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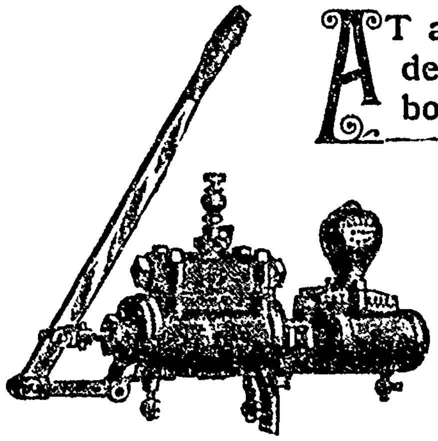
MARSH INDEPENDENT STEAM PUMP

FOR STATIONARY, PORTABLE AND MARINE BOILERS.

OVER 2,000 MARSH PUMPS SOLD IN THE UNITED STATES DURING 1890



THIS CUT SHOWS SMALLEST SIZE MARSH PUMP, WITH HAND LEVER.

AT a recent test by Prof Cooley, of Michigan University, 48 degrees of temperature was added between condenser and boiler in passing through pump.

Absolute Actuation and Regulation without the use of Tappets, Levers, or other Mechanical Construction.

As the exhaust mingles with feed water and returns to boiler, there is no loss of heat, hence it is the most economical pump in use. For hot or cold water or liquids, with or without Hand Pumping Attachment, NO PUMP EVER MADE THE RECORD OR BECAME SO POPULAR AS THE "MARSH."

Patented in Canada 7th February, 1889.

MANUFACTURED ONLY BY

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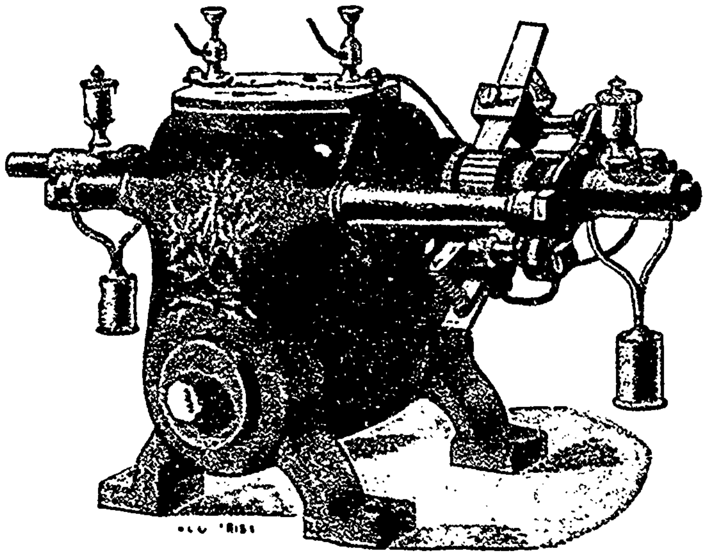


KAY ELECTRIC WORKS

NO. 263 JAMES ST. N. - HAMILTON, ONT.

MANUFACTURERS OF

DYNAMOS

For Arc and Incandescent Lighting.

MOTORS

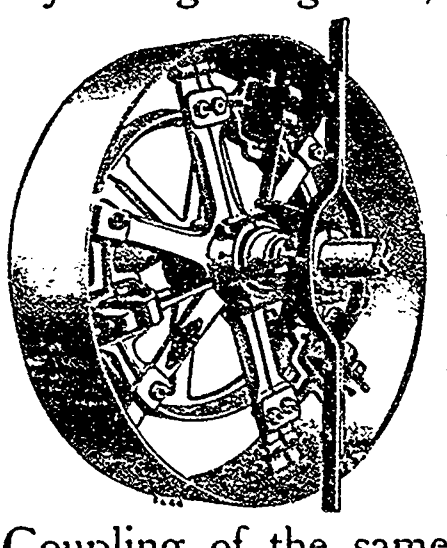
From 1-8 H. P. to 50 H. P.

ELECTRO PLATING MACHINES AND GENERAL ELECTRICAL APPLIANCES. SPECIAL ATTENTION TO MILL AND FACTORY LIGHTING.

WRITE FOR CIRCULARS.

DO YOU STOP YOUR MACHINE

By lifting a tightner, throwing off the heavy belt, or stopping the engine? All of these are objectionable.



We have patented a Friction Grip Pulley,—compact, simple, durable, large frictional area, ample clearance when out of engagement, powerful gripping mechanism.

We guarantee this pulley to work satisfactorily and to be thoroughly reliable.

Made split when required, and with 2, 3, 4, 6 grips for any class of work. Also a Cut-off Coupling of the same design.

Send for circulars and prices.

THE WATEROUS ENGINE WORKS CO., BRANTFORD, CANADA.

CANADIAN

ELECTRICAL NEWS

AND

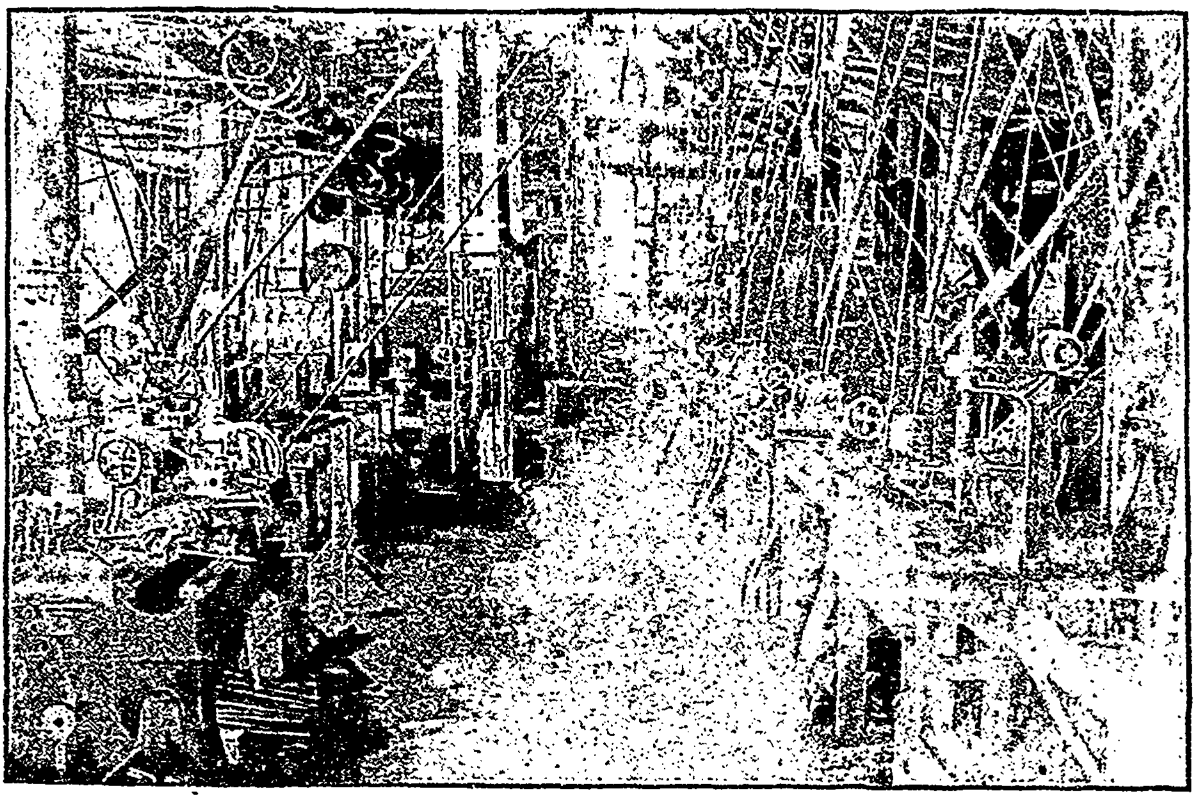
STEAM ENGINEERING JOURNAL.

VOL. I. TORONTO AND MONTREAL, CANADA, APRIL, 1891. No. 4.

THE BALL ELECTRIC LIGHT COMPANY.

THE accompanying engraving shows the arc lamp and brass working department of the Ball Electric Company's factory, 70 Pearl street, Toronto. This represents but one floor. We will give illustrations of the dynamo and armature departments in a later issue.

The business of the Ball Electric Company has been steadily enlarging, and now covers all branches of electric manufacture, as they manufacture arc, direct and alternating dynamos and lamps, railroad and power generators and motors. They make many of the fittings in connection with the above, and carry a full line of light, railroad and power supplies. We would call the reader's attention to the Wenstrom incandescent dynamos, power generators and railroad motors, the Ball Company having recently secured control of this system for the Dominion of Canada.



ARC LAMP AND BRASS WORKING DEPARTMENT, BALL ELECTRIC LIGHT CO., TORONTO.

NEWLY-FLEDGED ENGINEERS.

THE following persons having successfully passed the necessary examinations, have been granted marine engineers' certificates:

First class—James H. Ellis, Toronto.

Second class—Samuel A. Mills, Toronto; Eugene Belanger, Quebec; Constant Hamel, Quebec; William Parker, Kingston; Samuel Gillespie, Toronto; Alex. McRae, Toronto; David Foley, Toronto; Rupert McKay, Halifax; James Baird, Toronto; Oscar Flumerfelt, St. Catharines; Charles A. Farrer, Meaford; William F. Watts, St. Catharines; William Whipps, Collingwood; Edward W. Fox, Toronto; Frank White, Toronto, Andrew I. Foster, Halifax, N. S.; Alexander Cunstie, Halifax, N. S.

Third class Matthew Hayes, Toronto; William H Hinter, St. Catharines, Alexander Barton, Kingston; Albert F House, Port Dalhousie, George E. Wilson, Port Stanley, Alexander McKenzie, Owen Sound; David L. Johnston, Chatham; Hiram F. Chute, Halifax; Silas C. Soules, Queensville; Lawson B. Cronk, Wallaceburg, Henry Wilson, Victoria, B. C., Amos Knox, Halifax.

Fourth class—Anthony Strong, Kingston, John W. Hunter, Kingston, John Bolton, Kingston, William C. Spencer, Kingston; William T. Hyde, Dresden; John McDonald, Hamilton; James Ryan, Westport, James S. Adams, Toronto, Alma Lawder, St. Catharines, Andrew A. McLaren, Owen Sound; William Harwood, Owen Sound, John Burns, Owen Sound, George W. W. Rankin, Owen Sound; John H. Hewson, Owen Sound; John J. Cawgill, Victoria B. C.; Samuel J. Giles, Toronto; Robert W. Moore, Hamilton; Bertram Meyers, Toronto; Edmund J. O'Dell, Toronto, Isaac Modeland, Victoria, B. C.

Electric Light: "Does your mother know you're out, Mr. Lamp Post?"

Lamp Post: "Oh, yes, and you're to blame for it, too, you stuck up thing that you are."

Electric Light: "Well, that's pretty strong now, but then, you always were a little gassy, and a little, *just a little light in the head*, you know."

Lamp Post. "You needn't talk, for you're a good deal lighter in the head than I ever was."

Electric Light. "Oh, thank you." *Grip.*

THE WENSTROM DYNAMO AND MOTOR.

The principal features of the Wenstrom and the advantages claimed for it by the manufacturers are :

(1) The iron clad field magnets, in which the magnetizing coils are surrounded by iron in every possible direction, so that the iron core may collect all of the exciting force, radiated from

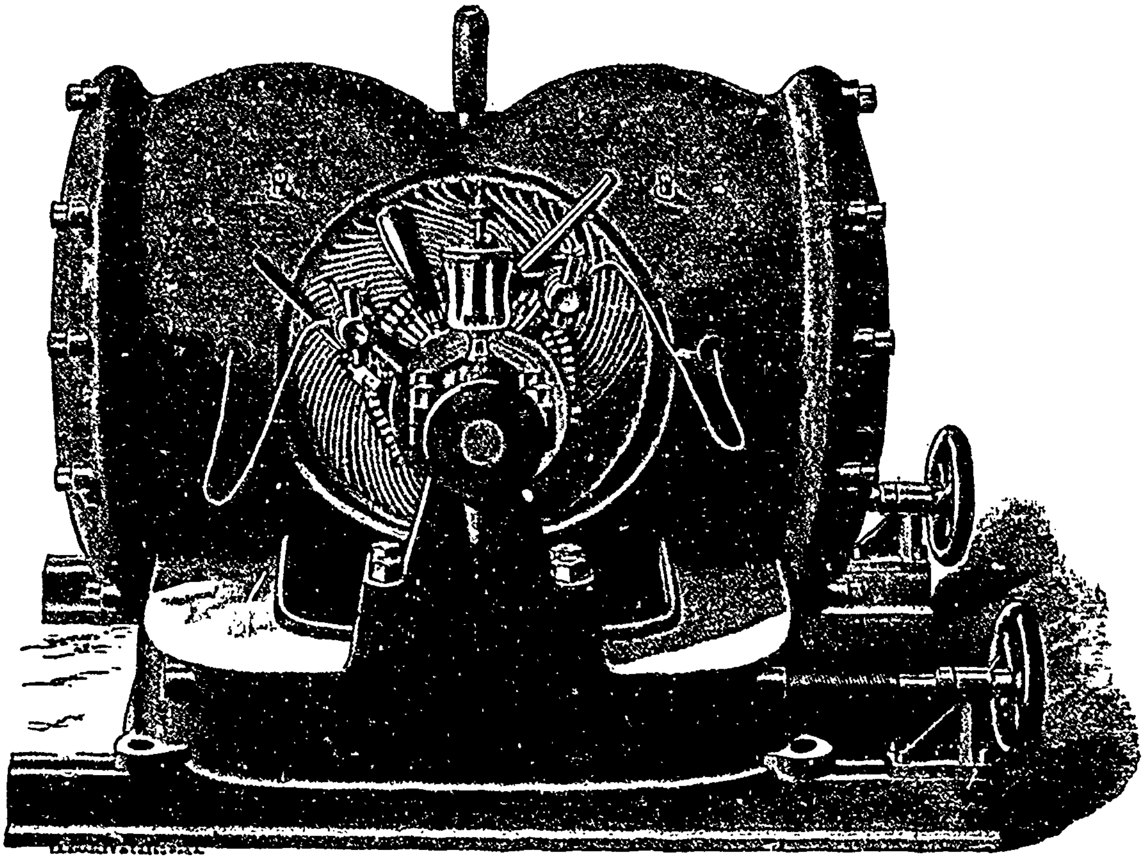


FIG. 1.—THE WENSTROM GENERATOR, (SIDE VIEW) SHOWING BRUSHES AND ARMATURE IN POSITION.

the coils, even that part which is usually dissipated in the surroundings. It follows from this arrangement that the exciting power is less in this machine, all other things being equal, because the power here is better utilized.

