influence of the field, however, is far from being as great as might be supposed at first sight.

Very varied experiments have been made on this subject in magnetizing the cores of soft iron of the induction coils by means of an electro-magnet, instead of fixing them, as is commonly done, at the poles of a magnet. It is then easy to produce magnetic fields of very different intensities, by causing the current which excites the electro-magnet to vary in intensity. By working in this way it is easy to arrive at a certain limit at which the effect of the telephone does not vary sensibly, this limit being reached when the mass of the iron becomes rapidly incapable, as it where, of absorbing all the lines of force of the field, and more and more of these lines traverse the diaphragm.

This can be tested by scattering some fine iron filings upon the diaphragm, and observing that an increasing portion of the field becomes useless in the production of telephonic effects.

It is necessary, further, to observe that these effects are due to the deformations of the lines of force of the field; that these resist the deformation due to the energy of the waves arising from the voice, according as the magnetic field is more intense, and that this energy is necessarily limited. These remarks apply equally well to the telephone receiver.

It is evident that, other things being equal, the best form of field is that in which the lines of force are perpendicular to the directions of the wire in the coils. Moreover, the variations in the form of the field may be facilitated by the mobility of the field, and this can be increased up to a certain point by the mobility of the magnet and of the cores of the coils.

In summing up the foregoing facts, it seems that the following conditions are those by means of which it is possible to obtain the best results from a telephone, namely:

1. The mobility of the lines of force of the field should be favored.

2. The lines of force should be cut by the greatest possible turns of wire of the coils, and perpendicularly to their direction.

3. The thickness of the diaphragm should be diminished until it is just sufficient to absorb the greatest number of lines of force existing in its vicinity.

4. The ratio of that part of the diaphragm which comes under the influence of induction to the whole of the diaphragm should be increased.—*Comptes Rendus.*

THE CARE OF ACCUMULATORS.

The following directions for the general care of accumulators will be of value to those having charge of such apparatus.

Always charge the cells until they boil well. Never allow the battery to run down till its E.M.F. is below the average of 2 volts per cell. If this should occur when it is known that the charge is not low, an examination of every cell should be made. The acidometers in the cells give an approximate idea of the state of the charge, if they are intelligently observed. Examine the plates every few days by observing their color, and other characteristics. No current meter is of service to measure the charge remaining in the accumulator, since this instrument takes no account of the leakage which occurs before reaching it, nor of local action. As soon as only 25 per cent. of the total charge remains in the cells, the E.M.F. rapidly falls on further discharge. Precautions should be taken to guard against too large a current flowing when charging is commenced, by inserting a resistance, or by means of an automatic governor; also provision must be made against lamps being injured when they are turned on during charging hours, or the moment charging is completed. The instant any fault is noticed, it should be remedied at once, and any dead cell cut out immediately. Do not charge longer than necessary, but see that all the cells boil well; if they are much behind, observe if there is any obvious cause for this. One hour of over charging is advisable. Occasionally examine the insulation. Observe that the liquid in the cells does not become warm during charging. All measuring apparatus should be compared with standard instruments periodically, so as to avoid falling into errors which may prove destructive to the plates. Feel all connections and switches every now and then, to see if they become warm.

STEAM ENGINE EFFICIENCY.

Prof. Thurston contributed a valuable paper entitled "Steam Engine Efficiencies; the Ideal Engine compared with the Real Engine," to the recent meeting of the American Society of Mechanical Engineers. The ideal engine he defined as one having a non-conducting cylinder and frictionless rubber parts. The real engine would approach this in proportion to the improved conditions of construction and operation. He thought wastes could be reduced "by drying or moderate superheating of the steam, and by adopting high speed of engine to one-half these proportions." It ought to prove practicable to bring the water consumption by the adoption of these high pressures, and by further dividing the wastes by the use of three or four cylinders in series, and by properly supplying dry steam to the engine, down to within ten per cent. of the best figures here obtained for the ideal case. "The real measure of the useful power of an engine is not the indicated power, however, but the dynamo-metric power, as measured by the brake, or at the point at which the engine delivers its energy to the machinery of transmission. A well-built non-condensing engine should have an efficiency of machine at least as high as 92·5 per cent., and engines have been constructed doing better than this. An equally well-built condensing engine should approximate 90 per cent. efficiency of machine, though 85 is a much more common figure." The author then concluded: "It is apparently doubtful whether a vacuum will be found desirable, with its concomitant costs of the air-pump system, when we come to the utilization of these high pressures; unless we can at the same time find a way to reduce the waste of power and the tax thus imposed upon the engine."

AN ELECTRIC VENTILATOR.

L'Electricite notices a curious electric ventilator for supplying a building with fresh air, either cold or warmed, as desired. An electric motor sets the ventilator revolving and the revolution sucks cold air in. When warm air is desired, a current is sent into a network of fine wire possessing a high resistance, and through the network the air is obliged to pass; the current heats the wires, and the air necessarily becomes heated. The movement of a switch is sufficient to change the character of the air supplied by the ventilator. This system is capable of considerable adaption, and the hygenic results are uniformly good.

CELLULOID.

In view of the tendency to employ celluloid for several electrical purposes the following particulars may be of interest: Celluloid is simply made up of nitrocellulose, camphor and water. It was invented in 1869 in America. In 1876 the industry was introduced into France. Germany also possesses two large factories, whilst the largest in the world is in London. Crude celluloid is a horn-like transparent mass of a slightly yellowish color, and of specific gravity 1·25-1·45. Heat softens it and renders it capable of taking impressions. At 90 deg. it becomes very plastic. It readily kindles. Sulphuric acid rapidly decomposes celluloid on heating, whilst hydrochloric acid attacks it much less vigorously. Nitric acid slowly attacks it in the cold, very rapidly on heating, and the same is true of caustic soda. Acetic acid dissolves it, giving a solution from which water precipitates camphor and nitrocellulose; it is also soluble in ether, acetic ether, acetone, fatty oils, alcohol and turpentine.

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EDITOR'S ANNOUNCEMENTS.

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

WE are pleased to notice the increasing number of enquiries for information addressed to THE ELECTRICAL NEWS by its subscribers. It is desired that whenever a subscriber meets with a difficulty which he does not know how to deal with, he will send a statement of the case to this paper, and no efforts will be spared to afford him the desired information.

IT is satisfactory to know that the telephone company is making such extensive preparations in connection with its new building in Toronto to place most of the wires underground in the central part of the city, as well as to provide metallic circuits and return grounds in the more distant ones, else the advent of the electric street railway, running all day long as it will have to do, will prove anything but a means of grace to the man who has a constant use for his telephone.

ENGINEERS who desire to obtain certificates in accordance with the Ontario Engineers' Act, will note the fact that a board of examiners will be in attendance at Shaftesbury Hall, Toronto, every Wednesday evening for the purpose of examining candidates for certificates. The fact may not be generally known that examinations are also conducted at Hamilton and Brantford, so that engineers residing in or near those cities will not be under the necessity of going to Toronto.

IT is not likely that there will be much done this winter towards changing the motive power of the Toronto Street Railway. Several cars of heavy rails are to hand and unloaded, but beyond making ready the power house, which is to be located at the foot of Frederick street, the work is likely to be postponed till spring. Stoves are being placed in some of the cars for the winter, but it is likely that they will be replaced by electric heaters when the current supply is available.

THE fifth annual dinner of the Canadian Association of Stationary Engineers is set for the evening of Wednesday, Nov. 11th, at the Richardson House, Toronto. The dinners of former years have been occasions of much pleasure and profit, and the forthcoming one will undoubtedly be marked by the same characteristics. In fact, we shall be disappointed if it does not show a larger attendance and greater enthusiasm than any of its predecessors. The event should in a measure serve to mark the progress which the Association has made during the year. Let every member make a note of the date, and see to it that nothing shall prevent him from being present.

ONE or two complaints have been received from persons who favor the formation of a Canadian Electrical Association, that they did not receive invitations to attend the meeting recently held in Toronto with that object. It is a matter of regret that any person interested in the movement should have been overlooked. The purpose was to notify everyone who might be supposed to be interested. Let it be as widely understood as possible that the co-operation of all interested is earnestly desired on behalf of the success of the proposed Association.

IT is sometimes difficult to secure public recognition and support for a new invention, however meritorious it may be. Nobody wants to be the first to experiment with it. It is still more difficult, if not impossible, to induce the public to abandon the use of something which has proved itself to be an improvement, and return to the old order of things. Yet this is the course which the Council of the town of St. Johns, Que., is endeavoring to force upon the citizens with respect to electric lighting. The Council appear to be willing to do without the electric light rather than pay an additional $10 per year for each lamp, as was the understanding when the contract which is about to expire was made. The price paid under the present contract is $40 per year, and the agreement was that at the end of three years the price should be increased to $50. The citizens are manifesting their disapproval of the Council's policy of false economy, and it is safe to say that the councillor who votes to plunge the town into darkness again, will not find himself in the light of public favor when election time comes round.

