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CANADIAN ELECTRICAL NEWS AND STEAM ENGINEERING JOURNAL

OLD SERIES, VOL. XV.—No. 4.
NEW SERIES, VOL. III.—No. 11.

NOVEMBER, 1893

PRICE 10 CENTS
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CANADIAN
ELECTRICAL NEWS
AND
STEAM ENGINEERING JOURNAL.

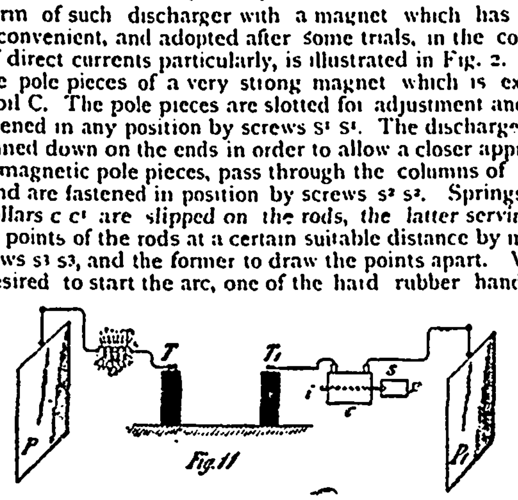
VOL. III. | NOVEMBER, 1893 | No. 11.

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.

BY NIKOLA TESLA.

(Continued from September Number.)

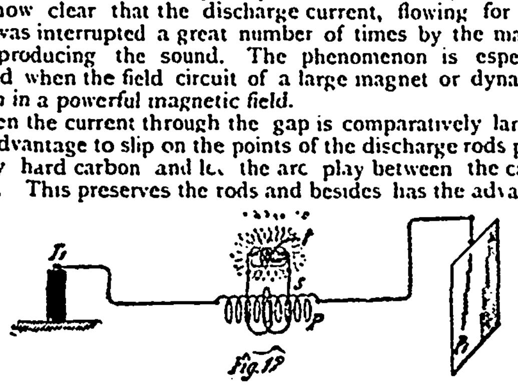
A form of such discharger with a magnet which has been found convenient, and adopted after some trials, in the conversion of direct currents particularly, is illustrated in Fig. 2. N S are the pole pieces of a very strong magnet which is excited by a coil C. The pole pieces are slotted for adjustment and can be fastened in any position by screws s^1 s^1. The discharge rods d^1 thinned down on the ends in order to allow a closer approach of the magnetic pole pieces, pass through the columns of brass b b^1 and are fastened in position by screws s^2 s^2. Springs r r^1 and collars c c^1 are slipped on the rods, the latter serving to set the points of the rods at a certain suitable distance by means of screws s^3 s^3, and the former to draw the points apart. When it is desired to start the arc, one of the hard rubber handles h



SHOWING EFFECTS OF CURRENTS FLOWING THROUGH OPEN CIRCUITS.

h^1 is tapped quickly with the hand, whereby the points of the rods are brought in contact, but are instantly separated by the springs r r_1. Such an arrangement has been found to be often necessary, namely in cases when the E. M. F. was not large enough to cause the discharge to break through the gap, and also when it was desirable to avoid short circuiting of the generator by the metallic contact of the rods. The rapidity of the interruptions of the currrent with a magnet depends on the intensity of the magnetic field and on the potential difference at the ends of the arc. The interruptions are generally in such quick succession as to produce a musical sound. Years ago it was observed that when a powerful induction coil is discharged between the poles of a strong magnet the discharge produced a loud noise not unlike a small pistol shot. It was vaguely stated that the spark was intensified by the presence of the magnetic field. It is now clear that the discharge current, flowing for some time, was interrupted a great number of times by the magnet, thus producing the sound. The phenomenon is especially marked when the field circuit of a large magnet or dynamo is broken in a powerful magnetic field.

When the current through the gap is comparatively large, it is of advantage to slip on the points of the discharge rods pieces of very hard carbon and let the arc play between the carbon pieces. This preserves the rods and besides has the advantage

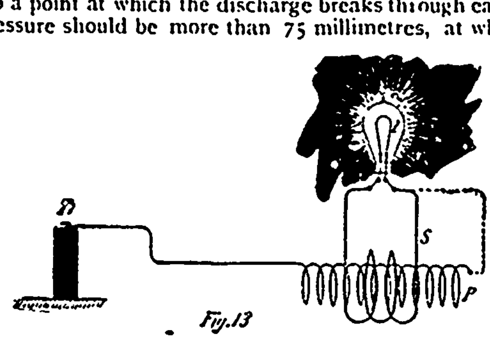


CONVERSION ON OPEN CIRCUIT WITH COAL AND INSULATED PLATE.

of keeping the air space hotter, as the heat is not conducted away as quickly through the carbons, and the result is that a smaller E. M. F. in the arc gap is required to maintain a succession of discharges.