(2). The buried wire in the armature. In the Wenstrom the conductors are buried in grooves, or laced through holes transversely in the periphery of the armature, the distance between the pole piece and core being limited only to that small space required for the safe revolving of the armature. (See fig. 1.) The resistance of the magnetic circuit is by this means reduced in a high degree, and the magnetizing power used for creating the necessary magnetism in the armature is also decreased, thereby effecting a saving of power.

(3). Highest efficiency, in other words, the largest amount of light (or candle power of lamps) obtainable with the least amount of power received from the engine.

(4). Economy of operation.

(5). No sparking.

The base, cast solid with the body, is broad and long, giving a firm bed to the machine. The shaft is of steel, ground on dead centres and runs in composition—self oiling bearings, insuring perfect lubrication and reduced wear. The commutator is composed of massive copper bars, does not heat, and never needs renewal. Its covered structure precludes the possibility of an interruption from external injury, and there is no risk in transportation or handling.

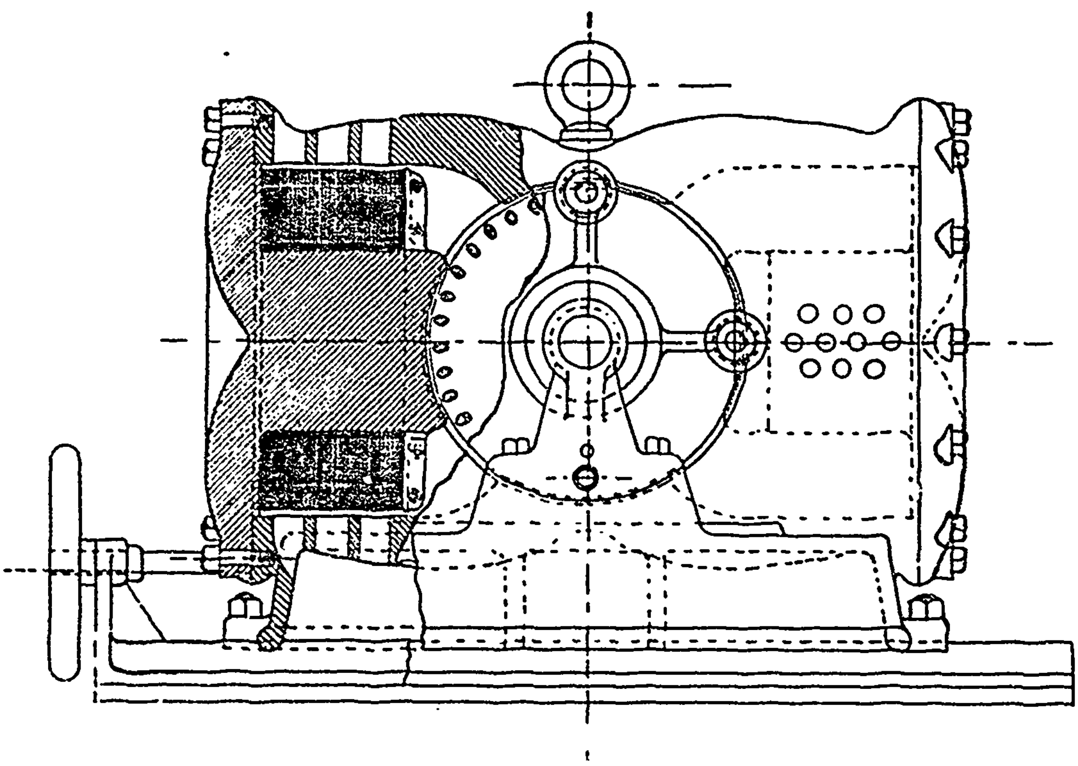
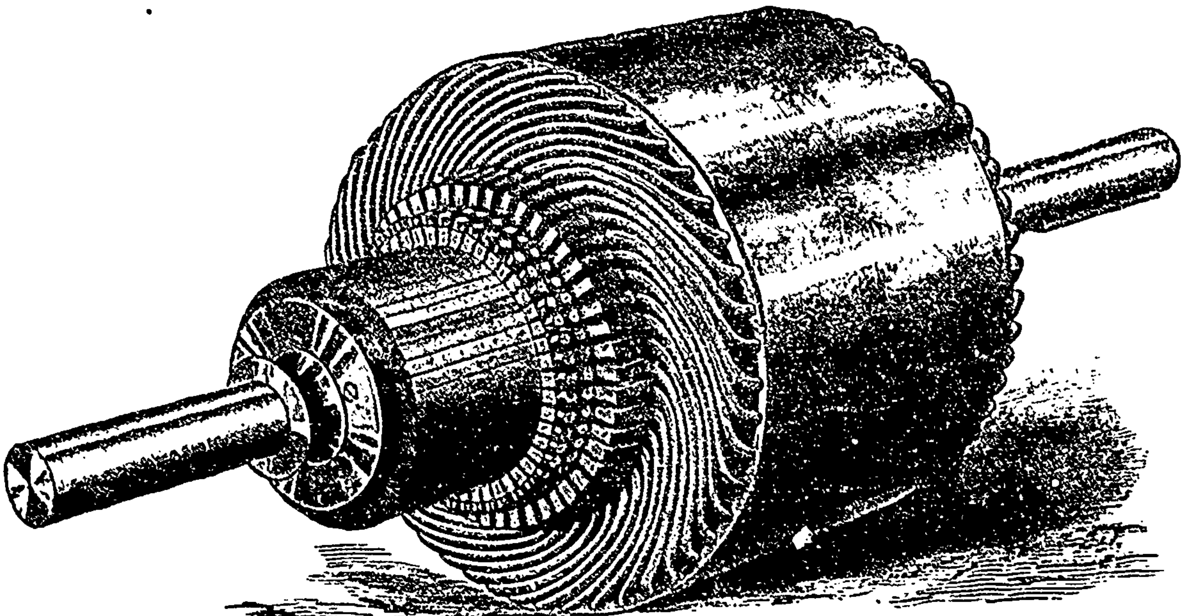


FIG. 2. - THE WENSTROM FOUR POLE GENERATOR (SECTIONAL SIDE VIEW) SHOWING FIELD COILS, POLE PIECES, ETC.

All parts of the dynamo are *easily accessible.* There is no loss of external magnetism into the surrounding air, as shown by the utter failure to attract or magnetize bits of iron in proximity to or in the vicinity of the machine ; consequently, no magnetizing of watches or other delicate instruments when brought near it. For marine lighting this is regarded as an especially valuable feature, as it means no deflection of the compass, on account of the electric lighting plant. Heating is said to be avoided in the use of this machine, consequently a saving of otherwise wasted power, and endangering of insulation or stopping of the machine from such cause. By means of a perfect automatic regulation, it is claimed that any number of lamps less than the full load of the dynamo can be run with approximately the same economy of power per lamp, and any changes of the number of lamps burning can be made with perfect safety to the lamps and dynamo without requiring the attention of an attendant at the machine, and with the Wenstrom system lamps of various candle power can be used from the same circuit at the same time. The thoroughly insulated character of the dynamo, together with the low voltage used, is said to render the Wenstrom system especially desirable and safe for house, hotel or other lighting service.

After a series of careful tests of the Wenstrom, Professor Kapp, the celebrated German electrician, writes of this machine as follows. "The Wenstrom possesses many novel and remarkable points. It is very simply constructed and most substantially built, both as to electrical and mechanical details. Up to this time a machine has never been seen in this country which utilized all the magnetic forces as fully and undergoes so little loss of power as does the Wenstrom. It is impossible to utilize all such magnetic forces without the aid of two very essential points, which are the principal features of this machine. In all the best dynamos, as at present constructed, the manner



THE WENSTROM ARMATURE, SHOWING SMOOTH EXTERNAL SURFACE AND WIRES LACED THROUGH HOLES NEAR PERIPHERY

of wiring the armature is such that it is impossible to bring the armature surface sufficiently close to the field poles to obviate the magnetic resistance, which it is very desirable to do. In all machines at present on the market, the old forms of field magnets have been strictly adhered to, and the currents produced by them generate magnetism in such a way that a large and valuable portion of it is generally lost. This, as will be readily perceived, it is very desirable to utilize, as, if it could be retained, more magnetism could be generated with less power. In the Wenstrom machine the desired end is attained by the peculiar construction of the field magnets and the cast iron shell, which while accomplishing the result demanded of it, also renders the dynamo more substantial and rigid in all its bearings. By this form the magnetic forces which are generally lost in other makes of machines are retained, while in the armature the two great obstacles are overcome by lessening the distance between the armature and the field, and by reducing the magnetic resistance to the core. The machine runs evenly and smoothly at extremely low speed. A careful examination of it will convince any one that it is the very best compared with other machines. In point of speed none can equal the Wenstrom, as it produces more current at low speed than any other can give at high speed. This machine has overcome some of the principal defects of other makes in speed, efficiency, weight and electrical and mechanical details, and no machine of equal capacity at present known could be manufactured as cheaply or run better."

THE "WENSTROM" SLOW SPEED RAILWAY MOTOR

is a four pole machine cast in one piece, being very simple in construction. The field coils are wound on bobbins which slide on to the main poles at either end of the motor. The construction of the armature is similar to that of the dynamo and generator, but its advantages are even more apparent for this work. There being no wire on surface of the armature, it is possible to run it within 1-16 inch of the field poles. The boxes are so arranged as to take up any wear, and by the same device the armature can be adjusted to 1-100 part of an inch. The difficulty of taking out the armature is obviated by making the pinion seat conical, so that the pinion can readily be taken off and armature slid out, taking but a few moments time, without any danger of injury to armature wires, which will be appreciated by persons who have had this difficulty to overcome. The Wenstrom motor complete weighs about 2,000 lbs., and it is claimed will develop 35 H. P., although the manufacturers have seen fit to rate it at 25 H. P. Its speed is only 400 revolutions per minute, which allows it to be geared to the car axle *direct*, without the annoyance and expense of the intermediate countershaft. Brush holders are arranged to slide on to the bracket so that they can be adjusted or taken off the motor entirely without removing the brackets. But one motor is used to a car, excepting in special cases where special grades, or work, renders two motors necessary, as it is an impossibility to construct two motors identical in power, speed and other details, the result being that where two are applied to the car axles, one does the greater share of the work ; therefore, while one is running light, the other is overworked and overloaded ; there are also twice as many parts to wear out and keep in repair. Owing to the low revolutions of the motor, it will give a maximum speed of 15 miles per hour (by one reduction and without use of a countershaft), and by use of patent *hydraulic* noiseless wooden toothed gear, the armature is allowed at all times to run at full speed regardless of the speed of the car, and cannot be tied up or overloaded. By means of this hydraulic gear the speed of the car may be varied, without relation to speed of armature, which may be kept running all day. This also avoids the jerking in starting and stoppage of cars.

Further particulars will be cheerfully supplied by the Canadian manufacturing agents, THE BALL ELECTRIC LIGHT CO., LTD., Toronto.

TORONTO WATER SUPPLY.

THE Toronto water supply continues to demand a great deal of attention, and the daily papers are constantly referring either to the quantity or quality of the supply or the management or

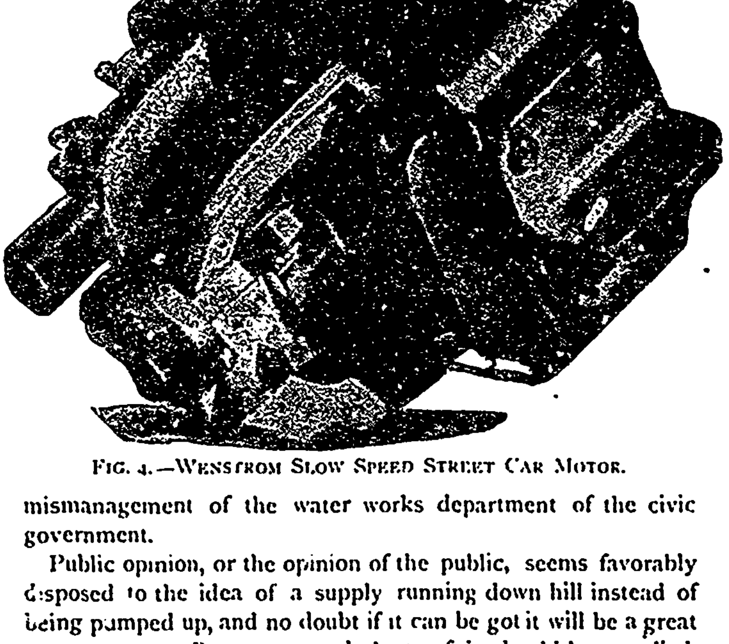


FIG. 4.—WENSTROM SLOW SPEED STREET CAR MOTOR.

mismanagement of the water works department of the civic government.