SEVERAL attempts have been made by the friends of technical education in Toronto to establish means for imparting instruction of this character, but nothing practical has been done. Technicalities arising out of the law regulating the purposes for which municipalities may devote public money, have proved a hindrance to definite action being taken. There has likewise been a great deal of apathy shown by the public towards the movement. One of the newspapers has gone so far as to call in question the necessity for anything of the kind. In assuming such an attitude, it either ignorantly or wilfully places itself in opposition to the views of many of the leading educationists and thinkers of the day, to whom the fact is apparent that scientific theory and practice should go together. We are pleased to notice that during last month an Association was formed in Toronto for the promotion of technical education. The officers are: Prof. Galbraith, President; John Galt, C. E., Vice-President; W. G. Blackgrove, Secretary-Treasurer. The Association calls upon the city council to grant financial aid to assist in establishing technical training schools of science for the benefit of artisans, mechanics and the working classes generally, and to appoint a board of directors, representing the different practical and manufacturing interests of the city, to manage and conduct the affairs of this important movement. The officers of the Canadian Association of Stationary Engineers are taking an active interest in the project, which it is hoped will now assume a tangible form.

AN agitation appears to be developing in Toronto against the use of an overhead wire for street railway purposes, and statements are finding their way into print that are not correct. We are all free to admit that if another way can be found the overhead wire is not desirable, but no other way has as yet proved a commercial success, and it will be a pity if the advent of an electric service with all its advantages is delayed from mere sentimental objections. We have particular reference to a blood-curdling interview with an alderman which recently appeared in one of the city papers. He spreads himself all over the subject with more than the ordinary amount of aldermanic pomposity, and talks about the frightful danger of overhead wires "death to touch them, actually killed a horse in Buffalo the other day! And if strong enough to kill a horse, where would a human being be?" He evidently is not as well posted on horses as he might be, or he would know that a horse is infinitely easier to kill than a man, and that as a matter of fact there is no record that any person has been killed by a street railway current, and these wires are now used for very nearly, if not quite as many, cars as horses are. The electro-motive force of electric railway currents is about standardized at 500 volts. This amount can be taken by a healthy person with perfect impunity, and the chances of an invalid handling a wire of any kind, railway or otherwise, are very remote. Members of the disappointed syndicate, by which we mean the enterprising projectors who wanted the city to find the money while they pocketed the profits, have considerable influence in the control of one or two of Toronto's daily papers. It therefore behooves the careful citizen to provide a liberal apportionment of salt to take with the various statements he will presently find in print. The people of Toronto are not likely to get rapid and comfortable transit by electricity except by the overhead system of transmission, and while, of course, it has its disadvantages, there is no doubt but that the benefits derived from its use will much more than compensate for them.

AGAIN it is Niagara. In connection with the utilization of the power of Niagara proposed a short time ago in such glowing and grandiloquent terms by a syndicate of speculators who have purchased land some ten miles from the cataract, it seems strange that the immense water power of the old Welland canal available for instant use is entirely neglected. We have heard of manufacturers who have jumped at the land sharks' glittering bait, and bought lots in this manufacturers' El Dorado, where they will have to pay for their water power in addition to the cost of the land, while at the same time there are offers in the market of free land, free water power, and exemption from taxation without any takers. It is also interesting in this connection to note the astounding news that Mr. Ferranti has severed his connection with the London Electrical Supply Company. This is the company who were building the enormous machines for electric lighting at a potential of 10,000 volts. It was a bold undertaking, and this "severing of connection may be taken as an indication of its failure, at least from a commercial point of view. Now, this Mr. Ferranti proposes to come to Canada to exploit this Niagara Falls scheme. Here are his figures, and if he used this kind of arithmetic to his London stockholders, it is no wonder the Electrical Supply Company is "in the soup":—"He estimates that he can deliver 20,000 horse power by electricity at Buffalo at an outlay of $2,000,000 for the plant. If this power were sold at the uniform rate of $50 per annum, it would realize $1,000,000 or one half of the original cost each year. In view of this, the value of the company's rights, according to Mr. Ferranti's figures, is certainly very great." Well, we should rather say so! But not one word about interest, or capital, nothing for operating expenses, nothing for selling and distributing this large amount of output nothing about the utter impossibility of getting $50 a year for 20,000 horse power in Buffalo, nothing for maintenance of motors and dynamos and repairs, not a word about the opposition of natural gas which is universally used there, to say nothing of Buffalo being the headquarters of the coal supply for this end of the continent. The failure of Mr. Ferranti's big scheme in London is a poor augury of success here, where the chances to be taken are on an equally gigantic and daring scale.

WE are pleased to notice the increasing interest being manifested in the formation of the proposed Canadian Electrical Association. We are receiving words of welcome and good will from all quarters, and from what we hear, we believe it has met the popular idea. The meeting to be held on the 26th of November, in Toronto, we expect will mark the commencement of a most successful organization. We hope the date will be kept in mind by our electrical friends, and if formal notification be omitted by inadvertence, that it will not prevent any one from being present. Come to Toronto by all means and look up this office for information of the location of the place of meeting. It is proposed that all who were present at the original meeting should be personally notified, as well as all others interested in electrical matters, but it is unadvoidable that some should be omitted. Do not take this as any evidence of neglect on the part of the officers pro. tem., but put in an appearance on the date above mentioned, and make your presence both heard and felt. It is expected that many members will be enrolled from the more distant provinces. Though they will be unable very largely to be present at the deliberations of the Association, they will have the benefit of receiving in printed form the proceedings, together with all information, statistical, practical and legal, that may be compiled as a result of those deliberations. It is also proposed to appoint a committee on legislation, whose province it will be to watch the progress of all legislation that will have any bearing *directly or indirectly on electrical interests.* There will be much to discuss with reference to practical matters. The development of electrical science is so rapid that there is a constant introduction of new methods and material. It will be the province of the Association to discuss and criticize these new matters. The collective wisdom of the members will thus be made available to the individual, and cannot fail to be a source of profit as well as pleasure. Though there might at first glance appear to be diverse interests which it would seem difficult to reconcile, we cannot but think that an Association of this kind, being a neutral ground on which all can meet and discuss, each from his own standpoint, their various interests, will go very far towards promoting a friendly feeling and a disposition to recognize the rights of all. We trust all who can do so will make a point of attending the initial meeting of the Association to be held in Toronto on November the 26th.

THE craze for deputations that afflicts the average alderman is something astonishing. On the slighest provocation a deputation is appointed to visit an American city in search of information, and usually consists of half a dozen men who have no qualifications either of intelligence or training to enable them to understand the matter in hand. The civic treasury is depleted by some hundreds of dollars, while the deputation from a lack of knowledge of the subject either return in a state of denser fog than ever, or, on the principle that "a little knowledge is a dangerous thing," come back with only a partial or one-sided grasp of the situation and prepared to dogmatically fly off at a tangent from the proper course and wreck what might otherwise be fair legislation A special example of this absurd waste of public funds, if nothing worse, is to be seen in the deputation appointed to go to Pittsburg to the Street Railway Convention "to find out the best motor for use on the Toronto Street Railway" The City Engineer, who had a perfect grasp of the situation, having resigned in disgust, the acting engineer was appointed to go *Although an otherwise* estimable man, he knows not the first rudiments of electricity as applied to railways or anything else This would have been bad enough, but the climax of absurdity is reached when, finding other engagements prevent him going, the city surveyor and an alderman who is a lawyer are sent in his stead. There was bound to be a deputation, and we suppose that failing the surveyor and the lawyer, rather than the glorious institution of the deputation should be dishonored they would have sent the keeper of the dog pound and the caretaker of the city hall The absurdity goes even further when we recollect that the aldermanic and trigonometrical deputation go not to a conclave of municipalities, but to a gathering of street railway companies, where all arguments and discussions are in favor of the railroads and against the municipalities The chances are, therefore, that if they are able to assimilate any ideas from the gathering at all, they will come back "loaded up the wrong way." But what we want to know most of all is, what have the council to do with the "best motor" anyway? The company can safely be trusted to look after their own interests by putting in the best systems available, without interference born of the partially acquired information of the lawyer and the surveyor The danger from the citizens' point of view is, that the adoption of improved electric service and rapid transit will be unduly interfered with and delayed, and that crude and impracticable legislation inimical to the best interests of the citizens will be founded upon the imperfectly understood ideas of the civic "deputation."