Another form of discharger which may be employed with advantage in some cases is illustrated in Fig. 3. In this form the discharge rods d d^1 pass through perforations in a wooden box B, which is thickly coated with mica on the inside, as indicated by the heavy lines. The perforations are provided with mica tubes m m_1 of some thickness, which are preferably not in contact with the rods d d_1. The box has a cover C which is a little larger and descends on the outside of the box. The spark gap is warmed by a small lamp l contained in the box. A plate p above the lamp allows the draught to pass only through the chimney c of the lamp, the air entering through holes o o in or near the bottom of the box and following the path indicated by the arrows. When the discharger is in operation the door of the box is closed so that the light of the arc is not visible outside. It is desirable to exclude the light as perfectly as possible, as it interferes with some experiments. This form of discharger is simple and very effective when properly manipulated. The air being warmed to a certain temperature has its insulating power impaired, it becomes dielectrically weak, as it were, and the consequence is that the arc can be established at much greater distance. The air should, of course, be sufficiently insulating to allow the discharge to pass through the gap disruptively. The arc formed, under such conditions, when long, may be made extremely sensitive, and the weak draught through the lamp chimney c is quite sufficient to produce rapid interruptions. The adjustment is made by regulating the temperature and velocity of the draught. Instead of using a lamp it answers the purpose to provide for a draught of warm air in other ways. A very simple way which has been practised is to inclose the arc in a long vertical tube with plates on the top and bottom for regulating the temperature and velocity of the air current. Some provision had to be made for deading the sound.

The air may be rendered dielectrically weak also by rarefaction. Dischargers of this kind have likewise been used by me in connection with the magnet. A large tube is for this purpose provided with heavy electrodes of carbon or metal between which the discharge is made to pass, the tube being placed in a powerful magnetic field. The exhaustion of the tube is carried to a point at which the discharge breaks through easily, but the pressure should be more than 75 millimetres, at which the



CONVERSION ON OPEN CIRCUIT WITH COIL ALONE.

ordinary thread discharge occurs. In another form of discharger, combining the features before mentioned, the discharge was made to pass between two adjustable magnetic pole pieces, the space between them being kept at an elevated temperature.

It should be remarked here that when such, or interrupting devices of any kind, are used and the currents are passed through the primary of a disruptive discharge coil, it is not as a rule, of advantage to produce a number of interruptions of the current per second greater than the natural frequency of vibration of the dynamo supply circuit, which is ordinarily small. It should also be pointed out here, that while the devices mentioned in connection with the disruptive discharge are advantageous under certain conditions, they may be sometimes a source of trouble, as they produce intermittences and other irregularities in the vibration which it would be very desirable to overcome.

There is, I regret to say, in this beautiful method of conversion a defect, which fortunately is not vital, and which I have been gradually overcoming. I will best call attention to this defect and indicate a fruitful line of work by comparing the electrical process with its mechanical analogue. The process may be illustrated in this manner. Imagine a tank with a wide opening at the bottom, which is kept closed by spring pressure, but so that it snaps off suddenly when the liquid in the tank has reached a certain height. Let the fluid be supplied to the tank by means of a pipe feeding at a certain rate. When the critical height of the liquid is reached, the spring gives way and the bottom of the tank drops out. Instantly the liquid falls through the wide opening, and the spring, reasserting itself, closes the bottom again. The tank is now filled, and after a certain time interval, the same process is repeated. It is clear, that if the pipe feeds the fluid quicker than the bottom outlet is capable of letting it pass through, the bottom will remain off and the tank will still overflow. If the rates of supply are exactly equal, then the bottom lid will remain partially open and no vibration of the same and of the liquid column will generally occur, though it might, if started by some means. But if the inlet pipe does not feed the fluid fast enough for the outlet, then there will be always vibration? Again, in such cases, each time the bottom flaps up or down the spring and the liquid column, if the pliability of the spring and the inertia of the moving parts are properly chosen, will perform independent vibrations. In this analogue the fluid may be likened to electricity or electrical energy, the tank to the condenser, the spring to the dielectric and the pipe to the conductor through which electricity is supplied to the condenser. To make this analogy quite complete it is necessary to make the assumption that the bottom, each time it gives way, is knocked violently against a non-elastic stop, this impact involving some loss of energy, and that, besides, some dissipation of energy results, due to frictional losses. In the preceding analogue the liquid is supposed to be under a steady pressure. If the pressure of the fluid be assumed to vary rythmically, this may be taken as corresponding to the case of an alternating current. The process is then not quite as simple to consider, but the action is the same in principle.