Public opinion, or the opinion of the public, seems favorably disposed to the idea of a supply running down hill instead of being pumped up, and no doubt if it can be got it will be a great improvement. Pure water and plenty of it should be supplied, and every householder should be made to pay for his share of the water supply as well as for police protection, street cleaning, etc. The gravitation scheme, even if adopted, cannot possibly be in operation for several years, and the water is required now. A new pipe has been laid, but not yet completed, to bring the lake water into the well at the pumping house. The present pipe, which for over 4000 feet is only three feet in diameter, cannot let as much water into the well as the present engines can pump out of it. The present pipe has often leaked so badly at some point that bay water has got in. To many it seems a mystery how a pipe under water, but full of water, can draw water into it out of the bay. The reason is that the present pipe supplying the well is so small that before enough water can be got to flow through it to supply the pumps running at their ordinary speed, the water level in the well is about 13 feet below the level of the water in the lake. Hence the water pressure inside the pipe is less than that outside of it, and any joint not abso-

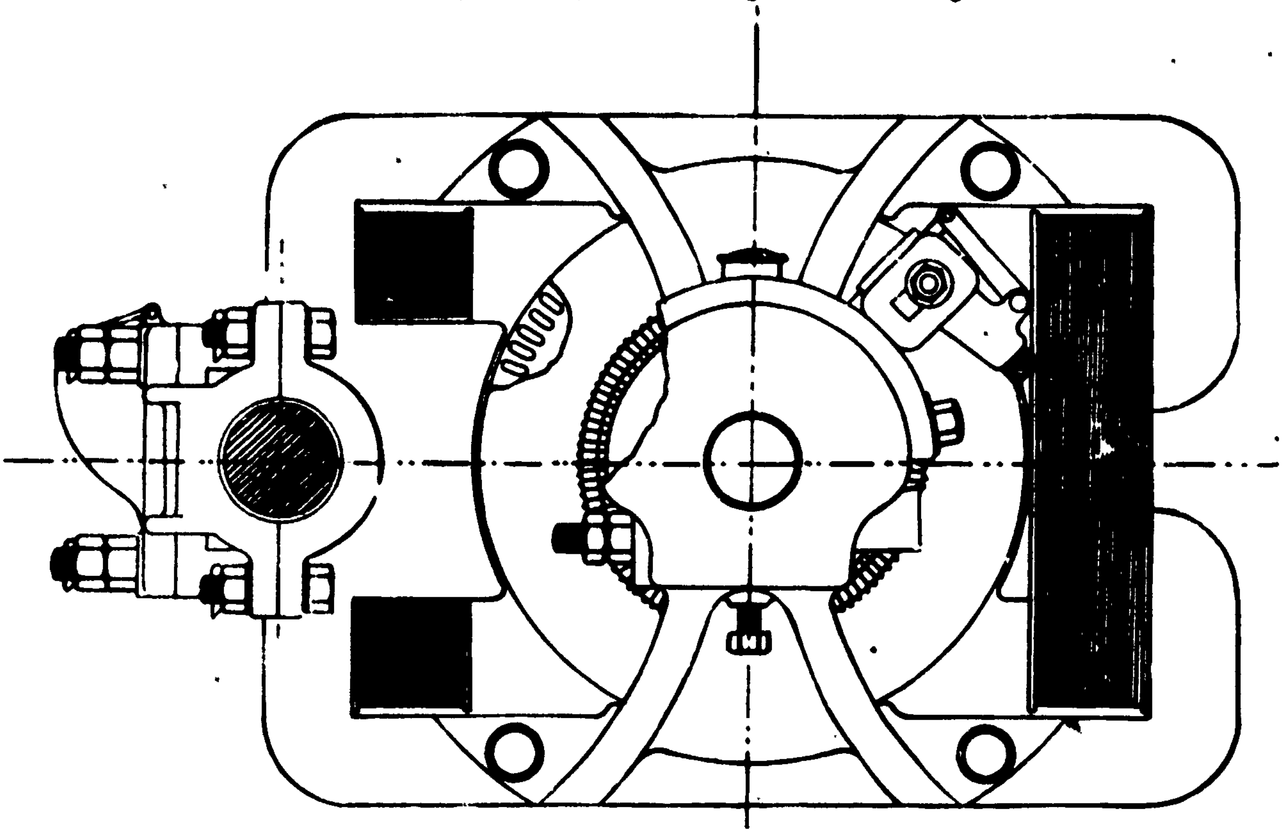


FIG. 5.—SECTIONAL VIEW OF WENSTROM SLOW SPEED STATIONARY MOTOR, GEARING DIRECT TO SHAFT.
[See description on pages 46 and 47.]

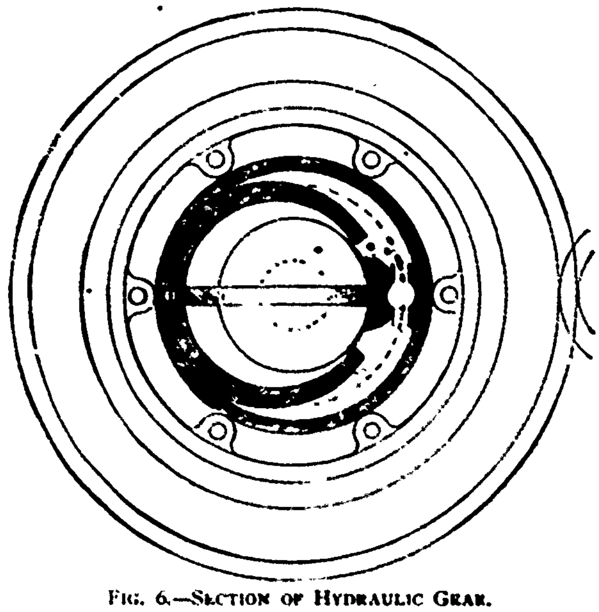


FIG. 6.—SECTION OF HYDRAULIC GEAR.
[See description on page 47.]

lutely tight will permit bay water to enter. The new pipe is considerably larger than the present one, and when it is in use the water level in the well will be much higher, and the danger of leakage will be greatly reduced. Even if the new pipe should be found not absolutely tight, a very simple remedy could be found. By means of a centrifugal pump or a spiral pump, the water could be raised over on the island, and the well at the pumping house kept at a level a little above that of the bay. Any leakage then would be from the pipe into the bay. The water would be more easily lifted by the present pumps, and they would work more satisfactorily and pump a larger quantity. The *quality* of the supply would then be of undoubted purity, and by running the centrifugal pump on the island at a higher speed the *quantity* could be indefinitely increased as the public demand became greater. After the gravitation scheme has been settled, as in all likelihood it will be, to be doubtful as to quality and too expensive as to quantity, then the question of additional pumping stations will be sure to be raised. From one point of view it is a wise and economical plan to have the machinery all at one point and under one management. From another point of view it is most unwise and positively dangerous.

What would Toronto do for water should a boiler explosion occur at the main pumping station as disastrous as that in Quebec last month? One boiler exploding might do in a moment damage enough to destroy the buildings and to disable the machinery to such an extent that no pumping could be done for two or three weeks. Where would we get water? In some towns water is sold on the streets as milk is here. Imagine bay water carted through the streets and sold at so much per pint! There should be at least two complete and independent pumping stations, each large enough to supply the city, and so far separate that an accident or fire at the one would not injure the other. Each station should then be kept running at half its pumping power, and should one become entirely disabled, the other would be in order to go on in full power at once.

FIG. 7.—HYDRAULIC GEAR WITH INTERCHANGEABLE RUN AND WOODEN COGS.
[See description on page 47.]

The gravitation scheme advocate says: "Get our plan and there will be no boilers to burst and no engines to break down!" That may be, but the bursting of pipes and the breaking of water channels have led to as serious results and as long stoppage of supply as ever occurred by the break-down of a pump or the explosion of a boiler.

THE ELECTRIC CIRCUIT.*

THE electric circuit is the path or paths by which the current passes, and it must be complete from any given point, say the positive pole of the generator, through the wires, cables, etc., forming the external circuit, back to the negative pole of the generator, and through that to the positive pole from which it started. If any portion of the circuit be wanting; that is to say, if there be any place, or any body present in the path of the current, where the available E.M.F. cannot force any current through, then no current passes in any part of the circuit; and the apparatus which should have been actuated by the current does not work. A complete electrical circuit is sometimes spoken of as a *closed circuit*, and the operation of causing the current to cease is referred to as *breaking circuit*, or *opening circuit;* and again, a circuit in which no current is passing is sometimes called an *open circuit*. Thus, a dynamo machine is spoken of as being run on *open circuit*, when no work is being done in the circuit external to the machine. The same current—that is, the same strength of current in *Amperes*—passes in every part of a closed electric circuit; so that if a body whose resistance is comparatively high form part of the circuit, it will weaken the current passing in every part, in accordance with Ohm's law; and conversely, lowering the resistance of any part of the circuit will raise the current strength.

Though it has been stated that for all electrical action, or rather for the working of all apparatus requiring the passage of electrical currents, a complete electric circuit is necessary, it does not follow that there may not be more than one electric circuit; in fact, there may be as many of them as you like, and they may be arranged all to emanate from one source, or to branch out from other circuits. But no matter how many there are, the same rules hold good, viz., that no current will pass in any circuit—whether it be one of a number of circuits, a branch from another circuit, or a simple circuit by itself—unless that individual circuit is complete; and it follows, of course, that in the case of branches from a larger circuit the main circuit and the individual branch must be complete. Further, when a main circuit is divided into a number of branches, technically called derivations, the current in the main circuit divides between the branch circuits in the inverse ratio of their resistances, the branch having the highest resistance taking the smallest current, and *vice versa*. This again is strictly in accordance with Ohm's law.

A simple method of grasping the idea of an electric circuit, which the author has been accustomed to place before the pupils

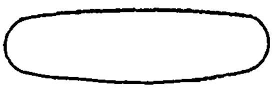


Fig. 1.

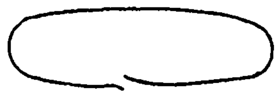


Fig. 2.

of his firm in the early days of their articles, is the following:—

Imagine a complete ring or hoop of wire, as shown in Fig. 1; and that an electro-motive force arises at some point in the ring of sufficient magnitude to generate a current. This current will go on circulating round the ring as long as the E.M.F. exists, and the wire remains intact. For simplicity, it is assumed that the ring is perfectly insulated from every other conductor, and that there are no branch circuits.

Now, suppose that we cut the ring of wire with a pair of pliers, at any convenient point, as Fig. 2. The current will no longer pass. Now, let us take a galvanic cell and connect its two poles—that is, the points at which the current can be taken from it—to the ends of the wire we have just cut, as Fig. 3. We have in the galvanic battery the source of electricity we require, and the current from it will continue to circulate through our ring of wire and our cell—which it must not be forgotten forms part of our circuit—as long as the cell continues to create an E.M.F., and there is no break in any part of the circuit, either in the wire loop or in the cell itself. But how are we to know that we have a current passing? Well, in some cases the action visible in the battery cell tell us, but not always; and, as we shall see later on, a battery may be consuming materials when no useful work is being done. Cut the wire in a second place and connect to the ends some apparatus that will denote the presence of the current furnished by one cell, against the resistance of our loop of wire, say an electric trembling bell, as Fig. 4. The current that will pass will be as the E.M.F. created by the cell, divided by the resistance of the circuit, that is, the combined resistance of the cell, the bell, and the connecting wire. If our bell is constructed to work with the current passing in our circuit, it will commence ringing, and will go on until either the battery ceases to create an E.M.F., there is a break in the circuit as before, or the resistance of some part of the circuit—say that of the cell itself—rises sufficiently to reduce the current below the strength at which the bell will work.

The question of the increase of the resistance of the battery will be dealt with later on; at present we will only consider actual breaks in the circuit. Cut the wire in a third place, and, this time, insert a push, as shown in Fig. 5, such as are to be seen in every optician or electrical apparatus dealer's window,

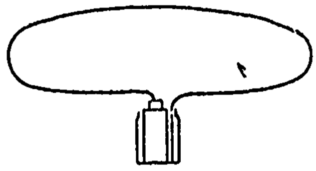


Fig. 3.

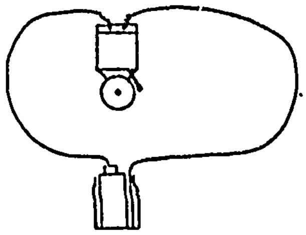


Fig. 4.

and which consist simply of two springs mounted on a board, and so arranged that the ivory button facing them, when pressed by the thumb, brings them into metallic contact; the ends of the two wires being connected to the two springs.

If we have carried out the above experiment carefully, the bell will now ring whenever we press the button of our push; and we have control of the bell as long as we have no other break in our circuit. It is obvious, of course, that the wire connecting the push, bell, and battery may be of any convenient length, provided that the battery, wire, and bell be so proportioned that the latter will ring with the current that passes. The reader will recognize the arrangement as that of an ordinary domestic electric bell.

But now cut our wire in a fourth place, and we shall find that we have lost the control of our bell, because we have another break in the circuit besides the one at push. (Fig. 6.)

Let us suppose, also, that our wire is covered with gutta-percha which we know has a very high resistance, and is, for most practical purposes, an insulator. Suppose that in any one of the connections we have made—to battery, bell, or push—we neglected to remove this covering before making our connection, we should find that we had no current passing; and the reason would again be, because, in accordance with Ohm's law, the resistance offered by the two thicknesses of gutta-percha was so great in proportion to the E.M.F. created by the cell, that no appreciable current could pass. Therefore, in all connections between wire and wire, or between wires and terminals or other

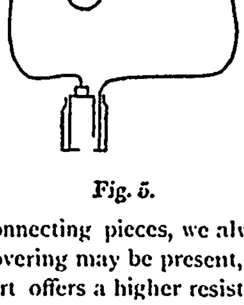


Fig. 5.

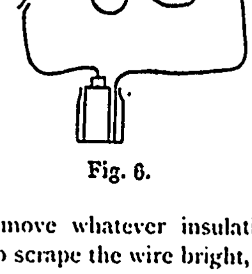


Fig. 6.

connecting pieces, we always first remove whatever insulating covering may be present, and we also scrape the wire bright, as dirt offers a higher resistance than copper. The reader must not imagine that gutta-percha offers an impassable resistance under all conditions; each case works out in exact accordance with Ohm's law. It was only because the E.M.F. of the cell was low, that the gutta-percha barred the passage of the current; if a high tension generator had been used, some current might have passed through the covering.

Let us attach wires to the bell and battery, and lead them to a second push, as shown in Fig. 7. We have now a circuit with two branches, the bell and battery being included in each, and we therefore control the action of the bell from either push, so long as there is no other break in the circuit. If there should

*Walker's "Electricity in Homes and Workshops."

be a break in that portion of the circuit between the bell and battery which is common to both branches, we lose the control of the bell from both pushes. If there is a break, other than that at the push, in either branch outside the bell and battery, we lose the control of the bell from the push belonging to that branch.