THE attempts made by some municipalities to go into the business of generating electricity for lighting purposes have already commenced to bear their expected fruit We have pointed out that there is no more reason in a municipality entering this field than there is for it to go into the manufacture and supply of "plug" hats or corsets, each of which are articles in popular demand and universal use There is less reason for the non technical father of the hamlet undertaking to exploit an electrical installation, inasmuch as he knows as much, or rather as little about it as a Jew is popularly supposed to know about the taste of pork He is therefore entirely at the mercy of the commission hunting agents of electric manufacturing concerns, and as he is utterly unable to make a distinction between small lies and great ones, the most imposing and colossal fabricator of the lot carries the day But the dazzling and monumental character of his promises are not realized, and they "learn too late that men betray" The cost of installation is usually more than double the original estimate, and the cost of production in about the same ratio. Toronto Junction is a case in point. The sum appropriated and passed by by law will probably not half cover the outlay, and further sums will have to be voted, besides the whole matter having been a source of wrangling and bitter fight for a year past The worst of the matter is that being "in for a penny they are in for a pound," and the further supplies must be voted or what has already been spent will be thrown away This is usually the case, but like every other rule it has its exception The exceptional wisdom referred to is the case of the municipality of Vancouver, Washington Territory. Recognizing their mistake, and being unwilling to get deeper into the mire, they have recently offered their electric light plant for sale, and advertised for proposals for its purchase. In the notice it was stated that "Each bid must be accompanied by a bond in the sum of $1,000, conditioned that, if the bid is accepted by the city, the successful bidder will enter into contract with the city to make the purchase as proposed within 30 days. The city reserves the right to reject any or all bids. Bidders must state the rates they will charge for street and house lights in the event of purchase, which rates must be graduated for a series of not less than ten years, decreasing to an agreed minimum upon the attainment by the city of a certain population. The purchaser will be required to give adequate bonds for the faithful performance of his contract." Thus we see how time brings its revenges, but it requires some pretty hard knocks in the way of financial loss to pound sense into the head of the average civic representative when it is the public money and not his own that he is experimenting with.

STEAM HEATING.

AT this season of the year the heating of houses is a subject of interest to nearly every one. Many of the readers of our paper are especially interested in steam heating, and are now engaged in getting such appliances ready for the winter's work.

The most important part of a steam heating apparatus is the boiler, and next to that in importance is the furnace. Unless these are suitable and of sufficient capacity, all the rest of the apparatus will be found unsatisfactory, no matter how skilfully it may be done. Some steam fitters advocate the use of sectional boilers of cast iron, and containing the furnace within the parts of the boiler. These, no doubt, are cheaper and more convenient to sell and erect in place, but when that much has been said in their favour, the list of their good qualities is about complete. In some circumstances it is necessary to have a boiler in which steam is quickly raised, but it should be remembered that a boiler in which steam can be quickly raised is also one in which it will quickly go down, should the fire become dull.

For this climate, with its great variations of temperature during the winter, the boiler of a steam heating apparatus should be made large enough to give ample steam for the coldest weather, and the furnace part should be so arranged that the fire may burn slowly and yet maintain a steam pressure. The boiler should contain a considerable quantity of water, and it will be found of advantage to have the furnace of brick, so as to form a reservoir of heat, which will be radiated to the boiler whenever the fire becomes dull.

The boiler and furnace should be of such capacity and so arranged as not to require the constant attendance of the man in charge. The first cost may be more, but the annual expenditure for fuel, attendance and repairs will be less when the boiler is large and the furnace made so that a slow burning fire keeps up steam The comfort and satisfaction obtained will more than repay for the greater outlay.

In another article the size of boiler and furnace in proportion to the amount of piping to be kept hot will be discussed—at present it is proposed to say something about getting ready for winter.

The boiler, it is assumed, is all right and not requiring any repairs, what, then, should be done in order to get ready? The boiler should be carefully gone over, and all dirt and dust removed from it and from the furnace. This should be done, even though it was all cleaned out in the early summer. The next thing to do is to remake the hand hole and man hole joints. The hand hole joints should be very carefully made, as they should be absolutely tight in order to prevent the slightest amount of leakage. Corrosion of the boiler head soon follows a little leakage at the hand holes. In making these joints, it is a good plan to use moderately thick rubber, and to make a paste of black lead and oil, and put it on both sides of the rubber. The hand hole cap should not be screwed up too tightly when the boiler is cold, and should be screwed up after steam has been up or the water at the boiling point. All the valves about the boiler and its connections should be examined, and the spindles properly packed if new packing is needed. Then close the blow-off cocks, see that any check valves either in the feed or return pipes are in order, and while free to rise have not too much lift. The lift should never exceed one-fourth the diameter of the valve, and may be less. Open the valves on the steam and return pipes, and then turn on the water and fill the boiler to within a couple of inches of the level at which it is intended to keep the water when steam is up.

While the water is being run in, the guage cocks, or safety valve, should be open to allow the air to escape from the boiler. The fire should then be lighted, and the water slowly heated until steam is raised. When steam has begun to flow through the pipes the valves at all the radiators should be opened, and any requiring packing marked for attention by re-packing. If any radiators do not heat, the air valves should be opened to allow the air to escape.

When steam is up the return pipe should soon become warm, showing that circulation is going on throughout the apparatus. If it does not become warm, the cause of the stoppage of circulation should be searched out and removed.

A NEW ARC DYNAMO REGULATOR FOR THE BALL DYNAMO.

A NEW dynamo regulator for constant current machines has just been patented by Mr. Royal E. Ball, and the device is being attached to the new Ball dynamos now being manufactured. The device consists of a disc of magnetic metal working in a cavity left in the yoke between the magnets, the disc being mounted on the shaft where it is provided with ball bearings, so that there is little friction to speak of. Attached to the disc is the yoke carrying the brushes, which are held in the required position by the action on the disc of the magnetism of the field magnets. A number of grooves are cut in the disc to remove a portion of the metal, so that as the magnetism of the fields increase, the thicker parts of the disc are drawn more nearly into the center of the field. The lack of equilibrium in the disc is the only device used to revolve the disc and carry the brushes into the region of the highest potential on the commutator. As the current of the machine increases, the increased magnetism of the field attracts the disc and moves the brushes on the commutator, thus cutting down the current to the required amount.

The Ball dynamo possesses such good practical qualities as show it to be a very efficient machine, and the convenience with which it can be handled by itself or when coupled with dynamos of a different make, have gained for this machine considerable praise from those who have used it for lighting purposes. The only particular objection that we have ever heard offered to the machine, was that it was not automatic in its regulation, although it can be perfectly regulated by movement of the brushes. Now that the new regulator is being applied to all machines built, the last lingering objection to this dynamo will have been overcome. *Practical Electricity.*

No oil has been made, says a contemporary, that can economically lubricate all the journals of a mill. An oil running a heavy Corliss engine would not do to run a spindle or a fast revolving dynamo. The former runs slowly and has great pressure and strain on its journals, and consequently requires an oil which will not spread too quickly, but with low gravity and high viscosity. The latter needs a pure mineral oil, viscous and quick, to enable it to enter into the closest parts of the bearing as rapidly as the speed at which it revolves necessitates.

ON THE RELATION OF THE AIR GAP AND THE SHAPE OF THE POLES TO THE PERFORMANCE OF DYNAMO-ELECTRIC MACHINERY.*

THE object of this paper is not to deal with the subject in a new light, but to add to its literature a limited amount of data, the deductions from which go to establish the correctness of the ideas, and the utility of the suggestions put forth in the papers read by Messrs. Swinburne & Esson, at the meetings of the Institution of Electrical Engineers on February 13 and 20, 1890. Up to the time of the publication of these papers the air gap was usually treated by contributors to electrical literature as an evil in a dynamo, having a necessary existence, and the smaller that it could conveniently be made the better. The shape of the poles had often been spoken of as having a somewhat decided effect on the performance of the dynamo, while but little had been said regarding the cause of such an effect.