It is desirable, in order to maintain the vibration economically to reduce the impact and frictional losses as much as possible. As regards the latter, which in the electrical analogue correspond to the losses due to the resistance of the circuits, it is impossible to obviate them entirely, but they can be reduced to a minimum by a proper selection of the dimensions of the circuits and by the employment of thin conductors in the form of strands. But the loss of energy caused by the first breaking through of the dielectric—which in the above example corresponds to the violent knock of the bottom against the inelastic stop—would be more important to overcome. At the moment of the breaking through, the air space has a very high resistance, which is probably reduced to a very small value when the current has reached some strength, and the space is brought to a high temperature. It would materially diminish the loss of energy if the space were always kept at an extremely high temperature, but then there would be no disruptive break. By warming the space moderately by means of a lamp or otherwise the economy as far as the arc is concerned is sensibly increased. But the magnet or other interrupting device does not diminish the loss in the arc. Likewise, a jet of air only facilitates the carrying off of the energy. Air, or a gas in general, behaves curiously in this respect. When two bodies, charged to a very high potential, discharge disruptively through an air space, any amount of energy may be carried off by the air. This energy is evidently dissipated by bodily carriers, in impact and collisional losses of the molecules. The exchange of the moleculee in the space occurs with inconceivable rapidity. A powerful discharge taking place between two electrodes, they may remain entirely cool, yet the loss in the air may represent any amount of energy. It is perfectly practicable with very great potential differences in the gap, to dissipate several horse power in the arc of the discharge without even noticing a small increase in the temperature of the electrodes. All the frictional losses occur then practically in the air. If the exchange of the air molecules is prevented, as by inclosing the air hermetically, the gas inside of the vessel is brought quickly to a high temperature, even with a very small discharge. It is difficult to estimate how much of the energy is lost in sound waves audible or not, in a powerful discharge. When the currents through the gap are large, the electrodes may become rapidly heated, but this is not a reliable measure of the energy wasted in the arc, as the loss through the gap itself may be comparatively small. The air or a gas in general is, at ordinary pressures at least, clearly not the best medium through which a disruptive discharge should occur. Air or other gas under great pressure is of course a much more suitable medium for the discharge gap. I have carried on long-continued experiments in this direction, unfortunately less practicable on account of the difficulties and expense in getting air under great pressure. But even if the medium in the discharge space is solid or liquid, still the same losses take place, though they are generally smaller, for just as soon as the arc is established the solid or liquid is volatilized. Indeed, there is no body known which would not be disintegrated by the arc, and it is an open question among scientific men whether an arc discharge could occur at all in the air itself without the particles of the electrodes being torn off. When the current through the gap is very small and the arc very long, I believe that a relatively considerable amount of heat is taken up in the disintegration of the electrodes, which partially on this account may remain quite cold.

The ideal medium for a discharge gap should only crack, and the ideal electrode should be of some material which cannot be disintegrated. With small currents through the gap it is best to employ aluminum, but not when the currents are large. The disruptive break in the air, or more or less in an ordinary medium, is not of the nature of a crack, but it is rather comparable to the piercing of innumerable bullets through a mass offering great frictional resistance to the motion of the bullets, this involving considerable loss of energy. A medium which would merely crack when strained electrostatically—and this possibly might be the case with a perfect vacuum, that is, pure ether—would involve a very small loss in the gap, so small as to be entirely negligible, at least theoretically, because a crack may be produced by an infinitely small displacement. In exhausting an oblong bulb provided with two aluminum terminals with the greatest care I have succeeded in producing such a vacuum that the secondary discharge of a disruptive discharge coil would break disruptively through the bulb in the form of fine spark streams. The curious point was that the discharge would completely ignore the terminals and start far behind the two aluminum plates which serve as electrodes. This extraordinarily high vacuum could only be maintained for a very short while. To return to the ideal medium, think for the sake of illustration, of a piece of glass or similar body clamped in a vise, and the latter tightened more and more. At a certain point a minute increase of the pressure will cause the glass to crack. The loss of energy involved in splitting the glass may be practically nothing, for though the force is great the displacement need be but extremely small. Now, imagine that the glass would possess the property of closing again perfectly the crack upon a minute diminution of the pressure. This is the way the dielectric in the discharge space should behave. But inasmuch as there would be always some loss in the gap the medium which should be continuous should exchange through the gap at a rapid rate. In the preceding example, the glass being perfectly closed, it would mean that the dielectric in the discharge space possesses a great insulating power; the glass being cracked, would signify that the medium in the space is a good conductor. The dielectric should vary enormously in resistance by minute variations of the E. M. F. across the discharge space. This condition is attained, but in an extremely imperfect manner, by warming the air space to a certain critical temperature, dependent on the E. M. F. across the gap, or by otherwise impairing the insulating power of the