Even a break in the circuit itself acts strictly in accordance with Ohm's law. If no current passes, it is because the resistance *interposed by the break is infinitely large, compared with* the E.M.F. available. If the E.M.F. were increased very much, a current might still pass, as in the case of the electric spark, the arc lamp, and in a lightning discharge, the strength of the current in each case being strictly proportional to the E.M.F. divided by the resistance; but it is always necessary to be sure that we have *all* the resistance of the circuit included in our calculation. Not infrequently the resistance of the generator itself, of the body from which the current proceeds, is of very great importance. Often, too, matter which we do not want, such as dust or dirt, interposes itself in the circuit, and before we can apply the law correctly, we must know this resistance, and it must take its place in our calculations.

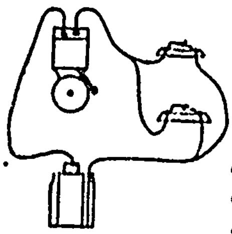


Fig. 7.

It may perhaps be as well here to give the rule for determining the joint resistance of two or more derived or branch circuits. Supposing that we have a source of electricity, with a certain E.M.F. available at a certain point, from which branch out several derived circuits, as they are called. The current in each branch is determined strictly by reference to Ohm's law; that is, the E.M.F. being the same, all we have to do is to divide it by the resistance in each case. A dynamo feeding a number of incandescent lamps is a familiar instance, and easily understood. Suppose that the E.M.F. is the same at the terminals of all the lamps; then, if the resistance of each lamp is the same, the current passing through each *will* be the same, but if their resistances be different, as when they are of different candle-powers, or different patterns, then we calculate the current in each case by the formula, and having obtained all the currents, add them together, and apply the formula $R=\frac{E}{C}$ to the whole, and we have the joint resistance of the group.

To take an example, suppose we have a dynamo, or an electric light service with 100 volts difference of potential, and that we have lamps whose resistances when burning are respectively 400 Ohms, 200 Ohms, 100 Ohms, 50 Ohms, 10 Ohms. These lamps will take ¼ Ampere, ½ Ampere, 1 Ampere, 2 Amperes, and 10 Amperes. The sum of these $10+2+1+5+\cdot25=13.75$ Amperes, and their joint resistance $=\frac{100}{13.75}=7\cdot57$ Ohms.

The joint resistance of a number of branch circuits, whose resistance is equal, as, say, a number of incandescent lamps, all of the same pattern and of the same candle power, is found by simply dividing the resistance of one branch by the number of branches, thus, if we have 20 lamps, each of 200 Ohms resistance, their joint resistance is equal to $\frac{200}{20}=10$ ohms, when they are arranged as branch circuits emanating from the same points. Of course, in actual work, you do not always have all the branches emanating from the same points, and it is therefore generally more convenient to calculate the currents than the resistances.

For two branch circuits of unequal resistance, the joint resistance may be found by multiplying their resistances together, and dividing the product by their sum. Thus, if we have two resistances 10 and 2, their joint resistance $=\frac{10\times 2}{10+2}=\frac{20}{12}=1\cdot6$ Ohms. For any number of branch circuits greater than two, the formula becomes somewhat complicated, and the method given above, of finding the current strength in each case, will be found simpler

This matter will be explained more fully when dealing with electric lighting circuits. It may be mentioned, however, that the rule applies to such branch circuits as the insulation of telegraph or telephone lines, and to that of cables for electric lighting or transmission of power; each unit of length, say a mile, or a hundred yards, and each pole, being considered as a separate branch. Thus, if the insulation resistance of a telegraph or telephone line that is to say, the resistance between it and the earth be 1,000,000 Ohms for 1 mile, for 1,000 miles it would only be 1,000 Ohms, and the leakage path, as will be explained later, would be very serious, as, with ordinary telegraph wire, it would be less than that of the proper conducting path.

The Earth. In connection with the electric circuit, the Earth, or Ground, as the Americans term it, often plays a very important part.

It has been explained that the electric circuit consists of a path, from the generator, through the apparatus that is to be worked and that which is to work it, back to and through the generator itself. It will be seen that the apparatus to be worked the bell, lamp, or whatever it may be and that which is to control it say the push, key, or switch may be some distance apart. This requirement would necessitate two wires or conductors between the two places, unless some other path could be found that would perform the office of one wire, and carry the returning current.

The crust of the earth a river or stream, the metals of a railway, the water and mud of a dock, the gas or water service of a town, may each form this path, and thus save one wire or cable. But it must be distinctly born in mind that "earth," or "ground," as anything which answers this purpose is technically called, is subject to Ohm's law, exactly as the wire or cable which forms the other part of the circuit is. If the resistance of any part of the earth circuit is high, it will weaken the current, exactly as a bad joint would, or a small wire. Thus, if you make connection to the gas-pipe, and there happens to be a *good gas* joint; but, as often happens, a bad electrical joint; between one of the feed pipes and the main you get what is technically known as "bad earth;" or, in other words, you have a resistance in the circuit that you had not bargained for, and which must be avoided if possible. So also with reference to the rails; if the connections between the rails at the fish-plates are not electrically good, a like result will follow.

It must be borne in mind, too, that the resistance of the earth circuit must be proportionate to the current that is to pass. Thus, what would be good earth for a telephone current may be very bad earth for an electric lighting current. Very large iron water pipes, even, might offer so much resistance at their joints as to be quite unsuitable for electric-lighting currents of even moderate strength.

Another important point in connection with earth is its variability under different physical conditions. If the crust of the earth be used, for instance, in very dry weather, or in frosty weather, the resistance may be almost infinite, as the conducting path consists of the moisture in the pores of the earth. Again, a dock with 20 feet of water in it would afford a good conducting path, whereas the dock empty might not.

It will be easily understood, too, from what has been said on the laws of resistance, that it is of importance to have a large surface in contact with the earth, or whatever may be used for a return, as the resistance offered by the earth will vary directly as the distance between the two surfaces, and inversely as their sectional area. It is also of importance that the earth-plate should be proportioned to the current that is to pass, and that it should be subject to as little chemical action as possible. Under the very best conditions there will be some resistance at the surface of the plate, where it is in contact with earth; and that resistance will generally increase, owing to chemical action. It is therefore wise, in laying down electrical apparatus, when using earth, to allow for this, and to make your earth connections very much larger than they otherwise would have to be, or than a consideration of theory simply would dictate; that is to say, the theory that would apparently apply at the time the plate was laid down.

The earth is, of course, subject to the same laws of derived circuits as other conductors; and we may expect that if a portion of the earth's crust, or a stream, gas or water service, form part of several circuits, portions of current from one circuit will occasionally find their way into other circuits; and accordingly we find this the case with telephone circuits, it being most difficult to prevent messages being heard in wires not intended for them, owing to their passage by earth. This is always more marked where earth is bad, or of high resistance.

(To be Continued.)

STRATFORD BRANCH C. A. S. E.

CONTINUING our sketches of the Presidents of the various branches of the Canadian Association of Stationary Engineers, we have the pleasure this month of presenting to our readers a portrait of Mr. John Hay, who ably presides over the destinies of the Stratford branch. Mr. Hay's acquaintanceship with the steam engine dates back some seventeen years, during which period he has been laying up a store of practical knowledge which is the foundation of his present efficiency.

The other officers of the Stratford Association are: Messrs. S. H. Meir, Vice-President; W. Bates, Secretary; A. McArthur, Treasurer; P. A. McDonald, Conductor.

The Association has suffered the loss of a considerable percentage of its membership, owing to the removal from the city of a number of the members, but it is gratifying to know that notwithstanding these discouragements, the remaining members of the organization are pushing forward the work of self-improvement which it was designed to accomplish."

THE VALUE OF A CONDENSER.

IT is sometimes difficult to decide whether a condenser attached to an engine will pay or not. At first sight one is apt to at once declare, "Why, of course if a condenser will add 25% or more to the power of the engine or diminish the fuel bill that much, it must pay!"

In the early days of the steam engine as a practical machine, the condenser played a most important part. At first the steam cylinder itself formed the condenser, and in 1769 James Watt obtained a patent for improvements in "fire engines," of which the following were some of the claims;

"*First.*—That vessel in which the "powers of steam are to be employed "to work the engine, which is called "the cylinder in common fire engines, "and which I call the steam vessel, "must during the whole time the engine is at work be kept as hot as the "steam that enters it; first, by enclosing it in a case of wood or any other "material that transmits heat slowly; "secondly, by surrounding it with steam "or other heated bodies; and, thirdly, "by suffering neither water nor any "other substance colder than the steam "to enter or touch it during that time."

"*Secondly.*—In engines that are to "be worked wholly or partially by condensation of steam, the steam is to be "condensed in vessels distinct from the steam vessels or cylinders, although occasionally communicating with them; these "vessels I call *Condensers;* and whilst the engines are working, these condensers ought at least to be kept as cold as "the air in the neighborhood of the engines, by application of "water or other cold bodies."

"*Thirdly.*—Whatever air or other elastic vapour is not condensed by the cold of the condenser, and may impede the "working of the engine, is to be drawn out of the steam vessels "or condensers by means of pumps, wrought by the engines "themselves, or otherwise."

From these claims it will be seen that Watt had a clear idea of the economical working of a steam engine, even before any such were in existence. In his fourth claim he describes a non-condensing engine discharging steam into the atmosphere, and, of course, using steam of a higher pressure.

In the early condensing engines the pressure of steam used was very low, and the withdrawal of the pressure of the atmosphere by means of the condenser was really the main source of the power of the engine. Steam of two or three pounds pressure raised the piston in a large cylinder which was open to the air on the other side of the piston. When the top of the stroke was reached, the valve opened, the steam escaped to the condenser, and a vacuum being formed on the under side, the weight of the atmosphere forced the piston down. These single acting engines were chiefly used for pumping water out of mines. In a later style of engine, also patented by Watt, the double acting engine was produced, and another of Watt's patents describes the expansive use of steam in the cylinder.

It will be apparent that with the low pressure of steam used, the condenser was of great advantage, but the point now to be considered is. Having steam of from 90 lbs. to 100 lbs. on the boiler and an automatic cut-off engine, will it pay to add a condenser? The answer to this problem can only be correctly solved by considering what use can be made of the exhaust steam, and what it will cost to get water enough to work a condenser. Sometimes the exhaust steam can be utilized during part of the year for heating buildings, and in factories where large quantities of hot water are used, for heating water. If water for condensing can be had cheaply, in most cases it would pay better to use a condenser, and taking the water from the condenser at about 120° temperature, feed the boilers from this and use live steam to heat the buildings and the water. But if water has to be bought, as is often the case in cities, it will require a careful calculation to determine at what price for water will a condenser cease to pay.

Let us suppose a case of an engine indicating eighty horse-power. No use can be made of the exhaust steam except to heat the feed water, and water for condensing purposes can be had at 20 cents per thousand gallons. Will it pay to use it?

MR. JOHN HAY, PRESIDENT STRATFORD BRANCH, C. A. S. E.

A non-condensing engine with a good feed water heater, and using steam expansively as is commonly done, will in every day work require about thirty pounds weight of steam for each horse-power per hour. With the ordinary boiler efficiency, this means a consumption of coal for eighty-horse power of about thirty-six hundred (3600) pounds per day.

The same engine with a condenser attached would use about twenty-two pounds weight of steam for each horse-power per hour, and the consumption of coal would be about 2400 lbs. per day for eighty horse-power. The condenser would require a supply of water of about 50,000 gallons per day more than the amount required to feed the boilers. The saving effected in coal was shown to be not quite half a ton per day, amounting in value to a little over two dollars, taking coal at $4.40 per ton. The water used to effect this saving amounts to 50,000 gallons, and if bought at 20 cents per thousand gallons would cost ten dollars, making a loss of eight dollars per day without adding anything for interest on the additional cost of the condenser or for "wear and tear."

If the water can be had for the pumping, by having the engine and factory close to a river or lake, a condensing engine will in most cases be the more economical one to use, and where there is any doubt about its economy, it would be better to attach an independent condenser and arrange the engine to be run either with or without the condenser.

In the winter time the exhaust steam might be utilized for heating purposes, and in the summer time the condenser could be used.

TRADE NOTES.

Mr. G. W. McCrae, of Montreal, has received an order from the St. John's, Que., Electric Light Co, for a 150 h. p. triple expansion engine to drive their electric plant. This is said to be the largest engine ever built in Canada on this principle. The maker guarantees a saving of 20 per cent. in the quantity of coal used.

The Dodge Wood Split Pulley Co. advise us that the introduction of the dynamo and motor has materially increased the demand for high class pulleys, and that they are daily in receipt of special orders for pulleys to run at high speed for electrical purposes, and that in addition to their regular wood split pulley, they make a specialty of an iron centre pulley with fine hard maple face, which has given excellent service where a great amount of power is required at high speed. They report recent large orders from the Toronto Electric Light Co., Toronto, and Saint John Gas & Electric Light Co., St. John, N. B., as well as many others, and invite correspondence from all in need of anything in this line.

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EDITOR'S ANNOUNCEMENTS.

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

MR. W. C. McDONALD, of Montreal, has placed the youth of Canada under deep obligation to him by his recent bequest of $40,000 for the endowment of a chair of electrical engineering at McGill University. Thus the means has been provided by which our young men may obtain the knowledge they require without being obliged as heretofore to go beyond the bounds of their own country. We learn that the electrical laboratories in the new building, now in course of erection, will contain all the necessary apparatus and facilities for electrical work, and the classes of the professor of experimental physics with all the apparatus at his disposal will also be available for the instruction of the students in this department.

ACCORDING to experiments made by Dr. Tatum, of Yonkers, N. Y., with an alternating current machine of high frequency, namely, of some 8000 alternations per second (the usual frequency of alternations in commercial machines at present in use being 300), he finds that the physiological effect, or in other words the power to kill, with any given strength of current, decreases in proportion to the frequency of the alternations, and that even at 4500 alternations, the effect is less than that of a continuous battery current. It would be curious if this very property of alternation which has usually been considered an element of danger, should eventually be the means of rendering high tension currents comparatively safe.

AN interesting calculation was given by Mr. Gisbert Kapp in one of his recent Cantor lectures which is full of significance to the electrician and engineer. It was regarding the distance that power could be carried by means of a storage battery from a waterfall, the batteries being carried on a tram car, using the electricity from the batteries as motive power, compared with the distance that coal and corn could be carried with a similar loss in transmission—in this case 10 per cent. The corn would be hauled by a horse that lived on it as he went along, and the coal by a locomotive using it for fuel. The distance attained with a 90 per cent. efficiency in transmission would be: for the coal and steam engine, 1,300 miles; corn and horse, 440 miles; and storage battery and motor, 26 miles.