There exists some difference of opinion as to what should be known as the number of ampere turns on an armature. For our present purpose we will assume that the armature ampere turns equal

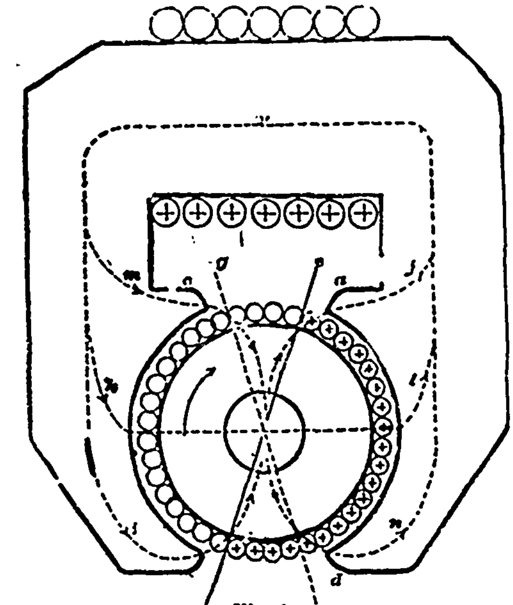

Fig. 1.

$$\frac{\left\{\begin{array}{l}\text{The number of conductors on}\\ \text{the surface of the armature.}\end{array}\right\} \times \left\{\begin{array}{l}\text{Strength of current in the}\\ \text{armature conductors.}\end{array}\right.}{\text{Number of poles.}}$$

Referring to Fig. 1, it is evident that, when we consider the magnetic forces acting in a working dynamo by the route *o, i, j, o*, the entire number of ampere turns on the armature are directly opposed in action to the ampere turns on the field. By the route *o, m, n, o*, all the ampere turns on the armature, except those that lie between the double angle of lead *g, e*, are acting with the field ampere turns, while those between *g e* are opposed to the same. Therefore, by this route, the total number of ampere turns actually aiding the field ampere turns is the total number of armature ampere turns, minus twice the number of ampere turns that lie between the double angle of lead. By the route, *o, k, l, o*, the number of ampere turns acting is the number of ampere turns on the field, minus the number of ampere turns that lie between the double angle of lead. We can then estimate with ample practical accuracy the magnetic density in the air gap at all points for any given total amount of magnetization through the armature. The ampere turns that lie between the double angle of lead are opposed to the action of the field ampere turns at all points. It is evident that the portion of the armature ampere turns not included between the double angle of lead will increase the magnetization through the air gap by the route *o, m, n, o*, just as much as they diminish it along the route *o, i, j, o*, as long as magnetic saturation does not take place in the strengthened pole corners *c, d*. If the pole corners are thin, as in the types shown in Figs. 2, 3 and 5, saturation is apt to occur. It is then that the magnetic resistance increases by the route *o, m, n, o*, and the magnetic density by this route is no longer increased by the same amount that it is diminished along the route *o, i, j, o*. On the other hand, when the pole corners are fashioned, as seen in Figs. 4 and 6, so that saturation in the strengthened pole corners cannot occur in practice, the current in the armature can produce no modification of the total amount of magnetization through it, other than that which is produced by the action of the ampere turns that lie between the double angle of lead. This action can always be compensated for by putting an equivalent number of series ampere turns on the field acting with the field ampere turns. The double angle of lead can be determined with sufficient accuracy, for with pole corners slightly extended at the center (see Fig. 11), the diameter of commutation at all loads is very near the weakened pole corners. The pole corners are slightly extended at the center, so that the coils always enter the field of the weakened pole corners gradually. The electromotive force developed in the coils as they pass under the poles can never be far different from that actually needed to reverse the current in the coil when passing under the brush. In this way the point of commutation in a dynamo can be kept the same when carbon brushes are used without undue sparking, as long as the armature does not reverse the magnetization under the weakened pole corners.

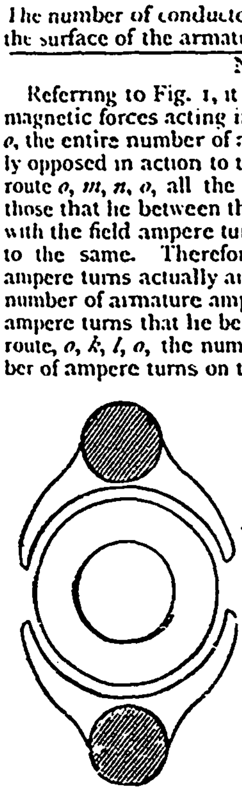

Fig. 2.

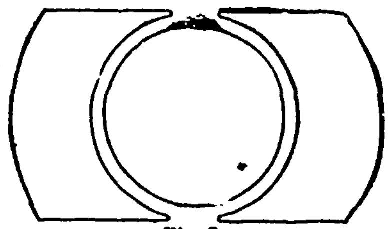

Fig. 3.

From the discussion of the magnetic relations of an armature to its field in a dynamo, in connection with Fig. 1, it is seen that the magnetization in the air gap under the weakened pole corners becomes zero, when the armature ampere turns are equal to the ampere turns on the field, whose magnetizing force is impressed between its pole faces through the armature. This impressed magnetizing force is that due to the difference between the total number of ampere turns on the field and the number of ampere turns required to set up the magnetization through the field cores, from pole face to pole face. In order to commutate the current without spark at the commutator the magnetization in the air gap under the weakened pole corners dare never be allowed to become zero. It follows, then, that the field ampere turns, impressing a magnetizing force between the pole faces, must always be somewhat in excess of the maximum number of ampere turns on the armature. The amount of this excess need only be sufficient to insure a positive field at *a* and *b*, Fig. 1, strong enough to reverse the current in the coils as they are commutated. When a certain amount of magnetization is to be set up through an armature, with the application of the magnetizing force of a given number of ampere turns impressed between the pole faces, we must provide the requisite amount of magnetic resistance between these pole faces. The value of this resistance will have to be such that the impressed field magnetizing force will establish the desired amount of magnetization. This resistance in most cases is best provided for in a proper length of air gap. In general, it is found best to avoid heating in the armature core, as far as consistent, by the use of comparatively low magnetic densities for wrought-iron. The magnetic resistance of the armature core, under these circumstances, is very small and may be neglected.

The magnetic resistance between the pole faces is occasionally provided for largely, either through a saturated core of a ring armature, saturated lugs on armatures where the wires are placed in grooves, or both. This, in addition to what air gap may be necessary from a mechanical point of view, go to make up the total amount of magnetic resistance that is provided between the pole faces. Machines of this order have been developed largely through the old and rather expensive method of experimentation. This method has given us some types in which ordinary results are arrived at through rather extraordinary means. Take the case of a machine with a ring armature, wires wound in grooves, a very small air gap, and poles shaped somewhat as shown in Fig. 2. Such a machine, operated as a dynamo, may require only a quarter of the number of ampere turns that it will have on the armature at full load for field excitation in order to produce a certain electromotive force at a given speed. Yet this machine produces a fairly constant potential at the brushes, under all variation of load, and without undue sparking at the commutator, in the following manner. For the production of a constant electromotive force at constant speed the total magnetization through the armature must remain constant. At no load one fourth of the ampere turns needed on the field at full load are provided by a shunt winding. This shunt winding is sufficient to set up the total amount of magnetization for the production of the normal electromotive force of the machine when there is no current in the armature. Now, in order to take the normal current from the armature without reversing the magnetization under the weakened pole corners, three times as many series ampere turns as there are shunt ampere turns must be added to

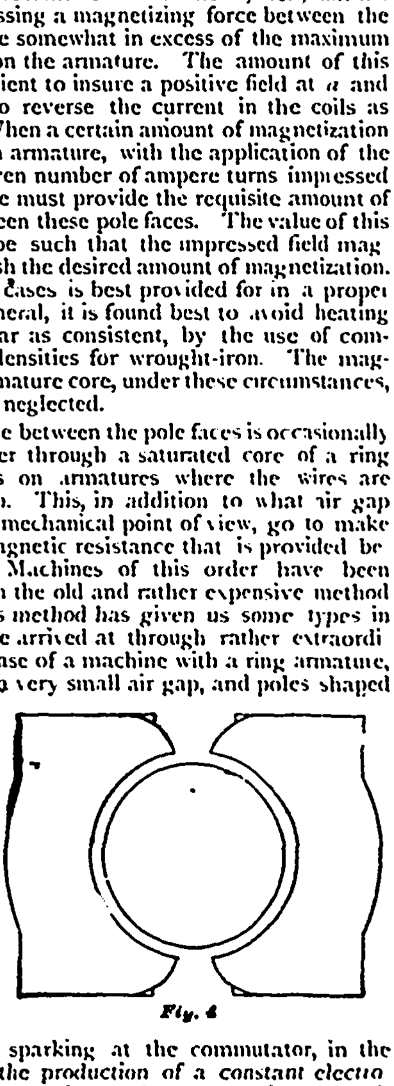

Fig. 4.

* Paper read before the American Institute of Electrical Engineers, New York, September 22, 1891, by Harris J. Ryan.

to the field The addition of these series ampere turns must not increase the total amount of magnetization through the armature, which is accomplished by the thin pole corners. The strong pole corners become saturated when the armature is furnishing even a small amount of the normal current for which it is designed For most values of the current, then, the armature ampere turns tend to diminish the magnetization under the weakened pole corners, but cannot increase it correspondingly under the saturated pole corners. The action of the series ampere turns on the field prevents the reduction of the magnetization under the weakened pole corners to zero, while the saturated portion of the pole pieces prevents the increase of the total magnetization through the armature, and thus a constant potential is maintained.