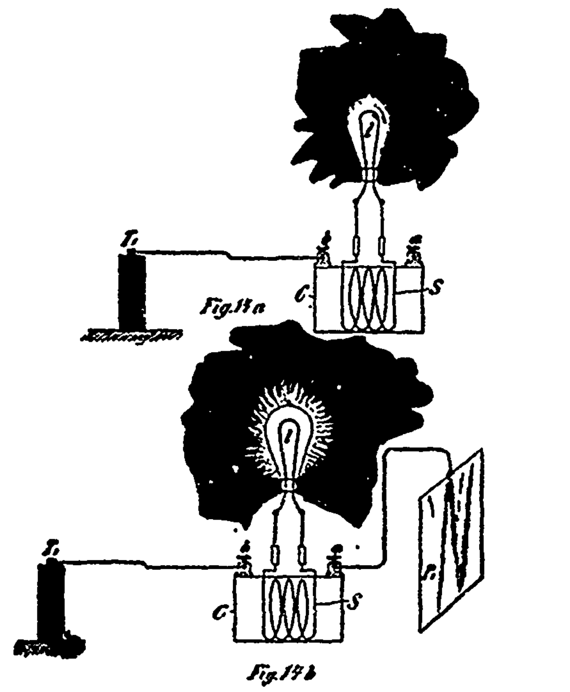


Fig. 14b

EFFECT OF ATTACHED PLATE WITH LOW FREQUENCIES.

air. But as a matter of fact the air does never break down disruptively, if this term be rigorously interpreted, for before the sudden rush of the current occurs, there is always a weak current preceding it, which rises first gradually and then with comparative suddenness. That is the reason why the rate of change is very much greater when glass, for instance, is broken through, than when the break takes place through an air space of equivalent dielectric strength. As a medium for the discharge space a solid, or even a liquid would be preferable therefore. It is somewhat difficult to conceive of a solid body which would possess the property of closing instantly after it had been cracked. But a liquid, especially under great pressure, behaves practically like a solid, while it possesses the property of closing the crack. Hence it was thought that a liquid insulator might be more suitable as a dielectric than air. Following out this idea, a number of different forms of dischargers, in which a variety of such insulators, sometimes under great pressure, were employed, have been experimented upon. It is thought sufficient to dwell in a few words upon one of the forms experimented upon. One of these dischargers is illustrated in Figs. 4a and 4b.

A hollow metal pulley P (Fig. 4a), was fastened upon an arbor a, which by suitable means was rotated at a considerable speed. In the inside of the pulley, but disconnected from the same, was supported a thin disc h (which is shown thick for the sake of clearness), of hard rubber, in which there were embedded two metal segments s s with metallic extensions e e into which were screwed conducting terminals t t covered with thick tubes of hard rubber t t. The rubber disc h, with its metallic segments S S, was finished in a lathe, and its entire surface highly polished so as to offer the smallest possible frictional resistance to the motion through a fluid. In the hollow of the pulley an insulating liquid such as a thin oil was poured so as to reach very nearly to the opening left in the flange f, which was screwed tightly on the front side of the pulley. The terminals t t were connected to the opposite coatings of a battery of condensers so that the discharge occurred through the liquid. When the pulley was rotated the liquid was forced against the rim of the pulley and considerable fluid pressure resulted. In this simple way the discharge gap was filled with a medium which behaved practically like a solid, which possessed the quality of closing instantly upon the occurrence of the break, and which moreover was circulating through the gap at a rapid rate. Very powerful effects were produced by dischargers of this kind with liquid interrupters, of which a number of different forms were made. It was found that, as expected, a longer spark for a given length of wire was obtainable in this way than by using air as an interrupting device. Generally the speed, and therefore also the fluid pressure, was limited by reason of the fluid friction, in the form of a discharger described, but the practically obtainable speed was more than sufficient to produce a number of breaks suitable for the circuits ordinarily used. In some instances the metal pulley P was provided with a few projections inwardly, and a definite number of breaks was then produced which could be computed from the speed of rotation of the pulley. Experiments were also carried on with liquids of different insulating power with the view of reducing the loss in the arc. When an insulating liquid is moderately warmed the loss in the arc is diminished.