THE Barking Road Tramway, London, on which cars are used driven by storage batteries as a motive power, is frequently instanced by friends of that method as proving the adaptability of storage batteries for street car propulsion. We do not think that anyone doubts that storage batteries can be used to push a street car. That has been frequently demonstrated. The vital question is, can it be made to pay? If it is not *commercially* practicable, it must fail. On that road it takes 2½ tons of batteries to move 3½ tons of passengers. The car takes at times 17 h. p. at the car, with an average of 7 h. p. delivered at the axle of the car when running. This costs, with the cheap fuel and labor available, over 16 cents per car mile, or about four times as much as horse power on the Toronto street railway.

THE city of St. Catharines is about to lose a valuable industry by reason of the stupidity of the gentleman who acts in the capacity of City Solicitor. When it was proposed to submit a by-law to the ratepayers authorizing the granting of a bonus of $9,000 to aid Messrs. Patterson & Corbin to erect a factory for the manufacture of electric cars, the solicitor's opinion was asked as to the proportion of votes required to legally carry the by-law. He replied that a majority of votes would be sufficient. The voting resulted in a majority being obtained for the by-law. While the Council and citizens were congratulating each other on the result, the City Solicitor announced that on further consideration of the matter he had discovered that to render the by-law legal, a majority of two-thirds of the votes cast must be secured in its favor. It is not surprising that everyone now feels disgusted with the situation. Messrs. Patterson & Corbin are understood to have selected a site for their factory at Peterboro'.

THE executive committee of the National Electric Light Association has fixed the 25th, 26th and 27th of August as the date of the next convention to be held in the city of Montreal. The convention will take place in Windsor Hall. The Victoria rink will contain the exhibition of electrical apparatus. The civic authorities and citizens of Montreal will leave nothing undone to make the occasion one of pleasure and interest. We have heard that it is the intention of one of our leading electrical companies to rank amongst the exhibitors, and no doubt the others will do likewise. We believe strong efforts will be made to induce electrical men in Canada to become members of the National Association on the occasion of this convention. Without wishing to detract from the benefits which might accrue to them from such a course, we are strongly of the belief that the electrical interests of Canada demand the formation of a Canadian Electrical Association, to which it would undoubtedly be to the advantage of every man interested in electricity in the Dominion to belong.

THE safety of the electric light as a means of illumination has been well demonstrated during the last year in Philadelphia. In that city the light or power is used in over 5000 buildings. 287 buildings have their own apparatus, ranging from a 20 light to a 4000 light installation; in the aggregate, 80,258 incandescent and 3,325 arc lights. There are also 15 central stations supplying from 2000 to 40,000 lights each, and motors from ⅛ to 30 h. p. Chief Inspector McDevitt of the Fire Underwriters' Association, reports that during the year "no insurance loss occurred in any building in our city from fire where the cause could be in any way attributed to electric wires." This is a splendid showing, and one of considerable encouragement to electric light men. It also demonstrates the wisdom of rigidly enforcing the rules of the insurance companies in the manner of running wires and installing electrical apparatus generally. These rules may at times seem somewhat arbitrary, but the results attained through their observance in the matter of reputation alone, are of as much value to the electrical interests as they are financially to the insurance companies.

THERE is to-day no more important problem to be worked out by the electrical engineer than the invention of a successful method of furnishing current from the generator to the street car motor without the use of overhead wires. The unsightly constructions which are found necessary will not be long tolerated in the principal streets of large cities. The authorities of Berlin have decided that no more permissions be given for this class of work. We are sanguine that the skill which has brought the electric railway to its present state of perfection will solve the problem, and that at a very early date. The action of municipal authorities such as we have mentioned, will no doubt be a spur to action, and if it becomes more general, we may look for more continued and earnest experiment such as will certainly command success. As we have before pointed out the conditions to be fulfilled by a conduit system are exacting in the extreme, and one reason perhaps that they have not been more successfully grappled with may be, that the growth of the business has been so rapid where overhead construction has been permitted, that little time has been available for experiment. When overhead construction is unattainable, we are confident the conduit will be provided.

THE introduction of electricity in the arts and as a necessity of every-day life, has been the means of giving an immense impetus to the development of power producing mechanism. The ideal power of course is that of falling water, and the facility with which the electric current can be transmitted by metallic conductors has made it possible to utilize some of these natural sources, which otherwise would have been unattainable. The immediate future will, no doubt, see more of this development carried out; but for any considerable distance the heavy cost of wire and loss in transmission make their utilization more expensive than the consumption of coal upon the spot. Various kinds of engines have been devised for the production of power petroleum engines, gas engines, hot air engines, and so forth. They are, to a certain extent, useful for small powers up to say 10 or 15 h. p., but above that, too expensive and complicated. It is the steam engine that has so far held undisputed sway, and the machines of magnificent proportions that are in use in driving steamships, and in our largest factories and electric works, are examples of what may be accomplished in the way of development when inventive skill and sufficient means go hand-in-hand. But enormous powers have now become such a necessity that, perfect though the steam machine may be, there still remains an enormous margin of profit by the accomplishment of even a small percentage of saving when taken in the aggregate. The far-seeing engineer is even now casting about to see if perchance there is not a new method of evolving motive power from Nature's resources that shall be under sufficient control. A few years back an effort was made to utilize a mixture of bi-sulphite of carbon and petroleum. If the promoters could have utilized the strength of the smell of that mixture, it would have been an immense success, but after poisoning half the town the affair was abandoned as a failure. To look with a prophet's eye into the future, it does seem possible that the enormous power locked up in some of the modern explosives might be tamed and brought sufficiently under control to develop a cheap and useful power. The tremendous energy contained in the gases liberated by the detonation of gun cotton or nitro-glycerine would be capable of doing yeoman work if imprisoned and used expansively in the modern cylinder. It would be ticklish stuff to handle while the experiments were in progress, and might possibly require a continuous supply of inventors before any measurable degree of success was attained, but if it were possible to secure the main bulk of materials against explosion, allowing only the atom required for each stroke to be separated safely and used, the rest would present no more difficulty than is met with in the ordinary gas engine. It might be possible to use reservoirs of unmixed material, each in themselves harmless, but capable of great explosive force when combined only in quantities necessary for use stroke by stroke in the engine. It is just possible that this suggestion of ours may be irreverently received by our engineering readers, and that they may prefer to pin their faith on their old reliable friend, the steam boiler, and say that with all its faults they love it still, and that for their part they decline to change their designation of steam engineer for that of dynamiter; but this is a rapid age in which we live, and we may yet see some such development of power-producing mechanism. What an advantage it would be in the way of portability, for instance, for a locomotive to start out with a pailful of fulminate instead of twenty tons of coal and water, while its possibilities on the ocean would be limitless. He will be a hardy pioneer in the field of invention, however, who undertakes the solution of this enticing problem.

THE question of the desirability of municipalities operating their own electric light plant is one that is just now attracting considerable attention. Extravagent claims have been made in the past of wonderfully cheap lighting, and these claims obtained considerable currency amongst the uninitiated, and were largely quoted by municipal economists until their true nature was shown up. This was done in the able paper read before the National Electric Light Association at its last summer meeting, by Mr. M. J. Francisco, of Burlington, Vt. The paper was the result of careful and thorough investigation of the circumstances surrounding the actual operations of municipal lighting in nearly every case in which the plant was then owned and worked by the municipality itself. It was found that invariably a certain amount of the cost of operating, and frequently the fuel and supplies, were charged to other departments of civic expenditure, hence the apparently low price at which lights were produced. Perhaps steam to run the dynamo was taken from the waterworks boilers, in which case the extra fuel was ignored and thus made a charge on the water department, and employees whose names appear on the civic pay sheet for entirely different purposes have been told off to perform parts of the work connected with the lighting outfit. By means such as these the advocates of municipal ownership have been able to show wonderful results on paper; but one or two recent cases of the willingness of municipalities to transfer the lighting plant to private parties have tended somewhat to dispel the illusion. In large cities where political influence is a factor, there is no doubt that a private company can furnish the light cheaper and better than the municipality itself. Level headed citizens recognize this fact, and there is a tendency to curtail the powers of corporations in the matter of owning and operating industrial enterprises of any description whatever. In smaller towns and villages, the case is somewhat different. There is usually an individual who is a sort of Pooh-Bah of village politics he is constable, caretaker of public offices, lamplighter, probably sweeps out the village school, and rings the bell; he is pound-keeper, and is vigilant in keeping the geese off the public street. He is expected to fill in his time repairing sidewalks, and probably has to do the digging when any of the forefathers of the hamlet come to be laid in their long, narrow bed. When the patriarchs commence to agitate the electric light question, it is at once considered that as this ubiquitous genius will not have the coal oil lamps to fill and light, his valuable services can be made available to look after the electric lamps, and the old man at the little pumping house down by the creek, who runs the town waterworks from eleven till one every day to fill up the citizens' barrels, can be kept out of mischief by running the dynamo at night. By thus taking the worth of their princely salaries out of the hides of these pampered officials, there is no doubt the community has the advantage by a cent or two per night over the man who would otherwise make a business of supplying electric light. There are quite a few small places in Ontario which adopt this method, and at first sight it would seem to be an argument in favor of municipal control. But follow it out to its logical conclusion and see what it means. If for the sake of saving a few cents the town utilizes its resources to drive out the electric light man who would pay his taxes like a good citizen and consume the storekeeper's supplies, why not save a few more by running out the baker, and have the town clerk in the intervals of his arduous duties bake the town bread, and supply it to the townspeople at cost? It might also be found that the shoemaker or tailor were making a little profit out of what they did for the people, therefore fire them out, and have a municipal shoemaker or tailor who might, when not otherwise employed, make himself generally useful by keeping the cows off the grass or pumping the requisite quantity of water into the town milk-pail. If the principle were followed out, as we said before, the town would degenerate into a commune, or a simple co-operative society of a few families where profits of any kind were unknown, and business enterprise entirely knocked on the head. The idea of these municipalities is (and there is one not a thousand miles from Toronto to-day figuring the same way) to do a commercial business with public resources, and it can have only one ending, and that is to drive away legitimate business enterprise and investment which might bring grist to the municipal mill. Some towns go to the other extreme, and will bonus a new enterprise, which is just as great a mistake in the other direction. If a business has any vitality, it will thrive without this pampering, but it is worse than folly for any community to kill off a new enterprise like the introduction of electric light and its concomitant industries by competition fostered by the expenditure of public monies, often at a loss to the municipality interested.

A LETTER FROM THE PACIFIC COAST.

KAMLOOPS, B. C., Feb. 21st, 1891.

Editor ELECTRICAL NEWS.

DEAR SIR,—I lately authorized my book-keeper to forward you one dollar, for subscription to the ELECTRICAL NEWS, and hope to hear that you received it. Please accept my most sincere felicitations for getting out a paper which I am sure will be very useful to the electrical fraternity. I have already derived benefit from it, for which please accept my thanks. I formed a stock company here on the 11th of this month; everything is going on very satisfactorily. Wishing you every success, I remain,

Yours truly,

J. E. SAUCIER.

CANDLE POWER OF ARC LAMPS.

SOUTHAMPTON, Ont., March 24th, 1891

Editor ELECTRICAL NEWS.

DEAR SIR, Would you kindly inform us either by letter or through the columns of your paper the amount of power that experts claim that each arc lamp will take on a 25 light machine, 1,000 candle power lamps on a two mile circuit, and oblige,

Yours truly,

BOWMAN & ZINKAN.

[The candle power of the arc lamp is a variable quantity according to the fancy of manufacturers. The usual standard of current for what is known as a 2,000 c. p. lamp is ten amperes, and therefore a 5 ampere current is considered about the thing for 1,000 c. p. For the 2,000 c. p. lamp about seven-tenths of a horse power is required to be delivered at the dynamo, and for a 1,000 c. p. four-tenths. A two mile circuit of wire such as is usually run, say No. 8 B. & S. gauge for the 1,000 c. p., would absorb about as much energy as one lamp. ED. ELECTRICAL NEWS.]

RENFREW, March 11th, 1891.

Editor ELECTRICAL NEWS.

SIR,—Enclosed you will find an interesting slip which I cut from one of our local papers, and which is doubtless going the rounds of the press.

"The Mayor of Marquette, Mich., reports that their electric light and water plant has netted the city $4,000 per year, and that in a very short while he hopes to run the city without any other tax than that received as profits from the users of water and electricity."

This is likely to do no little harm to electric light men, as it no doubt gives only half the truth. Have you any means of gaining reliable information in this particular case, so that the facts as they actually exist can be given?

Doubtless you will remember that the advocates of municipal lighting received a thorough exposition at the hands of Mr. Francisco in a very able paper read by him last August at the meeting of the National Electric Light Association at Cape May. Marquette had evidently not taken such a prominent position at that time in coining money for its inhabitants as it has of late, since he did not mention this progressive town in his valuable paper

Should you become possessed of any *facts* in this particular case, please let your readers have them through your columns. Will merely add that I am thoroughly in accord with the idea of forming a *Provincial* E. L. Association, and will be glad to forward my membership fee at any time.

A. A. WRIGHT.

ANNUAL DINNER OF HAMILTON NO. 2 C. A. S. E.

March 27th, 1891.

Editor ELECTRICAL NEWS.

DEAR SIR, The fourth annual dinner of Hamilton No. 2 C. A. S. E., was celebrated on the evening of March 26th at the Dominion Hotel. President R. Mackie occupied the chair, and Vice-President Potter supported him in the capacity of vice-chairman. The members of No. 2 have always spent a pleasant time at their annual gathering, and this year was certainly no exception to the rule. After justice had been done to the good things (and there was an abundance of them), President Mackie addressed the meeting with a few appropriate remarks.

Letters of regret were read from His Worship the Mayor, who was confined to bed by illness, and Mr. Gibson, M.P.P., who was unavoidably absent.

The toast of the Queen and Royal Family was loyally responded to by the singing of the National Anthem.