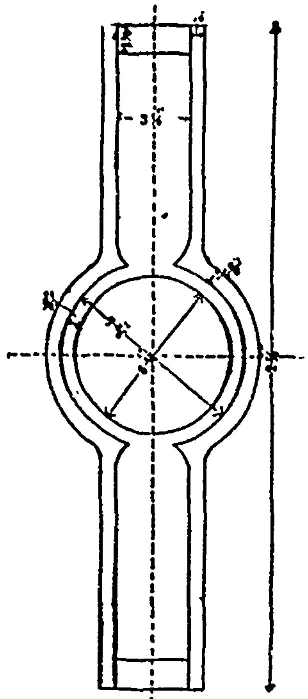

Fig. 5.

The "armature characteristic" IV, plotted in Fig. 7, was taken from the machine of the above sort, built with cast-iron fields. The cross-section of the field cores proved, on trial, to be too small, and became strongly saturated at full load, while they were quite a little under the point of saturation at no load. This curious result for a constant potential generator was due to the increased magnetic leakage produced as the series ampere turns on the field came up with the load. Saturation took place, as the curve indicates, when the armature furnished a current of about 140 amperes, and no possible compounding could ever make this generator produce even approximately a constant potential, with variation of load. Steel cores of the same dimensions were substituted for the cast iron cores. Saturation did not occur in them due to magnetic leakage. The pole corners were very thin, as in Fig. 2, and the "armature characteristic" III was obtained. The machine was then furnished with a shunt winding that produced a slightly smaller number of initial ampere turns than curve III indicates as required to produce 125 volts, and with series turns at such a number that the total number of ampere turns on the field for any current developed by the armature is shown by the broken line drawn through curve III. It was under these conditions that the machine performed in the manner described above, and not vary more than five per cent. from the normal electromotive force on either side, or a total variation of 10 per cent It was then almost entirely rebuilt. The armature was provided with a core that was considerably larger in cross-section, and the maximum magnetic density used in it was 11,000 lines per square centimetre, as against 20,000 used before. The lugs on the core were dispensed with and the wires wound on the surface of the core. The poles were made of cast iron, and fashioned to accord more nearly with those in Fig. 3. The air gap required 10,000 ampere turns to set up the magnetization through it at no load, while the armature ampere turns were

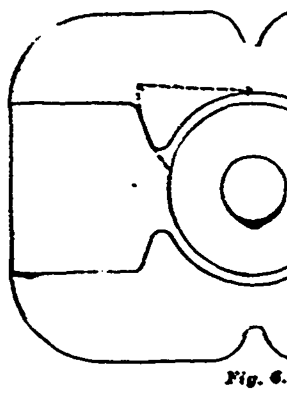
Fig. 6.

8,000 at normal output, so that series ampere turns had only to be added to counteract the action of the ampere turns on the armature that lie between the double angle of lead, to increase slightly the electromotive force by the amount equal to the fall of potential through the armature caused by its resistance, and to compensate for the slight effect of the pole corners that still became saturated to a limited extent for the higher outputs. It should be remembered that the magnetic leakage that takes place between the adjacent north and south pole corners, one of which is strongly and the other weakly magnetized, plays an important part in saturating thin pole corners. It is evident that unless the "armature characteristic" is a straight line, as in curve I, Fig 7, that the machine cannot be made to regulate for constant potential with a high degree of refinement. The poles were again changed and shaped as in Fig. 4, when an "armature characteristic" given in curve I was obtained and the proper number of shunts and series ampere turns for a refined degree of regulation were readily decided upon. These experiments confirm what has been said above, and show how useless have been the attempts to diminish the air gap beyond certain limits.

It was shown on the outstart how we can calculate the actual magnetic densities in the air gap for any total magnetization through the armature for any armature current. The results of the following experiments confirm the correctness of these methods. The diagrams in Fig. 8 give the values of the magnetic density at all points of the air gap of a generator, produc-

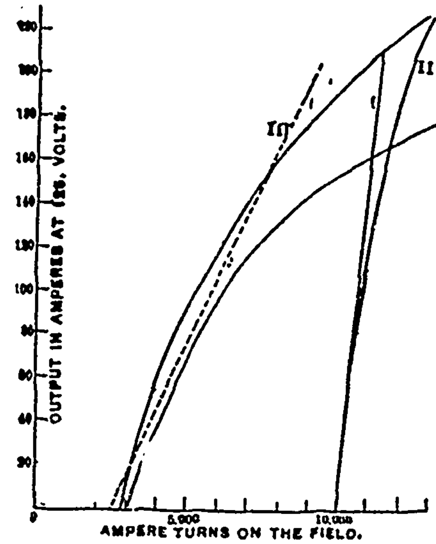

Fig. 7.

ing 125 volts at the brushes and 80 amperes. The following are its dimensions and data:

Diameter of armature core	6.25 in.
Length of armature core	12. in.
Diameter of bore of poles	7.19 in.
Double depth of air gap	.94 in.
Armature sections	50.
Turns per section	2.
Resistance of armature	.06 ohms.
Poles shaped as in Fig. 3.	
Shunt turns on field	6400.
Field current, no load, 125 volts	1.48
Field current, full load, 125 volts	2.10
Speed	1600.
Carbon brushes used without lead.	

The "armature characteristic" curved considerably, indicating that the pole corners become saturated. It is evident, too, that the normal magnetization in the pole corners, in addition to the magnetic leakage, which is greater there than anywhere else, produced saturation in all pole corners, even with no current in the armature. For, at full load, there were 4,000 ampere turns on the armature, while 4,000 series ampere turns had to be added to the field that produced 125 volts at no load to keep the electromotive force the same. Therefore, at full load, we have the same number of ampere turns acting through the weakened pole corners as at no load, and the total amount of magnetization has only been increased five per cent., to compensate for the resistance of the armature conductors. The conditions, however, are not the same, for there are just 4,000 more ampere turns to cause magnetic leakage at the pole corners, so that on the whole the magnetization in them is increased. This increase of magnetic density in them greatly increases their magnetic resistance, for they are saturated to begin with. It is on this account that we find the magnetization under the weakened pole corners diminished when apparently the forces acting have not

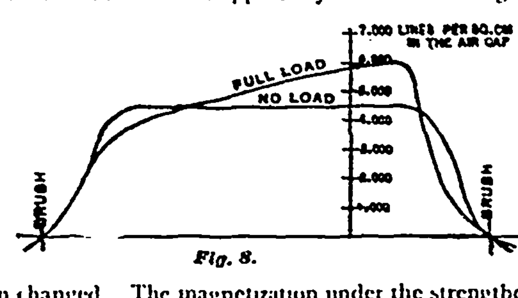

Fig. 8.

been changed. The magnetization under the strengthened pole corners through the air gap is increased more than it is diminished by the effect of the added magnetic leakage, through the 8,000 additional ampere turns, that act to produce magnetization by this route through the armature.

In Fig. 9 the diagrams show the magnetic action of the armature of a 10 horse-power, 110 volt motor, with poles fashioned as in Fig. 6. Measurements of the magnetic leakage were made on this motor, and the results indicate that the shape given to the pole corners avoided saturation in them even at full load. The double angle of lead was almost 60 degrees. The ampere turns embraced by it on the armature were partially compensated for by nine series turns on each of the consequent fields. The remainder of the armature ampere turns that lie between the double angle of lead served to weaken the field by just the amount required to produce a constant speed. The following figures give additional data on this motor:

Diameter of armature core	8 33 in.
Diameter over all	9 in.
Bore of poles	9.38 in.
Double air gap	1.05 in.
Shunt turns on field	2200.
Shunt current at 110 volts	3.55
Ampere turns on the field at 110 volts	7800.
Ampere turns on armature at full load	5750.
Armature sections	48.
Turns per section	3.
Speed	1200.

The ampere turns required to set up 2,600 lines per square

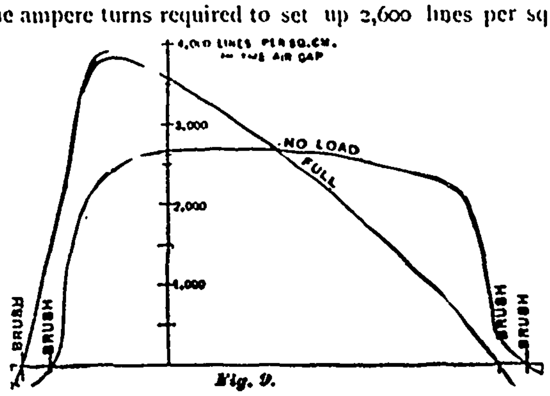

Fig. 9.

centimetre through a distance of 1.05 inches or 2.64 centimetres in open air:—

$$\frac{2600 \times 2.64}{1.26} = 5,600.$$

This is the number of field ampere turns that exerted their magnetizing force between the pole faces through the armature. The ampere turns acting through the weakened pole corners are, therefore, very near zero, which is entirely corroborated by the fact that the magnetization was observed to be zero at this point. See full load curve in Fig. 9. Through the strong pole corners the ampere turns acting were the 5,600 of the shunt ampere turns, + the 720 of the 9 series turns + the armature ampere turns, 5,750 – twice the ampere turns between the double angle of lead, 2. [.3 + 5,750], or 3,400 = 8,670, which will produce a magnetic density through an air gap of 2.64 centimetres depth of

$$\frac{8,670 + 1.26}{2.64} = 4,100,$$

while the actual magnetic density measured at this point was 3,950, an agreement within the possible limit of error.