A point of some importance was noted in experiments with various discharges of this kind. It was found, for instance, that whereas the conditions maintained in these forms were favorable for the production of a great spark length, the currents so obtained were not best suited to the production of light effects. Experience undoubtedly has shown that for such purposes a harmonic rise and fall of the potential is preferable. Be it that a solid is rendered incandescent, or phosphorescent, or be it that energy is transmitted by condenser coating through the glass, it is quite certain that a harmonically rising and falling potential produces less destructive action, and that the vacuum is more permanently maintained. This would be easily explained if it were ascertained that the process going on in an exhausted vessel is of an electrolytic nature.

In the diagrammatical sketch, Fig 1, which has been already referred to, the cases which are most likely to be met with in practice are illustrated. One has at his disposal either direct or or alternating currents from a supply station. It is convenient for an experimenter in an isolated laboratory to employ a machine G, such as illustrated, capable of giving both kinds of currents. In such case it is also preferable to use a machine with multiple circuits as in many experiments it is useful and convenient to have at one's disposal currents of different phases. In the sketch, D represents the direct and A the alternating current. In each of these three branch circuits are shown, all of which are provided with double lines switches S S S S S S. Consider first the direct current conversion; 1a represents the simplest case. If the E. M. F. of the generator is sufficient to break through a small air space, at least when the latter is warmed or otherwise rendered purely insulating, there is no difficulty in maintaining a vibration with fair economy by judicious adjustment of the capacity, self-induction and resistance of the circuit L containing the devices 1 1 m. The magnet N S can be in this case advantageously combined with the air space. The discharger d d with the magnet may be placed either way, as indicated by the full or by the dotted lines. The circuit 1a with the connections and devices is supposed to possess dimensions such as are suitable for the maintenance of a vibration. But usually the E. M. F. on the circuit or branch 1a will be something like 100 volts or so, and in this case it is not sufficient to break through the gap. Many different means may be used to remedy this by raising the E. M. F. across the gap. The simplest is probably to insert a large self-induction coil in series with the circuit L. When the arc is established, as by the discharger illustrated in Fig. 2, the magnet blows the arc out the instant it is formed. Now the extra current of the break, being of high E. M. F. breaks through the gap, and a path of low resistance for the dynamo current being again provided, there is a sudden rush of the current from the dynamo upon the weakening or subsidence of the extra current. This process is repeated in rapid succession, and in this manner I have maintained oscillation with as low as 50 volts, or even less, across the gap. But conversion on this plan is not to be recommended on account of the too heavy currents through the gap and consequent heating of the electrodes; besides, the frequencies obtained in this way are low, owing to the high self-induction necessarily associated with the circuit. It is very desirable to have the E. M. F. as high as possible, first, in order to increase the economy of the conversion, and, secondly, to obtain high frequencies. The difference of potential in this electric oscillation is, of course, the equivalent of the stretching force in the mechanical vibration of the spring. To obtain very rapid vibration in a circuit of some inertia a great stretching force or difference of potential is necessary. Incidentally, when the E. M. F. is very great, the condenser which is usually employed in connection with the circuit need have but a small capacity, and many other advantages are gained. With a view of raising the E. M. F. to a many times greater value than obtainable from ordinary distribution circuits a rotating transformer g is used, as indicated in Fig. 2a, or else a separate high potential machine is driven by means of a motor operated from the generator G. The latter plan is in fact preferable, as changes are easier made. The connections from the high tension winding are quite similar to those in branch 1a with the exception that a condenser C, which should be adjustable, is connected to the high tension circuit. Usually, also, an adjustable self-induction coil in series with the circuit has been employed in these experiments. When the tension of the currents is very high the magnet ordinarily used in connection with the discharger is of comparatively small value, as it is quite easy to adjust the dimensions of the circuit so that oscillation is maintained. The employment of a steady E. M. F. in the high frequency conversion affords some advantages over the employment of alternating E. M. F., as the adjustments are much simpler and the action can be easier controlled. But unfortunately one is limited by the obtainable potential difference. The windings also break down easily in