The next toast was "The Dominion of Canada and Her Legislature," which was responded to by Mr. Ryckman, M.P., in a capital speech, in which he highly eulogized the aims and objects of the Canadian Association of Stationary Engineers, and assured those present that they could always count on his help in the Legislature to assist in passing any fair measure which would have a tendency to raise the status of the stationary engineers, and at the same time make the steam boilers of Canada a source of less danger to the general public.

Next in order came the toast of "The Local Legislature," which, in the absence of Mr. Gibson, was responded to by Mr. Bell in a very happy speech, in which he alluded to the fact that at one time he had been a candidate for Legislative honors, but, unfortunately (for the country), when it came to counting the votes, the other fellow appeared to have the best of it. He paid a high compliment to the Ontario Government, and said that he had watched business in the Local Legislature very closely, and he was sure that when any measure came up that was to the best interests of the Province of Ontario, the majority of the gentlemen on both sides of the House, irrespective of politics, had always proved themselves worthy of the confidence placed in them by the electors.

The toast of "The Mayor and Corporation of the City of Hamilton" was ably responded to by Ald. Dixon. During the course of his speech he took occasion to mention the fact that there would in all probability be several new enterprises started in Hamilton during the present year; also that the City Council were doing their best to get the C. P. R. into Hamilton, and he was of the opinion that the object would be accomplished in the near future. He made some very complimentary remarks on the principles, aims and objects of the C. A. S. E. and the methods used in endeavoring to secure the same, and expressed himself as being strongly in favor of an Engineers' License Law, which he firmly believed would be passed by the Local Legislature now in session.

"The Manufacturers" was responded to in suitable terms by Mr. Dewry.

"The Executive Board of the C. A. S. E." was responded to by President Wickens of that body, who outlined the history of the Association and explained its chief aims and objects. He also proved to the satisfaction of all present that the duties of the stationary engineer of the present day were far more exacting than they were a few years ago, owing to the introduction of higher steam pressures and higher grade of complicated steam engines, such as the compound, triple expansion, automatic cut-offs, and the general adoption of electricity for generating light and power in connection with our manufacturing interests. A few years ago all an engineer was asked to do was to shovel coal and sling oil; but now the manufacturers are beginning to find out that a little extra outlay in a year to secure the services of a competent engineer, is a good investment, and a source of much comfort. Mr. Wickens explained the chief object of the C. A. S. E. to be to educate engineers, and thus fit them to fill positions with credit to themselves and with profit to their employers. In doing this the Association invite their employers to become honorary members, attend the meetings and see for themselves that the Association is working on proper lines. He felt satisfied if the manufacturers of Canada would do this, they would (in justice to themselves) join hands and help the good cause along.

The next toast on the list was "Toronto, No. 1 Association," which was responded to by President A. E. Edkins, who thanked the gentlemen present for the hearty manner in which they had received the toast. During the course of his remarks he made mention of the proposed amalgamation of the C. A. S. E. and the N. A. S. E. of America. He expressed himself personally as not being in favor of the proposed union, and advocated remaining as a Canadian organization. He said that he was aware he was treading on dangerous ground, as he was informed that Hamilton No. 2 was unanimously in favor of amalgamation, and hoped that whatever might be done in this matter would prove to be in the best interests of the Association.

The toast of "Brantford, No. 3, and London, No. 5," was duly honored, but, unfortunately, there was no one present to respond.

At this stage, Mr. Ryckman proposed the toast of "Hamilton, No. 2," which was replied to by President Mackie in suitable terms.

The meeting broke up after singing "Auld Lang Syne" and

"God Save the Queen," everyone expressing themselves as having spent a most enjoyable evening.

During the evening the proceedings were enlivened by some excellent songs by Mr. D. Robertson, Mr. Bowes, Mr. Bell, Mr. McDonald, Mr. R. Mackie, and a laughable recitation by Mr. Chapman.

Yours truly,

"SAFETY."

THE MECHANICAL PRINCIPLES OF WORK.

THE first of what is expected will be a series of very interesting lectures was given by Mr. John Galt, C. E., on Friday evening, March 27th, in the rooms of the Inventors' and Patentees' Association, Public Library Building, Toronto. The subjects treated of were the mechanical principles of work, and the expansion of steam. Mr. A. E. Edkins, President of the Society of Stationary Engineers, under whose auspices the lecture was held, occupied the chair. The meeting was largely attended.

Mr. Galt said it was a source of great pleasure to see an audience composed of practical men take so manifest an interest in something that was not intended to be a formal lecture, but a simple talk on scientific matters. The large audience present was sufficient to show the need of institutions for practical training, for evening schools to impart scientific knowledge which would be useful in the various trades. There were certain sciences that bore more directly upon each branch of trade, and the knowledge of them enabled a man to rise higher than a mere hewer of wood and drawer of water. To supply this want was recognized as an important part of the educational systems of England and the United States. Large sums were spent annually to give scientific instruction. When a boy left the public school he was merely on the threshhold of knowledge. There was an aching void between the public school and the University. The ordinary student could not step from one to the other. What was needed to supply the pressing want of the day was the missing link between the public schools and the University. He supposed all were aware that an agitation in this direction had long been going on in Toronto. It was pleasing to know that at last there was a prospect of obtaining the much needed workingmen's technical school. This was important from a national as well as a local standpoint. What the working classes wanted was a fair share of the public moneys spent on their behalf. They had only to make the demand, and it must be recognized.

Passing on to the subject of the evening, Mr. Galt said he did not intend to read a sermon. He proposed to give a practical talk upon the principles of mechanics as applied to work. To the mind work suggested something that was moving, therefore work was synonamous with motion. Work was active, not passive. A wall might support a great weight, and was an evidence of force without motion. Work was force in motion; to analyze force was a very difficult thing. Matter was endowed with this inherent principle. What causes motion must be defined as force. As in all sciences, it was here necessary that force should be reduced to some form of measurement. Every science had some typical instrument for measuring purposes. Astronomy had the divided circle. Chemistry had the balance. Heat was determined by the thermometer. So, also, the whole system of mechanical principles of work might be symbolized by a foot rule, set of weights and a clock. The rule determined distances, the weights gave the pressure, and the clock measured the time. One of these units of measurement did not mean anything. If he held up his hand and said "one" it would mean nothing, if he said "one pound," thereby combining two of the units of measurement, he at the same time gave a notion of work. All quantities in mechanics might be expressed in terms of units derived from the fundamental units of length, mass and time. The unit for length was one foot, the unit for mass was one pound, and the unit for time was one minute. From these three fundamental units were deduced the gallon measure and the cubic foot. Work is measured by the product of the existing force and the distance through which it is overcome. Whenever there was motion there must be something to produce it. The simplest conception of work is lifting against the force of gravity. The standard of work was the lifting of a pound weight one foot high. The question of time did not enter into this, but was connected with the question of power or the rate of doing work. Foot pound being the standard of work, all calculations were made upon that basis. Thus to raise ten pounds two feet, was equal to raising twenty pounds one foot. Work done in this way was overcoming the attraction of the earth at that point. Work was also done when two magnets were drawn asunder, or when a spring or electric cord was drawn out. Work being simply force in motion, it was only necessary to multiply the weight in pounds with the distance in feet traversed to get the work done.

The next point was to distinguish between work and power. The introduction of the unit of time into the calculation enables the scientist to calculate the power of a force. The term "power" meant the rate of doing work. It was very important to fully understand this definition. Take any quantity of work that was done in one minute, and if the same quantity were done in two minutes, the time of doing it being double, it would only require half the power to do it. Rate of work, therefore, was quantity performed in some given interval of time. The standard of power which had been generally adopted was called horse power. One horse power consisted in lifting 33,000 pounds one foot in one minute, or 1,980,000 foot pounds per hour. It never was supposed to be able to do one-tenth of this amount of work. From a swift footed race horse to a heavy draft, the product of their speed into the resistance overcome is a measurable quantity representing 33,000 foot pounds per minute. By means of a lever man could often best exert his power, but as the old proverb went, "What was gained in power was lost in speed." To gain power meant that it was possible to move a heavy weight by a small force, provided one loses time by doing it very slowly. This was illustrated by the mechanical principle of the wheel and axle, also by the reduplication of pulleys as found in pulley blocks. Where by any contrivance a man moved a great weight by a small force, the difference between the weight and the force was compensated for by the loss of time. It was impossible to increase power. No matter what mechanism was resorted to, there would be a loss of time in proportion to the power gained. If this simple fundamental principle were well known, much loss of inventive energy might be avoided. The doctrine of the conservation of energy was not very well understood; if it were there would be fewer attempts to invent perpetual motion, or to devise means for increasing power. The conservation of energy was as well demonstrated as the indestructibility of matter. The all-wise Creator had endowed all matter with energy, and it could never be destroyed. The energy which was utilized in the water fall was the same energy which propelled the steam engine.

Passing on to the expansion of steam the speaker explained the theory of expansion in the cylinder according to the parabolic curve. The power of an engine was calculated by the average pressure multiplied by the number of inches which gave the foot pounds, and this was multiplied by the feet travelled by the piston in a minute. From this the horse power was obtained, as already explained.

At the conclusion a hearty vote of thanks was tendered to Mr. Galt, Mr. Edward Meek and Dr Wm Fall speaking very highly of the lecture. They expressed the hope that there would be other lectures and that they would be equally successful.

Since delivering his lecture, Mr. Galt has received the following letter of enquiry, the reply to which is appended.

219 CHURCH ST., TORONTO, March 28, 1891.

SIR,—Re H. P. of steam engine, I am the party who raised the question of rate of speed of horse. A H. P. is defined as a power that can lift or raise 33,000 lbs. 1 ft. high in one minute, but the same horse power may lift 40,000 lbs. the same height in the same time exerting less power. Then it becomes necessary to limit or define the rate of speed of horse. If the rate of speed of horse is not taken into account, why take speed of engine into account? You cannot compare superficial ft. with cubic ft. If the three units of the one are taken, the same units of the other must of necessity be taken in order to compare them. Watt defines a H. P. as a power that could lift 33,000 lbs. 1 ft. in one minute travelling at the rate of 220 ft. per. minute, which is the rate of travel in estimates of horses on public works, *i. e.*, railroads, canals, etc.

With due respect I write this, so that if possible that I may make myself clearly understood.

Yours truly,

D. A. ROSS,

C. & M. E.

TORONTO, ONT., 30th March, 1891.

D. A. ROSS, ESQ., City.

SIR,—You are still in error, friend, and likely to remain so until you fully and clearly comprehend that the standard horse power is the rate of doing work equal to 33,000 ft. lbs. per minute. Any force moving any distance in overcoming resistance and producing motion, the product of which for one minute will give 33,000 units of work, must be taken to equal and represent a standard horse power. If 40,000 lbs. is to be raised by a horse power, it must be done at the rate of .825 of a ft. per minute, for $\frac{40\,000 \times .825}{33{,}000} = 1$ H.P.

Your contention as to the usual rate of speed by canal horses may for argument's sake be taken as correct, but your deduction is wrong, because $33{,}000 \div 220 = 150$, as representing the force exerted by horse so as to give in one minute of time the proper standard, viz., 220 ft. × 150 lbs. = 33,000 ft. lbs. = one horse power. Notice that the speed of horse has everything to do with the force exerted, but nothing whatever to do with the result. Greater speed × lever force = slower speed × greater force = constant quantity of work in given time = 33,000 ft. lbs. per minute = 1 horse power.

The speed of the horse, therefore, is only one element in the calculation. The speed assumed, however, is a very good example in practice, viz., 220 ft. per minute, or 2½ miles per hour.

I hope these simple explanations will put my friend right.

Yours truly,

J. GALT.

Prof. Silvanus Thompson says of Mitis metal in his recent lectures on "Magnets," that he has found it far superior to ordinary cast iron, and not much inferior to wrought iron, for electro-magnets. It is well known that the field magnets of dynamos and motors are made to certain forms, mainly to avoid expensive forgings on the one hand or inferior results with cast iron on the other. In most cases a compromise is made by using good wrought iron for the straight cores and cast iron for the pole pieces, the latter involving difficult work, if forged out of wrought iron.

Experiments were recently made by the Manchester Steam Users Association to determine the effect of showering cold feed water on red-hot furnace crowns. The boiler used for the purpose was of the Lancashire type, with plane furnace flues and single-rivetted lap joints not strengthened by flanged seams or encircling ring. It was found that the introduction of the cold feed did not lead to an explosion, even when the crown sheet was red-hot; but that, on the contrary, it was often followed by an actual *diminution* in steam pressure. The *Locomotive*, referring to the test, says, We should not recommend the introduction of cold feed-water at such a time, however, because it is likely that the consequent sudden chilling of the plates might, under some circumstances, produce strains in the shell that would hasten the failure of the crown-sheet, or of some of the tubes, so that the attendant might be scalded.

CALCULATING SIZES OF WIRES.*

[Continued from March Number.]

SAFE CARRYING CAPACITY.

The National Board of Fire Underwriters specifies that the carrying capacity of a conductor is safe when the wire will conduct a certain current without becoming painfully warm when grasped by the closed hand.

All wires will heat when a current of electricity passes through them. The loss of energy which was referred to in a previous chapter is a loss only in the sense that it is lost for *useful* work.

Nothing is lost in nature; electrical energy may be transformed into heat, light, motion, etc., but energy cannot be lost. This so-called lost energy in the wires will therefore re-appear as heat, although not wanted in the wire.

The greater the current in amperes and the smaller the wire, the greater the heating effect.

Larger wires will be heated comparatively more than smaller wires, as the latter have comparatively more radiating surface.

It is approximately true that the heat increases directly as the square of the current, and inversely as the cube of the diameter of the wire. This statement may be written thus.

Heating effect $= \frac{c^2}{d^3}$ where c is the current and d the diameter of the wire.

In Table 1 are given the carrying capacities in amperes, and lamps of different sizes of wire. A wire is here assumed to have a safe carrying capacity, when its temperature is not increased over 30° F. above that of the surrounding air, when conducting current. In many tables a much higher temperature is adopted as a standard. It is safe to fix upon 30° F. as a maximum, however, as many circumstances, such as may be found in hot engine rooms, proximity to steam pipes, in twists or sharp bends in the wire, may cause a considerably higher rise of temperature than anticipated. The following empirical formula is used for calculating the carrying capacity:

$c = \sqrt{\frac{d^3}{2500}}$ for an increase of 30° F. in temperature, where c stands for current, d for diameter in mils, and 2,500 is a constant.