In Fig. 10 are given curves showing the magnetic performance of an armature, with its conductors laid in deep narrow grooves, as shown in Fig. 12. The clearance on each side was one-sixteenth of an inch, making the double air gap one-eighth of an inch. Additional dimensions are as follows:

Diameter of the armature core	6. in.
Length of armature core	6. in.
Resistance of armature	.34
Number of sections	64.
Turns per section	3.
Output, amperes	20.
" volts	100.
Speed	1800

Curve I in Fig. 10 shows the distribution of magnetization at 112 volts, no current, a speed of 1,800, and a field excitation of 2,600 ampere turns. Curve II shows the magnetic distribution for an output of 97 volts and 24 amperes, at a speed of 1,800,

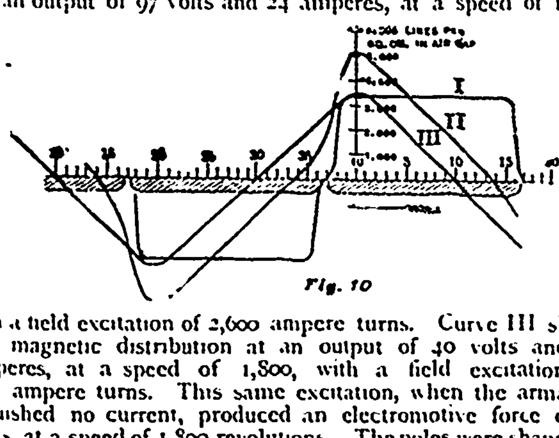

Fig. 10

and a field excitation of 2,600 ampere turns. Curve III shows the magnetic distribution at an output of 40 volts and 20 amperes, at a speed of 1,800, with a field excitation of 750 ampere turns. This same excitation, when the armature furnished no current, produced an electromotive force of 48 volts, at a speed of 1,800 revolutions. The poles were shaped as in Figs. 11 and 12, but modified as explained below. In making these experiments carbon brushes were used, and their position maintained at the normal diameter of commutation. An average magnetic density in the air gap of 3,400 lines per square centimetre was required to produce an electromotive force of 112 volts. The grooves on the armature in which the conductors were placed occupied one half of the armature surface, so that the actual magnetic density in the air gap was 1.8 times this average magnetic density. The ampere turns required to set up this magnetic density in the air gap were

$$\frac{.125 \times 2.54 \times [3,400 \times 1.8]}{1.26} = 1,520,$$

which is the number of field ampere turns whose magnetizing force is impressed between the pole surfaces through the armature, when it furnishes 112 volts and no current. The ampere turns on the armature at a current of 24 amperes are

$$\frac{2 \times 64 \times 3 \times 12.}{2.} = 2,300.$$

as against 1,520 impressed by the field. Under these circumstances the magnetism under the weakened pole corners is reversed, as is also clearly indicated by Curve II in Fig. 10, or the curve *c, e, d, f, c*, in Fig. 11. This curve also shows that the magnetic density under the strong pole corners was 5,100 lines per square centimetre. Now, in building this machine, six longitudinal slots, 1¼ inches deep, were cut in each pole immediately back of the surface, which enables us to be sure of the exact densities in the pole corners for a given distance. For a depth of 1¼ inches immediately back of the pole faces these slots took up one-half of the cross-section of the poles. Then a density, therefore, of 5,100 really means a density of 10,200, or a strong saturation for a distance of 2½ *inches in the cast-iron of the poles.* The *magnetizing force* required to produce 10,200 lines per square centimetre through cast-iron is 200 per centimetre length. Therefore, the ampere turns required to establish this density through 2½ inches are

$$\frac{2.5 \times 2.54 \times 200}{1.26} = 1,000.$$

The total number of ampere turns acting to produce magnetization through these strong pole corners was the sum of the field ampere turns that impressed magnetizing force from pole face to pole face through the armature, and the ampere turns on the armature covered by the poles. The poles covered approximately 85 per cent. of the armature surface, making this value. 1,500 × [2,300 × .85] = 3,400. Of this number, as was just shown,

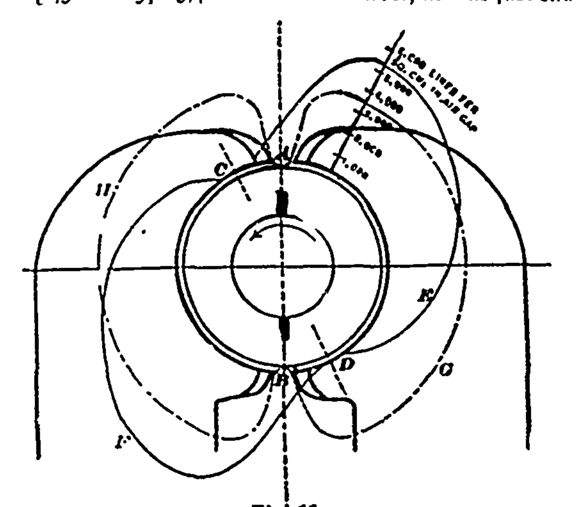

Fig. 11.

1,000 were utilized in producing the magnetic density of 5,100, through the saturated portions of the poles. The remaining 2,400 ampere turns exerted their magnetizing force in producing the average magnetic density of 5,100 through the air gap, and affords another opportunity of checking these ideas of the action of the armature on the field. For the ampere turns required to set up an average magnetic density of 5,100, through the air gap under consideration were:

$$\frac{[1.8 \times 5,100] \times .125 \times 2.54}{1.26} = 2,300,$$

which checks with the above value as well as could be expected. When the armature furnished 24 amperes, the electromotive force at the brushes was 97 volts, while with no current it was 112 volts. Of this drop of 15 volts eight are accounted for by the resistance of the armature, and the extra seven were caused by the saturated pole corners. By operating this same machine at an electromotive force at which the pole corners could not saturate with normal output of current, we have demonstrated for us in a very striking manner that the armature ampere turns cannot change the total magnetization established through the armature by the field when the pole corners do not saturate. The electromotive force, with the armature current at zero, was brought to 48 volts with a separate field excitation of 750 ampere turns. Then when the armature was allowed to furnish 20 amperes the electromotive force at the brushes dropped to 40 volts. Of this drop of eight volts seven were produced by the resistance of the armature. Yet the field is powerfully distorted by the armature current, as may be seen by reference to Curve III, Fig. 10, or the curve A, D, C, B, in Fig. 12. Even with this very great rearrangement of the magnetization produced by the armature current, the total magnetization set up by the field is practically unchanged. The difference of potential on the commutator between the points A, B, Fig. 12, was observed to be 72 volts. This excess of electromotive force over that which was produced at the brushes the figure shows clearly to be due to magnetization produced by the armature through itself and the strengthened pole corners. The points where the field is zero are at A, B. They mark the diameter through which the ampere turns encountered on the armature are just equal and opposite in action to the ampere turns of the field that impress a magnetizing force between the pole faces through the armature. A simple computation will show that this is true. The field ampere turns that impress magnetizing force between the poles when the armature produced an external electromotive force of 48 volts are

$$\frac{1,520 \times 48}{112} = 650.$$

The ampere turns on the armature opposed to the magnetization set up the force A, B, are $\frac{12}{40}$ of the total number of ampere turns on the armature [see Fig. 12], or,

$$\frac{12 \times 64 \times 3 \times 20}{40 \times 2} = 576.$$

This is a fair agreement when we consider the accuracy with which the original data may be determined.