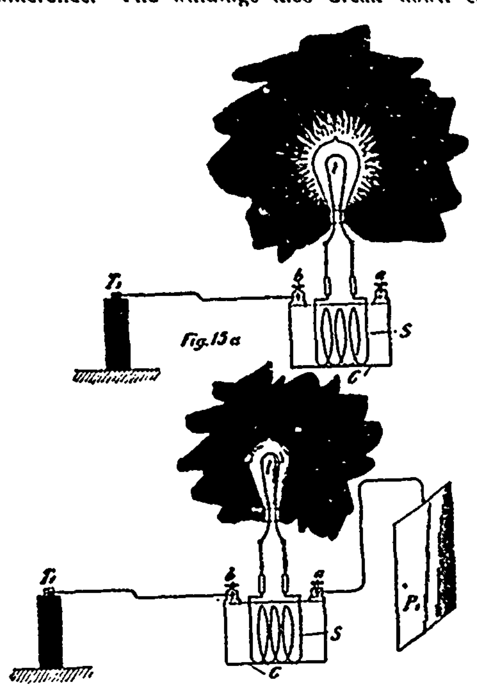


Fig 15b

EFFECT OF ATTACHED PLATE WITH HIGH FREQUENCIES.

consequence of the sparks which form between the sections of the armature or commutator when a vigorous oscillation takes place. Besides, these transformers are expensive to build. It has been found by experience that it is best to follow the plan illustrated in Fig. 3a. In this arrangement a rotating transformer g is employed to convert the low tension direct currents into low frequency alternating currents, preferably also of small tension. The tension of the currents is then raised in a stationary transformer T. The secondary S of this transformer is connected to an adjustable condenser C which discharges through the gap or discharger d d, placed in either of the ways indicated through the primary P of a disruptive discharge coil, the high frequency currents being obtained from the secondary S of this coil, as described on previous occasions. This will undoubtedly be found the cheapest and most convenient way of converting direct currents.

The three branches of the circuit A represent the usual cases met in practice when alternating currents are converted. In Fig. 1b a condenser C, generally of large capacity, is connected to the circuit L containing the devices 1 1, m m. The devices m m are supposed to be of high self-induction so as to bring the frequency of the circuit more or less to that of the dynamo. In this instance the discharger d d should best have a number of makes and breaks per second equal to twice the frequency of the dynamo. If not so, then it should have at least a number equal to a multiple or even fraction of the dynamo frequency. It should be observed, referring to 1b, that the conversion to a high potential is also effected when the discharger d d, which is shown in the sketch, is omitted. But the effects which are produced by currents which rise instantly to high values, as in a disruptive discharge, are entirely different from those produced by dynamo currents which rise and fall harmonically. So, for instance, there might be in a given case a number of makes and breaks at d d equal to just twice the frequency of the dynamo, or, in other words, there may be the same number of fundamental oscillations as would be produced without the discharge gap, and there might even not be any quicker superimposed vibration; yet the differences of potential at the various points of the circuit, the impedance and other phenomena, dependent upon the rate of change will bear no similarity in the two cases. Thus when working with currents discharging disruptively, the element chiefly to be considered is not the frequency, as a student might be apt to believe, but the rate of change per unit of time. With low frequencies in a certain measure the same effects may be obtained as with high frequencies, provided the rate of change is sufficiently great So if a low frequency current is raised to a potential of say 75,000 volts, and the high tension current passed through a series of high resistance filaments, the importance of the rarefied gas surrounding the filament is clearly noted, as will be seen later, or, if a low frequency current of several thousand amperes is passed through a metal bar, striking phenomena of impedance are observed, just as with currents of high frequencies. But it is, of course, evident that with low frequency currents it is impossible to obtain such rates of change per unit of time as with high frequencies, hence the effects produced by the latter are much more prominent. It was deemed advisable to make the preceding remarks, inasmuch as many more recently described effects have been unwittingly identified with high frequencies. Frequency alone in reality does not mean anything, except when an undisturbed harmonic oscillation is considered.

(To be Continued.)

ENGINES FOR ELECTRIC WORK.

To the Editor of the CANADIAN ELECTRICAL NEWS.

SIR, I was much interested in reading an article in your July number in regard to engines for operating generators for street railway work, and, as electric railways are increasing rapidly, I have no doubt your timely reference to the subject would receive close attention from a large number of your readers who are engaged in this work. Believing that your object is not only to furnish much needed advice, but to call forth discussion and criticism, I venture to discuss some points raised by you, and give the results of some little observation and experience.

I fully agree with you that compounding should not be adopted unless there is available either a supply of water for condensing, or a very high steam pressure, and I believe that frequently a loss and waste is sustained both in electric lighting and railway plants, particularly the latter, where the load fluctuates very greatly, when these conditions are not obtained. But in reference to the low speed engine being best, I think a full and unbiased investigation of all the conditions found in electric work would demonstrate that in many instances the high speed engine would possess advantages which would give it the preference for such circumstances. You hit the nail on the head when you say that "there are times when an engine being used for that purpose is suddenly required to jump from a few to hundreds of horse power in but a few seconds of time," and I think it will not be out of place to add that these sudden fluctuations are constantly taking place, and, if the engine does not respond instantly to the sudden increase or decrease of load, the electric generators and motors will suffer severely. A moment's consideration will demonstrate, to those who have not already learned it by experience, that it is not possible for a low speed engine to regulate as quickly or maintain as even speed under sudden changes of load, as one of the high speed type, for three reasons.