Rule X. Ascertain the proper size of wire for permissable loss, number of lamps and distance. Then determine by Table 1 whether the wire has the necessary carrying capacity. If not, assume smaller percentages of loss, until a wire is found that will be large enough to carry the current safely.

It may tend to make certain phenomena more easily understood to state that the electric current passing through a wire is

FIG. 9.—SHARP BEND IN A WIRE.

frequently compared to water flowing through a pipe. Prof. Ayrton says in "Practical Electricity," this analogy, however, like many other analogies, must not be strained too much; for example, a bend in the pipe, even with the steady flow of water, is found to cause a falling off in the water pressure; whereas, a bend in a wire has no effect on the electric potential if a steady current is flowing; or, again, if there be a sudden expansion or contraction in a pipe, there is a sudden alteration of the water pressure, which has no analogy in any sudden alteration of the electrical potential at a point in a circuit where the sectional area of the conductor changes abruptly. In fact, the flow of water or of gas in a pipe can be diminished to any extent by a contraction of one point *only*, which may be practically effected by partially closing a tap or cock; whereas, if an electric circuit consist of many yards of wire, no appreciable alteration of the current will be produced by making only half an inch of the wire, say one-tenth of its previous sectional area. The carrying capacity of any part of a wire, however, is materially reduced by making it of a smaller cross-section, and such a reduction in sectional area may cause a considerable heating of that portion of the wire.

A sharp bend in a wire is therefore only dangerous, as it reduces the sectional area, and not because it introduces a resistance.

Fig. 9 explains how a sharp bend may cause a wire to be partially torn asunder, and thus decrease the sectional area and cause undue heating at this point.

It may be stated as a general rule, that when a large percentage of loss is allowed with lamps at short distances, the size of wire calculated simply in accordance with resistance rules will be found too small to carry the current safely.

This simple fact is often overlooked, and even though wires may have been correctly calculated for a uniform percentage of loss, they will become painfully hot simply because the table of carrying capacity was not consulted.

The cross-connection of mains wherever possible, as already recommended, for the purpose of maintaining equal potentials, will also often reduce the heating effects of the current. A case

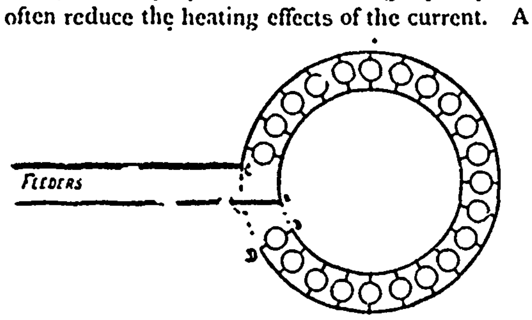

FIG. 10.—FAULTY LOOP CIRCUIT.

came under the author's observation which will well illustrate this fact. A circle of about 50 lights was wired, Fig. 10. After the current had been turned on the wires of the circuit became hot, and there was quite a perceptible difference of candle power between the lights near A and those near B. Investigation disclosed the fact that the loop, contrary to instructions, had been left open. A few inches of wire connecting A and B and C and D remedied the fault; the wires remained cool and the candle power was practically the same all round the circle.

The smallest wire used for incandescent wiring should be at least of 250 circular mils of cross-section. Smaller wire will break too easily when handled, and thus cause endless trouble.

THE THREE-WIRE SYSTEM.

The foregoing remarks which treat of "Drop of Potential" and "Safe Carrying Capacity," have reference only to conditions met with in a multiple arc system of distribution.

It has been briefly explained that in the three-wire system the electromotive force is double and the current is one-half that required for the same number of lamps on the multiple arc system.

All the rules previously given may readily be applied to the three-wire system.

Let us again compare these two systems.

Example: Find the electrical data for four lamps of 100 volts and 200 ohms' resistance each for both systems.

Demonstration: The current for one lamp according to Ohm's law $= \frac{100}{200} = \frac{1}{2}$ ampere.

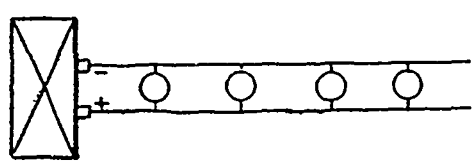

FIG. 11.—MULTIPLE ARC SYSTEM.

a. Multiple Arc System. (Fig. 11.) Joint resistance $= \frac{200}{4} = 50$ ohms; total electromotive force $= 100$ volts; total current $=$

$\frac{1}{2} \times 4 = 2$ amperes or $\frac{\text{electromotive force}}{\text{total resistance}} = \frac{100}{50} = 2$ amperes.

b. Three-Wire System. (Fig. 12.) The joint resistance may easily be found by omitting from the calculation the third or neutral wire. We will then have two series of two lamps each. The resistance of two lamps joined in series will be of course twice that of one lamp, or 400 ohms.

The joint resistance of two series will therefore be $\frac{400}{2} =$

* From "Incandescent Wiring Hand-Book."

200 ohms ; or in other words the joint resistance of the lamps in the three-wire system will be four times the joint resistance of the same number of lamps in multiple arc.

The total electromotive force in the three-wire system of course will be twice that of the electromotive force in the multiple arc system.

Again, the total current will equal $\frac{\text{total electromotive force}}{\text{total resistance}}$ or, $C = \frac{200}{200} = 1$ ampere, or in other words, the total current required for the lamps in the three-wire system, will be ½ of the

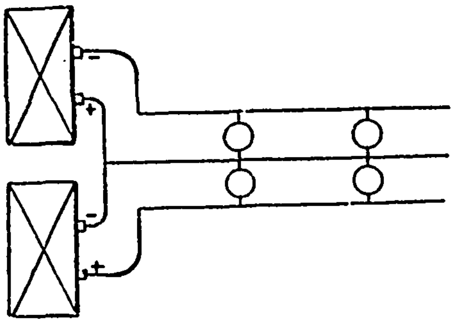

FIG. 12.—THREE-WIRE SYSTEM.

total current required for the same number of lamps in the multiple arc system.

With this demonstration in mind we are ready to form

Rule XI. For the same kind and same number of lamps the joint resistance of the lamps in the three-wire system is four times that of the multiple system ; the total electromotive force of the lamps in the three-wire system is twice that of the multiple arc system, and the total current strength of the lamps in the three-wire system is one-half the corresponding unit in the multiple arc system.

It can easily be seen that as the joint resistance of the lamps is four times greater in the three-wire system than in the multiple arc system, the resistance of the positive and negative conductors will be four times greater for the same percentage of loss. In other words, the cross-section of the wires in the three-wire system is ¼ that of the wires in the multiple arc system for the same percentage of loss. This gives us :

Rule XII. In order to find the proper size of wire for the three-wire system, first find the size of wire for the same number and kind of lamps on the multiple system in accordance with Rules VI and VII, then divide the number of circular mils by four.

The sum of the lengths of the positive and negative wires is the entire length of the circuit in the three-wire system, and the amount of copper required for the circuit is equal to one-fourth the amount of copper required in a multiple arc circuit ; the length of the central or neutral wire, if of the same size as the positive and negative leads will be only one-half the length of the total circuit ; hence the total amount of copper in the three-wire system will be ¼ + ⅛ = ⅜ of the amount necessary in the case of the multiple system.

As a matter of fact the neutral wire may be made smaller than the positive and negative wires, as it seldom will be called upon to carry more than a fraction of the maximum current. For practical reasons, however, it is advisable to make all three wires of the same size.

It will be seen that as the number of circular mils per wire in the three-wire system is ¼ the cross-section per wire in the multiple system, the carrying capacity in amperes of course is also reduced to ¼.

When Table 1 for the three-wire system is used it should be borne in mind that *only twice* the number of lamps may be carried by the wires, as the current is reduced to ½ for the same number of lamps.

The three-wire system in a building is generally followed throughout the whole network of feeders, mains, branches and sub-branches, down to circuits of from three to six lights ; smaller numbers would then be connected in simple multiple arc.

EXPLANATION OF TABLES.

Wiring Tables 3, 4 and 5 may be used by any one who does not care to study the principles underlying the calculations of the sizes of wires ; but even to those who thoroughly understand the demonstrations, the tables will be found of great convenience.

The first thing to do is to select the table for the lamps which are to be used. Let us consult the table for data relating to the 100 volt lamps.

We find in the horizontal columns at the top and bottom, numbers which correspond to "lamp-feet." (Lamp-feet is a brief expression used to denote the product obtained by multiplying the number of lamps by the distance in feet.) At the left of the table we find three vertical columns filled with figures representing circular mils ; and also underlined figures giving the numbers of the Brown & Sharp gauge. Each horizontal column corresponds to a vertical column.

The radial lines starting near the left hand corner represent percentages of loss. Each small space in the inside columns represents 2000, in the middle columns 500, and in the outside columns 125 ; that is to say in the horizontal columns the numbers represent lamp feet ; in the vertical columns the numbers represent circular mils, except where underscored, when they represent the number of the wire according to Browne & Sharp gauge.

Although the difference would be very slight in any case, it is necessary to note, for those who may desire absolute accuracy in determining the circular mils, that the short heavy lines beneath the Browne & Sharpe gauge figures in the vertical column, are the correct gauge lines and may be understood as extending the full width of the table.

The figures given in the columns represent thousands. For instance, 100 denotes 100,000 ; 4.25 = 4250 ; 2.5 = 2500, etc.

Example : Find the size of wire for 100 110 volt lamps at 1000 feet distance, at 10 per cent. loss.

Demonstration : 100 × 1000 = 100,000 lamp-feet. We find 100 in the *inside* horizontal column ; we follow the vertical 100 line until it intersects the 10 per cent. line. We take a ruler and lay it horizontally through this point and find it strikes about 88 in the *inside* vertical column. The proper size of wire has a sectional area of 88,000 circular mils. If we wish to wire on 5 per cent. loss we follow the vertical 100 line until it intersects with the 5 per cent. line and obtain by laying a horizontal line through this point about 186,000 circular mils.

From this demonstration we deduct the following general rule for computing from wire tables :

Rule XIII. Find the number of lamp-feet (lamp × feet), in one of the horizontal columns, follow the vertical line until it intersects the desired percentage line. A horizontal line laid through this point will show in the corresponding vertical column the cross-section of the wire in circular mils.

In consulting the table, always use corresponding columns. If the lamp-feet are found in the middle column, the circular mils must be read from the middle column ; if the lamp-feet are found in the outside column, the circular mils must be read from the outside column, etc.

Example : Find the size of wire for 20 110 volt lamps, at 900 feet distance at 5 per cent. loss.

Demonstration : 20 × 900 = 18,000. We find 18 in the *middle* horizontal column ; we follow the vertical 18 line until it intersects with the 5 per cent. line, and following the horizontal line we find in the middle column 33,500 circular mils.

Example : Find the size of wire for 50 110 volt lamps at 100 feet distance at 5 per cent. loss.

Demonstration : 50 × 100 = 5,000 lamp-feet. We find 5 in the middle lower column, and a glance shows us that the wire is over 9,300 circular mils or a little larger than No. 11 B. & S. gauge. We can find the same result by taking 5,000 in the outside horizontal column.

Rule XIV. The number of lamp-feet within moderate numbers can always be found in one of the three horizontal columns. Select the one which will intersect with the desired percentage line farthest from the left lower corner. If the number of lamp-feet is too great, and cannot be found in the table, divide it by 10 and find the circular mils for one-tenth the number of lamp-feet first, and then multiply the result by 10.

Example : Find the size of wire for 1,000 110 volt lamps, 1,000 feet distance at 10 per cent. loss.

Demonstration : 1,000 × 1,000 = 1,000,000 lamp-feet. Divide by 10 = 100,000 lamp-feet. Size of wire for 100,000 lamp-feet = 88,000 circular mils, for 10 × 100,000 = 1,000,000 lamp-feet = 10 × 88,000 = 880,000 circular mils.

The 55 and 75 volt tables, of course, are to be used in the same manner as explained in the case of the 110 volt table.

It will be noticed that the small spaces in the three *vertical* columns of all three tables represent the same values while the values in the *horizontal* columns of the three tables differ as follows:

Number of Lamp-feet per Small Space	Tables..		
	55 Volt.	75 Volt.	110 Volt.
Inside Horizontal Column.....	500	1000	2000
Middle Horizontal Column.....	125	250	500
Outside Horizontal Column	31 25	62 5	125

The tables are very simple, and will become familiar to the user after a short practical experience.

The 55 volt table may be used for lamps of a voltage between 50 and 60 volts, the 75 volt table for lamps of a voltage between 70 and 80 volts, and the 110 volt table for lamps of a voltage between 100 and 115 volts. The results will be accurate enough for all practical purposes.

In calculating the tables, lamps requiring 55 watts were assumed. The following table gives the electrical data of such lamps:

16 CANDLE-POWER LAMP REQUIRING 55 WATTS.

Electromotive Force in Volts.	Current in Amperes.	Resistance hot in Ohms.
110	.50	220
75	.7338	102.207
55	1.00	55

Under Rule VII it was shown that Rule VI could be simplified by calculating the constants for each kind of lamp and each percentage of loss. In the following table are given the constants for 55 watt lamps at different percentages of loss in the conductors.

TABLE OF CONSTANTS.

	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	12½	15%
55 Volt Lamp.	38.8	19.2	12.7	9.4	7.5	6.1	5.2	4.5	4.0	3.6	2.7	2.2
75 Volt Lamp.	20.9	10.3	6.8	5.1	4.0	3.3	2.8	2.4	2.1	1.9	1.5	1.2
110 Volt Lamp.	9.7	4.8	3.2	2.4	1.86	1.5	1.3	1.1	.99	.88	.66	.56

The wiring formula, Rule VI, can now be written $d^2 = N \times D \times K$, or, *the size of wire in circular mils = lamp-feet multiplied by constant*. The constant K is found from the formula

$$K = \frac{21.58}{r \text{ hot}} \times \frac{100 - \%}{\%}$$

From the foregoing it will be very easy to find the constant for any lamp and any percentage of loss, and calculate the size of wire without the aid of any tables whatever.