Mr. Esson, in his valuable paper above referred to, discussed the requisite features for a generator of constant current with closed coil armatures, in which regulation is effected by shifting the brushes. He stated that the field should be uniform at all points under the poles, and that the armature cord should be saturated. These statements are a little misleading. The magnetizing force impressed by the field ampere turns must be uniform at all points between the pole surface. This is accomplished by proportioning the poles so that the strongly magnetized pole corners will not become saturated when the brushes

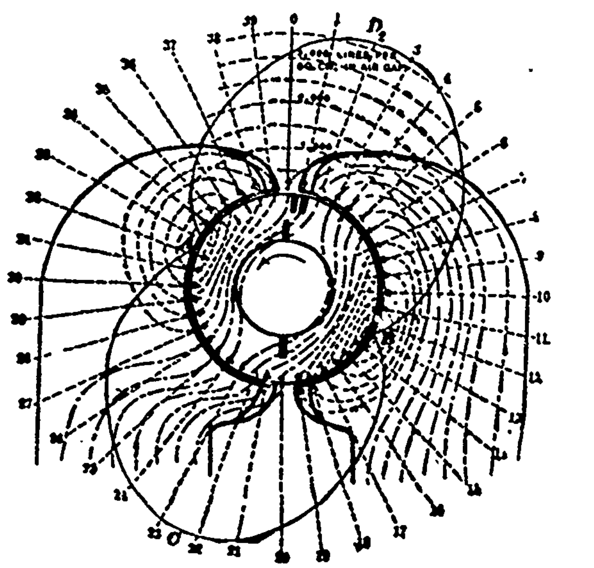

Fig. 12.

have their extreme position for the development of the highest electromotive force that the machine is to produce. The air gap is made of such a depth that the ampere turns required to set up the magnetization through the armature, without current, and for the production of the highest electromotive force that the machine will be called on to give, shall be a little more than the armature ampere turns when it furnishes its normal current. Then as long as the brushes are kept under the pole faces the non-sparking point will be wherever the brushes are placed. This will be the case whether the armature is or is not saturated. A practical demonstration is found in the following experiment. A Siemens & Halske dynamo, with magnet and armature cores, whose shape and dimensions are shown in Fig. 5, was used.

Length of armature core	7.25 in.
Number of armature sections	56.
Turns per section	6.
Revolutions	1000.
Output in volts	50.
" amperes	30.

The field was separately excited with 4,000 ampere turns on each of the sets of consequent poles. Regulation could then be effected for a constant current in the armature of 22 amperes, by shifting the brushes from no electromotive force to 35 volts without the slightest sparking, even when metallic brushes were used. Within this limit the pole corners did not saturate. The field cores were wrought and the yokes cast iron. When the armature circuit was broken it was found that the field excitation of 4,000 ampere turns produced an electromotive force of 50 volts. The magnetic density in the field cores, including leakage, was only 11,000 lines per square centimetre. Therefore, of the 4,000 ampere turns on the field not more than 200 were applied in setting up the magnetization from pole face to pole face through the field cores. It is safe to assume, then, that of these 4,000 ampere turns 3,800 were active in producing a magnetizing force impressed uniformly over the pole faces through the armature. This same value is obtained by the method adopted in the previous cases. That is, by calculating the magnetic density in the air gap when 50 volts were developed, and then deducting the number of ampere turns required to establish such a magnetic density through a one and one-half inch air gap. As to the armature, when it produced 22 amperes its ampere turns numbered

$$\frac{2 \times 56 \times 6 \times 11}{2} = 3,700,$$

or an excess of 100 ampere turns impressed by the field over and above those on the armature. As long as this same number of ampere turns was maintained on the field it was not possible to regulate for a constant current of a lower or a higher strength without sparking. The impressed field ampere turns are in excess of the armature ampere turns by that amount which is just sufficient to produce a weak positive field that will reverse the current in the coil when its terminal bars at the commutator pass under the brush. When regulation is effected by this means it is seen that all pole corners are alike magnetized and at the center of the pole faces the magnetization is zero when the machine is short-circuited. At full output, at the highest electromotive force, the magnetization under the one set of pole corners is almost zero, and under the other set it is at the maximum value that is ever obtained. In a generator of this type when the poles are made stout enough at all points, the total amount of magnetization through the armature, at all loads, will remain at a constant value.

What has been said of dynamos applies equally well to motors. In a motor the armature rotates in an opposite direction when field and armature currents remain the same as in a dynamo. The electromotive force of self-induction, caused by the reversal of the current in a current has not changed, while the electromotive force developed in the coil by the field has changed sign with the change of the direction of rotation. The result is that the reversal of the current in an armature section must take place in a weak field of an opposite sign in a motor from what it does in a dynamo, when sparking is to be avoided entirely.

The action of the current in the armatures of multipolar dynamos and motors will be the same as that found for two pole machines.

BOILERS FOR 120 POUNDS PRESSURE.

The following table, taken from *Power and Transmission*, shows how thick cylindrical boiler shells of 50,000 pounds iron will have to be to stand 120 pounds pressure. It allows a safety factor of six, and deducts 44 per cent. for single riveting, and 30 per cent. for double:

Diam.	THICKNESS.		Diam.	THICKNESS.	
	sing. riv.	d'bl. riv.		sing. riv.	d'bl. riv.
24	.3082	.2468	50	.6420	.5142
26	.3338	.2674	52	.6676	.5348
28	.3596	.2880	54	.6934	.5554
30	.3852	.3086	56	.7190	.5776
32	.4108	.3290	58	.7446	.5966
34	.4366	.3496	60	.7704	.6170
36	.4622	.3702	62	.7960	.6376
38	.4840	.3908	64	.8218	.6582
40	.5136	.4116	66	.8474	.6788
42	.5392	.4320	68	.8732	.6994
44	.5650	.4526	70	.8988	.7200
46	.5906	.4730	72	.9244	.7404
48	.6164	.4936			

BELTS FOR DYNAMOS.

It is best when purchasing a belt for driving dynamos to have it well stretched before placing upon the machine. New belting stretches very much and gives a great deal of trouble until it settles down to its work. Before measuring for a belt, screw the dynamo upon its slides as near to the engine or driving pulley as possible. For moderate powers the belt should have one inch in width for each horse power transmitted, running at a speed of 1,000 feet per minute. It is impossible to avoid a slight slipping of the belting when new, but moving the dynamo from the driving pulley by means of the slides will tighten it. Care must be used to keep the belt from being too tight, as a belt that is too tight is as bad as one too loose. Thin, flexible belting is generally used for dynamo work, but rope driving is coming rapidly into favor for large dynamos, a single or multiple rope being used upon a groove pulley. There is less liability to loss by slipping in this method, and there is no stoppage to the plant by a belt coming off of the pulley. *Electrical Age.*

The Kingston Locomotive Works recently presented a four h. p. gas engine valued at $500 to the Carruthers Science Hall of Queen's University.

SPARKS.

A new engine with a fly-wheel measuring 18 feet in diameter and 4½ feet across the face, is being put into the Electric Light & Tramway Co.'s premises at Victoria, B. C.

Messrs. Patterson & Corbin have been granted exemption from taxation for ten years by the St. Catharines city council, and purpose engaging in the manufacture of street cars, etc.

An American exchange says: The North American Phonograph Company, of New York, have commenced legal proceedings against every Edison phonograph now in Canada that has been obtained under an American lease. It is understood that a number of persons are operating the phonograph illegally, and under the terms of the lease are subject to seizure by the company, and the lease cancelled.

Mons. Redier has invented an ingenious apparatus for indicating the revolutions made by the wheels of rapidly driven machinery, especially of dynamos. The indicator requires no attention on the part of the operator, and works without the aid of a chronograph. It is, in fact, perfectly automatic. In order to ascertain the number of revolutions made per minute by a wheel, the needles are brought to zero by means of a button, and a triangle is appended to the extremity of the axis, the speed of which it is desired to determine. The two needles which record the turns, and the hundred of turns, put themselves in motion, and stop when the operation is completed. It is only necessary then to read the indicated figures. It is not essential to follow the action, which occupies about twenty seconds. The mechanism stops of its own accord when the needles have arrived at the desired stage.

"Hanging in a room in my shop," said an electrical manufacturer, "is a 32 candle power Bernstein series incandescent lamp, fed from an arc circuit. The lamp hangs about five feet below the ceiling, and the switch, operated by pulling a string, is placed on the ceiling. The floor in that room is of dry wood about five inches thick. If I go in there after dark, when the current is turned off the lamp, and wish a light, I simply put out my hand and feel around for the lamp. When my fingers come within a few inches of it the whole bulb begins to glow with a mellow light, as if it were filled with white smoke. This gives me enough light to find the string attached to the switch, which I pull to turn on the current. Then the lamp burns as usual. But what makes that lamp glow when there is no current on? *Electrical Review*, N.Y.