1st. Because the governing mechanism, employing any of the forms of trip cut-off gear, will not respond as readily to sudden changes as a rapidly revolving fly-wheel governor, directly connected to the cut-off valve.

2nd. The trip cut-off only has an opportunity to control the speed during a very small part of each stroke, viz: from the time of admission to the time of cut-off, which may be only one-sixteenth, one eighth, or at latest one-half the stroke, so that it is impossible, even with the aid of a very heavy balance wheel, to make the engine respond to a sudden change of load, should it come after cut off has taken place, while the high speed engine, with single valve attached direct to the governor, operating both cut-off and compression, has control during nearly the whole stroke, after cut-off has taken place, the governor may still hasten or retard compression, thus decreasing or increasing the area of card.

3rd. The opportunities for regulation will occur more frequently in the high speed engine, just in proportion to its greater rate of revolution in a given time, than a slow speed one. If the slow speed engine makes 80 R. P. M. and the high speed one 250, the latter will have about three chances for regulation to one of the former. Your suggestion that the cranks be placed at 90 degrees will not help the difficulty I think, if a compound engine be used, because in that case a large receiver should be used to equalize the pressure between the high and low pressure cylinders, and, if a sudden increase in work be required, several strokes will elapse before a sufficient pressure will reach the low pressure cylinder to meet the increased load, consequently the engine will lose speed, and for the same reason an increase of speed will take place from a sudden decrease of load.

In regard to the relative economy of high and low speed engines, I believe the difference in steam consumption of the two types of engines has not been accurately determined, and, as the economy of any type of engine depends so much upon the conditions of work, probably it cannot be definitely fixed. It seems, however, to be pretty well established that a long stroke engine, under the best conditions, as to number of expansions to suit the steam pressure, etc., will develop a horse power with less steam than a short stroke one, working under similar conditions, but it is also well known that a long stroke engine is very wasteful under light loads, and, although the high speed engine also will not be as economical under light loads as when working with its best rate of expansion, it is quite certain that it will not be as wasteful relatively, as the long stroke one. This is due to a variety of causes, the discussion of which would require too much space to be treated fully here, but briefly may be stated as due to the variable compression of the single valve high speed engine which tends to equalize the temperature in the cylinder, and, as the power is increased or decreased, both by altering the cut-off and compression, less variation of cut-off takes place for a given change of load. In a high speed engine, a loop in the indicator card showing expansion below the atmosphere is rarely seen, while in a long stroke engine with fixed compression it is very common. From experience the writer believes that in very many cases, particularly for electric railway plants, where the load ranges between wide extremes, the high speed engine is more economical, or rather less wasteful, than the low speed one.

Now, as to the "frequent and expensive repairs of high speed engines," although I think some engineers, through unfortunate experience with high speed engines, are liable to lay more stress on high speed as a course of trouble than it deserves, it is undoubtedly true that very many so called high speed engines have been supplied for electric work which have caused so much annoyance and trouble that it would have paid their purchasers to cast them aside, and substitute the more mature and reliable long stroke engine, with its greater cost for foundations and room, besides a possible loss of power, and wear in counter-shafting and belts, but it must be remembered that the long stroke engine has had a much longer and more favorable chance for development than the more recent high speed machine, which is the natural outcome of the high rotative speeds and limited space frequently available for enormous electric installations; and, because the high speed engine has not at once reached the desired and necessary perfection, I do not see that it should be too hastily condemned. If this course had been followed in other lines of steam engineering, where would the locomotive and marine engine be? (the latter, combining at once the highest economy in steam, and the greatest amount of power, in the most limited space and least possible weight). If past experience may be taken as indicating the future trend in this direction, I think it would be safe to predict that the high speed engine is the coming steam motor.