THE BOILER EXPLOSION AT QUEBEC.

THE boiler explosion at the Riverside Worsted Factory, which happened on the 12th February, was the most disastrous which ever occurred in Canada, both as regards loss of life and destruction of property. Our readers will no doubt be interested in some of the facts regarding this very serious occurrence. The engineer who had charge of the steam plant was among the killed, and if carelessness on his part was the real cause, he has paid his share of the penalty. The second engineer stated that he had nothing to do with the boilers and was employed only in the engine room.

There were three steam boilers of the type so commonly used in Canada, and known as horizontal tubular boilers. These were 6 feet in diameter and 16 feet long, with about 84 tubes in each, the tubes being 4 inches in diameter. Each boiler had a dome 30 inches diameter and 30 inches high, and rivetted to the boiler shell by a double rivetted joint. The boiler plates were said to be of good boiler plate iron, three-eighths of an inch thick, and the logitudinal seams double rivetted. The boilers were built in brickwork with Jarvis furnace setting. Each boiler had a safety valve, loaded by lever and weight and intended to open at about 80 pounds pressure. There were also shut-off valves by which the outlet to the steam pipe might be shut, and each boiler had a steam gauge and glass water gauge and try cocks.

The mill had not been running for some days, it having been closed to permit of some changes and repairs to the engine. On the morning of the day of the explosion, steam was got up intending to start the mill, but on trying the engine it was found there was something wrong and it would not go, and while a number of men were engaged on the engine, the explosion took place. The middle boiler exploded, being literally blown to pieces, the other two were thrown out of their seats, the one to the right and the other to the left, and were each broken into several pieces. The dome of the exploded boiler was torn off, leaving the flange rivetted to the plate of the shell. The body of the dome was thrown to a considerable distance. Such were the facts connected with the disaster, and it is important to notice that steam was up in all the boilers, and that none had been used except what was required for the heating apparatus.

A coroner's inquest was held, and after a very lengthy enquiry and the examination of many witnesses and of the remains of the exploded boiler, the following verdict was returned. "That the said Arthur Tweedell and others were killed by the explosion of the centre boiler of the Quebec Worsted Company's mill, the said explosion being due to an over-pressure of steam in the said boiler, caused by the stop valve being then closed. Furthermore, that the jurors recommend the appointment, as in other places, of a competent city and district boiler inspector, one who has both theoretical and practical knowledge, and who has had experience in the manufacturing of both boilers and engines and all the connections thereof."

The verdict says the boiler exploded because of over-pressure "caused by the stop valve being then closed." But what of the safety valve? It was there for the very purpose of preventing over-pressure, either when the stop valve was closed or open.

The jury *said* nothing about the safety valve, but they saw it. And when they saw it, they saw that before the explosion took place it had ceased to be a safety valve, and its condition really made the explosion possible. The probability is that the steam gauge had been frozen while the mill was closed, as there had been some very cold weather during these days. These boilers were under the inspection of the Quebec Provincial Inspector who was examined at the inquest. His qualifications may be guessed at by the wording of the jury's recommendation. He had no experience or special training to qualify him for the position, but after working in a boiler shop for a few weeks when a boy, had worked at a variety of businesses, such as carpenter, butcher, ship chandler, traveller for sale of boots and shoes, jewellry, &c. How these various occupations qualified him to inspect boilers may be judged from the fact that he did not discover the condition of the safety valve and other fittings on this exploded boiler.

If ever there is to be compulsory inspection of steam boilers, let this example be a warning. The government that will attempt to make boiler inspectors part of the political machine, and appoint as inspectors, men who are expert politicians, deserves to have its own safety valve rusted up and a good fire kept going till it gets blown so high that the scattered fragments will be forever lost. Had there been competent inspection and ordinary prudence, this terrible disaster would not have occurred.

To all engineers and firemen the lesson is: *make sure* for yourselves that whenever you put a fire under a boiler there is plenty of water in it, and way for the steam to get out. This boiler exploded simply because there was no outlet for the steam, and the probability is that there was a pressure of not less than 300 pounds in it when it exploded. It would hold about eight tons of water, and the explosion would not be much less than that of a ton of gunpowder, so that there need not be much surprise at the serious destruction of property.

The President of the Bell Telephone Company, of Montreal, recently inquired of the Secretary of the Treasury at Washington whether the end of the telephone cable to be passed through the tunnel connecting Sarnia with Port Huron, Mich., will be permitted to enter free of duty. Assistant Secretary Spaulding has informed him that so much of said cable as may be brought within the limits of the United States will be subject to duty under existing laws, the Department having no authority to waive the same.

An exchange points to the fact that the possibility of electricity being used as the motive power for railroads in the feature is assuming an interesting condition. Stations may be located some forty or fifty miles apart, which will be run by large engines, and from recent tests it is found that an electric motor will mount a grade of more than fifty per cent. Not only on railroads, but on ocean steamers will a new era be inaugurated when electricity is introduced. The advantages being a saving of expense, higher rate of speed, and the danger of accidents decreased.

PUBLICATIONS.

Prof. Silvanus Thomson's series of lectures on "The Electromagnet, delivered in February, 1890, before the Society of Arts, London, have been reprinted in book form by the W. J. Johnston Co., N. Y., to whom we are indebted for a copy.

The April issue of *The Arena* is at once rich in variety and strong in its presentation of great fundamental problems, which are agitating the popular mind at the present time. No magazine of the present age is in such perfect touch with progressive and reformative thought as this review

We are in receipt of a copy of *The Electrician* Electrical Trades Directory and Hand-Book for 1891. The book shows an increase of 100 pages as compared with last year, and contains a vast amount of carefully compiled information relating to the electrical industries throughout the world. Among the many features of interest to the electrical and allied professions are a Digest of the Law of electric lighting, a list of central stations in the United Kingdom for the distribution of electricity, a list of electrical railways and tramways, a summary of the leading events of the past year: a complete list of the local authorities of England; information relating to the obtaining of letters patent; and a reliable biographical section, containing interesting sketches of the careers of the leading living electrical notabilities. Price 5 shillings (postage extra). *The Electrician* Publishing Co., 1, 2 and 3 Salisbury Court, Fleet street, London, E. C.

ENGINE FOUNDATIONS.

THE question of brick versus stone foundations for engines is being discussed. The advantages of brick foundations are given by one correspondent in citing a case. The foundations were of hard-burned vitrified brick, laid in Portland cement. The gentleman in charge of the work stated that stone, unless dressed with extreme nicety, never gets a perfect bearing on its bed, as perpendicular joints can very seldom be filled solid, hence stone foundations, no matter how heavy, are full of vacant spaces that allow vibration. On the other hand, with brick a perfect joint can always be made, thus obtaining a foundation practically one immense block, all of which has to be shaken before vibration can occur.

A few days later, in conversation with a well-known mechanical engineer, I was given another explanation of the matter. This gentleman stated that in such structures all the vibration has its origin in the machine, which is the centre of the foundation, and being at the top is at the most distant point from the earth. Vibration loses much of its force in passing from one distinctly defined body to another, and the more frequently the vibration is transmitted from one body to another in a given space, the more nearly it is overcome. In a stone foundation while the large blocks possess weight, and lying together, have great frictional resistance, a vibration will only be transmitted once or twice before the same is reached. In a brick foundation the same gross weight may be attained, and at the same time the vibration must pass from one body to another infinitely more frequently than in the stone foundation.

A LEVEL-HEADED BOY

A BOY about fifteen years of age applied to a factory on Atwater street for the job of running a small engine in the place of a boy who had quit.

"Have you run an engine?" was asked.

"Yes, sir."

"You understand how steam works, do you?"

"I do."

"You know that water makes steam?"

"Of course."

"How is water got into a boiler?"

"By an injector."

"Suppose you have too much water?"

"Then I can't get steam enough until I draw it down."

"Correct. Suppose you haven't enough?"

"Then look out for an explosion."

"Correct again. Suppose you found the water almost gone and couldn't start the injector—what would you do?"

"Come upstairs and notify you to get your insurance policies out of the safe and make a sneak before she busted."

"You seem to be all right, young man; you can come on in the morning."—Detroit *Free Press.*

Mr. John Paynter, a widely known and highly esteemed engineer of Kingston, Ont., died in that city during the last month.

SPARKS.

The Listowel Gas & Electric Light Co (Limited) has been incorporated.

Two or three of the electric companies are anxious to introduce the electric light to the citizens of Drayton, Ont.

The Electric Light Co. at Rat Portage, Ont., has made a contract with the Council to light the streets for three years.

An expert will be employed by the Council to report on the best electric light system to be adopted by the town of West Toronto Junction.

Telephone communication has been opened during the past month, by means of a land and submarine cable, between the cities of Paris and London.

Messrs. Baird & Son, of Parkhill, have purchased an electric plant, and are supplying incandescent lights to the business establishments of the town.

The Nanaimo Electric Railway Co. will adopt the storage battery system of propulsion if its adaptability for the work can be satisfactorily demonstrated.

The Council of West Toronto Junction have decided to throw away $200 in sending a deputation of town fathers in search of information on the subject of electric lighting.

After exhaustive experiments the French post-office has decided to substitute a copper-coated steel wire in place of the ordinary iron wire for telegraphic and telephonic service.

The Building Inspector of Montreal is said to have condemned the tall chimney of the east end works of the Royal Electric Company, having found it to be defective 30 feet above its base.

Mr. Calder, chief of the Brantford fire brigade, has effected an arrangement for lighting instantly the gas jets by means of electricity. By this means a saving of $25 per year is realized in the gas account.

Incorporation has been granted the Ottawa Electric Street Railway Co. (Limited). Capital stock, $5,000,000. The promoters are: Thomas Ahearn, W. Y. Soper, W. Scott, D. C. Dewar and R. Quain, of Ottawa.

The Brooks Manufacturing Co., of Peterboro', have entered into a contract to supply all the carbons required by the Royal Electric Company of Montreal, averaging $1,000 per month. The company manufacture 10,000 carbons per day.

The Canada Permanent Loan and Savings Co. will sell by auction on the 15th inst. the premises and plant of the Hamilton Electric Light Co. to satisfy a mortgage. The city is interested in the matter, as the lighting contract has yet two years to run.

The Niagara Falls Electric Railway Co. is applying for incorporation for the purpose of constructing and operating an electric railway from a point near Niagara to a point near Port Erie. Among the applicants are Albert D. Shaw, John G. Scott, Benjamin G. Lake and Thos. McGaw.

Mr. John Griffin, Minneapolis, Minn., has invented a device for preventing electric street car wheels from slipping. The invention is a simple contrivance consisting of a revolving brush which is connected with the forward axle of the car by a belt. As the axle revolves it sets the brushes to revolving, brushing a path for the wheels about a foot wide. There is also a box for sand or salt, which lets down just enough without wasting any.

Hamilton *Herald:* The placing of telephone transmitters in churches puts a premium on laziness. A Hamilton man lengthened his wire in his house yesterday morning until he could hold the instrument to his ear comfortably in bed. Snuggling himself up beneath the bed covers he lay all morning listening to Canon Curran's discourse in St. Thomas Church.

The Bell telephone patent monopoly in England has expired. The patent there was granted for fourteen years. Cheap telephones will now prevail in England the same as in Germany, where Bell failed to obtain a patent. In the United States the Bell patent will expire March, 7, 1893, having been originally granted March, 7, 1876, for a term of seventeen years.

The new electric power house erected at New Westminster, B. C., is constructed of red brick, roofed with iron shingles. It has a frontage on the street of 45 feet and extends back 95 feet. It is divided into compartments, the larger being in front, and containing the dynamos and electric apparatus, office, etc. In the rear division is the generating machinery, which is of great power and weight. The boiler, engine and dynamo beds are of broken granite rock set in cement and covered with blocks of Nelson Island granite. The boiler bed has a foundation of 25 x 30 feet. The engine bed 24 x 16 feet; and the dynamo base is 8 feet square, tapering at the top to 8 x 4 feet. The boiler and engine have sufficient capacity for five times the present requirements.

SPARKS.

The citizens of Merrickville, Ont., want the electric light.

It is the intention to light the streets of Madoc, Ont., by electricity.

The Arnprior Electric Light Co. sustained loss by the recent fire in that town.

The Brockville Incandescent Light Company will shortly enlarge their circuit.

The Bell Telephone Co. have just completed an electric fire alarm system for Napanee.

The Penetang Electric Light Co. intend putting in an engine to assist water power in the spring.

The Northwest Legislative buildings at Regina will in future be lighted by electricity instead of gas.

Application is made to the Legislature for a Bill to amalgamate the Kingston Gas and Electric Companies.

The Canada Electric Company of Halifax, N. S., are putting in another dynamo of 325 light power, at Amherst, N. S.

Incorporation has been granted the Fort William Electric Railway Co. Messrs. Donald and Peter Mackellar are among the promoters.

Tenders will be asked shortly for the construction of a proposed electric tramway at Nanaimo, B. C., the length of which will be 10 miles.

At a meeting of the directors of the New Westminster and Vancouver Railway Co. held a few days ago, the route for the road was definitely fixed.

The Windsor, Walkerville and Amherstburg Street Railway Co. have ordered 225 tons of rails and ten cars, together with all the machinery necessary to operate their line.

The Essex Brass and Iron Co., London, Ont., capital $30,000, has secured incorporation for the purpose of manufacturing brass and other metal goods, and electrical machines and appliances.

The Davenport Electric Railway Co. has been organized, with Mr. Jas. Austin as President, for the purpose of constructing an electric railway along Davenport Road from Toronto to Lambton.

Rapid progress is being made with the construction of the New Westminster and Vancouver, B. C., electric tramway. A portion of the machinery for the power house has arrived. Contracts have been let for the poles and wires, which will be erected at once.

Messrs. Ahern & Sopher have purchased property on Albert street, Ottawa, on which to erect car shops and offices, quarters for workmen, and work shop for repairs in connection with the proposed electric street railway. The building will be solid brick, 125 x 55 feet.

Property on the north side of the inlet opposite the city of Vancouver, B. C., to the extent of 1,279 acres has been purchased from Capt. Power, of Moodyville, by a syndicate of local capitalists, who will proceed at once to lay out a town site to be known as North Vancouver. Among the improvements to be carried out will be the construction of an electric railway to connect with the city lines.