Mr. Thos. Laing Kay, of Hamilton, secured a patent on August 25th last, on a storage battery, for which the following claims are made Each individual plate after being filled with electrolytic compound, is covered with a perforated sheet of lead, rubber or equivalent material that will resist the action of the acid to prevent the compound from falling out of the plates. The combination, with the cells of projecting lugs made to be secured to horizontal bars, said bars provided with upward lugs so that when two or more batteries are placed side by side the lugs of the bars come together, and are secured by a rectangular clamp with binding screw and a rubber washer, interposed between the point of the screw and the lug. Perforated rubber plates or the equivalent non-conducting substance formed with non conducting projections on each side interposed between the positive and negative electrolytic plates to prevent said plates from buckling or coming in metallic contact.

Mr. C J. Page is endeavoring to introduce incandescent electric lighting in the town of Welland, Ont.

According to Mr John T. Grier, in the *Electrical Engineer* of New York, "we may roundly define a dyne in language that will be more likely to stick to the memory and be more easily grasped by some if we slightly paraphrase the definition and say it is that force which, acting for one second on a mass of matter equal in weight to four-tenths of a dime, gives to it a velocity of almost four-tenths of an inch per second."

SPARKS.

All engineers will soon require as much knowledge of electricity as of mechanics.

The city of Winnipeg possesses a telephone exchange which has now 750 subscribers, being about one to every 36 of the population.

It is an acknowledged fact that the change from horse power to electric power increases the travel on street car lines. This is a very pretty compliment to electricity.—*Ele. Review, N. Y.*

Electric light has been employed advantageously on board a West Indian steamer crossing the ocean to keep alive and flourishing certain plants which were being transported for acclimatization.

The Association of the Edison Illuminating Companies has accepted the invitation of Mr. Nicholls, Manager of the Toronto Incandescent Electric Light Co., to hold a convention in Toronto next year.

Now that the electric shoe polisher has entered the field, the dirty-faced, but bright-minded little boot-black who for years has adorned the street corners, must qualify himself to earn a living in another way.

Prof. Elihu Thomson corrects the popular impression that luminosity of arc lamps is due to heated carbon particles. He says that, although there is a steady stream of carbon vapor between the carbons, yet the light is nearly all derived from the enormously heated surfaces from which the evaporation takes place.

The Executive Committee of the National Electric Light Association of the United States, at its last meeting unanimously adopted a resolution of thanks to Mr. John Carroll, manager of the Eugene Phillips Electrical Works, Montreal, for the unremitting and eminently successful efforts put forth by him on behalf of the visitors to the recent convention in Montreal. The resolution was ordered to be engrossed and presented to Mr. Carroll. No one will deny that the recognition is well deserved and timely.

The following lead alloy for accumulator plates is proposed by a M. Worms. It consists of 945 parts of lead, 22 of antimony, and 13 of mercury. The lead is melted first, and the antimony added, the mercury being introduced as the molten mass is run into the mould. The result is said to be an alloy of lead which can be easily split up into comparatively thin sheets.

Referring to the new Ottawa electric railway, the *Electrical Age* says: It is quite a point, too, in favor of electric railroads to have one in the capital city of the Dominion, where the legislators and chief officials can study its advantages. With these gentlemen on the side of electricity for motive power on street railways a great advantage will be gained. Their voices will be heard in connection with other similar projects, and if they believe in the new power, as they undoubtedly will when they become thoroughly familiar with it, capitalists will find it much easier to carry forward their plans than they would if they were required to argue and fight for every point involved when trying to obtain necessary legislation. It is hard work at best to get an electric road established, and it requires good generalship; but when the authorities understand for themselves what electric roads are and what they are good for, we claim that it is a big advantage gained.

The electric and gas lighting companies at Woodstock, Ont., will, it is said, amalgamate.

The Edison Electrical Diamond Drill and Prospecting Company will place a complete plant in the Sudbury district for the purpose of prospecting and developing properties.

SPARKS.

The town of Virden, Man., is to have the electric light.

The citizens of Waterloo are opposing the erection of electric light poles on the streets.

The Bell Telephone Co. are removing their wires to their new building in Hamilton, Ont.

The drills and hoists in the Templeton phosphate mines are to be worked by an electric plant.

During the Ottawa Exhibition, the Ottawa electric railway carried upwards of 100,000 passengers.

An incandescent lighting plant has recently been installed at Morden, Man., by Simson & Davis, of Winnipeg.

Messrs. John Inglis & Sons, Toronto, are constructing the engines and boilers for the new electric light works at New Westminster, B. C.

The St. Thomas Edison Electric Co., (Ltd.,) has recently been organized at St. Thomas, Ont., with a capital of $25,000, with the object of installing in that city a 1,000 light Edison incandescent plant. Among the leading stockholderers are Judge Hughes, G. R. Rennington, Frank Hunt and N. McDonald.

It is said that the experiment of the telephonic church service has proved so successful in Birmingham, Eng., that it is now proposed to develop the idea by connecting the hospitals of the locality to Christ Church, the centre of the experiment. Already the wire has been switched onto the bedrooms of sick folk, and with marked success—a flexible cord being attached to the ordinary receiver with a specially adapted instrument for fixing on the head of the invalid.

For the purpose of increasing the power of vibration in the telephone, Mr. Oscar Pohlmann, of Nuremberg, inserts a microphonic relay in the circuit. The disc of this relay has on one side a ... net, and on very thin layer ... microphone. In conseq... the waves of the current the electro-magnet ca... the disc to vibrate; and, as a result, the m... phone begins to move. The relay should ... placed in a void or a space in which the air has been rarefied. The suppression of the air diminishes the resistance to be overcome by the disc, and its vibrations are extended or amplified, and the undulations of the current are thus reinforced. This apparatus will be found of advantage in long-distance transmission, according to the *Revue Scientifique.*

WHEN TO STOP ADVERTISING.

An English trade journal once requested a number of its largest advertisers to give their opinion concerning the best time to stop advertising, and the following replies were received:

"When population ceases to multiply and the generations that crowd on after you, and never heard of you, stop coming on."

"When you have convinced everybody whose life will touch yours that you have better goods and lower prices than they can ever get anywhere else."

"When you perceive it to be the rule that men who never advertise are outstripping their neighbors in the same line of business."

"When men stop making fortunes right in your very sight solely through the discreet use of this mighty agent."

"When you can forget the words of the shrewdest and most successful business men concerning the main cause of their prosperity."

"When every man has become so thoroughly a creature of habit that he will certainly buy this year where he bought last year."

"When younger and fresher houses in your line cease starting up and using the newspapers in telling the people how much better they can do for them than you can."

"When you would rather have your own way and fail, than take advice and win."

"Wh...y else thinks 'it pays to advertise.'"

FIRSTBROOK BROS.

King St. East, - TORONTO.

MANUFACTURERS OF

Toppins, Side-Blocks — AND — Cross-Arms

WRITE FOR PRICES.

Please mention the ELECTRICAL NEWS when corresponding with advertisers.

SUBSCRIBED CAPITAL, $100,100.
AMOUNT ON DEPOSIT WITH THE GOVERNMENT OF CANADA, $54,724.

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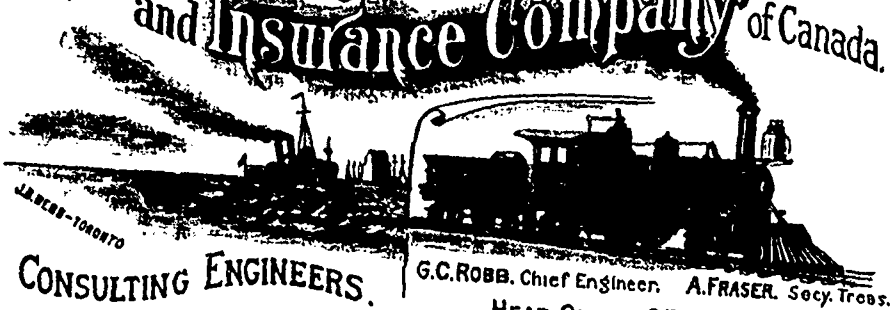
SIR ALEX. CAMPBELL, K.C.M.G. PRES. (Lieut Govr. of Ontario)
JOHN L. BLAIKIE ESQ. VICE PRES.



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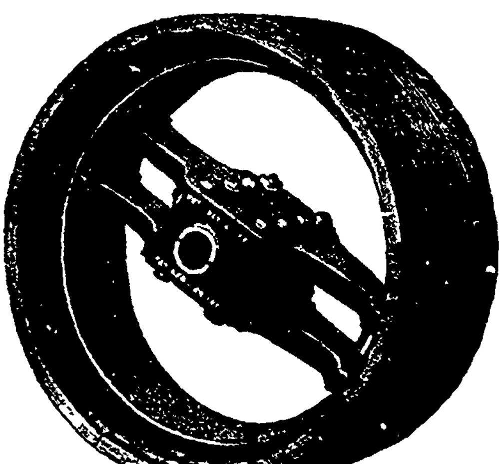

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