It may not be out of place to state briefly some of the grounds on which the writer bases his belief that the high speed engine will continue to be improved until it will be used not only on account of its convenience for driving high speed machinery, economy of room and perfection of regulation, which perhaps are the only reasons for its use at present, but, we believe will be brought to such a state of perfection that it will bear favorable comparison with, if not outstrip, its faithful progenitor the long stroke engine, in durability and even economy in fuel. The reasons for this belief may be stated briefly as follows:—It is a well known fact that relative speed is not necessarily an element of either friction or air. If a journal be perfectly true and smooth, and properly and continuously lubricated, it does not matter whether it run at 100 revolutions or 1000. It has been stated by eminent and experienced engineers that perfection in workmanship and lubrication are the only limits to rotative speed, and every mechanic, who is at all acquainted with the history of mechanics, knows that it is more easy to-day to produce a machine that will run without heating and wear at 1000 revolutions, than it was, before the present era of perfection in engine lathes, exact measurements, and journal grinding appliances, to get 100 revolutions satisfactorily. (Many engineers can probably remember engines that it was difficult to hold together at 50 revolutions.)

Just a moment's consideration of the reasons why journals wear and heat—it is because the metals of which they are composed are not completely separated by oil. If they were they could not do either. How is it possible to separate them? Take two surface plates, and put a thin film of oil between them, and see how much weight they will bear, distributed evenly upon the three points of support of the upper one, before the oil will be forced out, and the plate refuses to move. Arrange a continuous supply of oil, and the surfaces will never come in contact. The perfection of surfaces in round journals will give like results. I mean that, if the surfaces are perfect, and the load in proportion to the size of journal, it will never wear, if continuously and sufficiently lubricated, no matter what the speed or movement. The wear and consequent heating will always be in proportion to the imperfection of surfaces or lubrication, and, if either of these is imperfect, then increase of speed will increase the rate of destruction. If the journals are simply turned in a lathe, the unevenness of the metal, springing of the tool, and heating, will cause the surface to be lumpy and irregular; filing will only tend to smooth it without making it round. These lumps on a journal project through the oil, resting on the metal of the box, and will continue to wear until they wear below other portions of the surface, when some other place takes the wear, and so on. This defect may be remedied in round bearings by careful grinding operations, and flat surfaces may be made true by scraping to surface plate; both of these operations are now well understood, and constantly practiced in the best machine shops. Springing of the shaft or frame of the engine, or insufficient bearing surface, is the result of imperfect design, and may also cause heating and wear.

The high speed engine is in itself such a simple and apparently harmless affair, that many manufacturers, engaged in other lines of machine work, perhaps slow speed engines, not requiring such special attention to the perfection of wearing surfaces, have been tempted to copy somebody's high speed engine, or originate one of their own, and have found to their sorrow that it was a much more troublesome business, both for themselves and their customers, than they anticipated, and as a result have cursed speed as the cause of all their woes, and have led others to do the same, when the trouble lay not in the nasty little engine, but in their not understanding the business. However, although high speed engines are built which are anything but nasty, and are a credit to the preseverance and skill of their designers and builders, there is still room for improvement in the way of overcoming the twisting and vibration of parts, more simple and perfect lubrication, reliable oiling devices, and economy of steam, but who will doubt that the same skill and ingenuity which has made it possible to produce good watches by machinery, and to construct engines which will develop thousands of horse power economically for days and nights without pause, in the cramped up hold of a ship, will likewise evolve an engine for electric work, which will at the same time have high rotative speed, good regulation, durability, and highest steam economy. Any engineer who has visited the Chicago Fair must have realized that rapid strides are being made in this direction, and that this result will be attained unless something intervenes to throw the steam engine out of the race entirely.

D. W. ROBB.

SUNDRY NOTES ON HEAT. *

By CHAS. HEAL.

I lay no claim to originality in this paper, the matter having been gleaned from time to time from standard works and papers, and memorized or recorded in my note books. The object of the paper is not to settle any theoretical tangle, but to create discussion. Further, I wish you to understand that I am not here as a teacher, only as a learner, and I hope the members will give all the aid in their power either by reading a paper or giving their experience on any matter appertaining to steam, electricity or kindred subjects. There is no such thing as knowing it all, the most diligent only learns what he can, and that learning continues through life to those that desire to work near the top. With these few preparatory remarks, I will now proceed with the paper.

The object of the study of steam and its application is to obtain the greatest possible amount of work with the least possible expenditure of fuel, and in order to arrive at a correct understanding of the principles which underlie the economical production and use of steam, we must study, among other subjects, the nature and effects of heat. And here a difficulty meets us which we cannot altogether overcome, which is to define what heat really is; it is however so familiar to us in the effects it produces on our bodies and on objects around us, that we need not be deterred in our enquiries from our inability to solve the question.

The chief physical source of heat which we enjoy is the sun, which, although situated at such a great distance, warms the earth with its rays. Of this source nothing is known. In addition to this external heat we have an internal source known as terrestrial heat; this heat is very great, and it is computed by scientists that at the depth of a few miles it is capable of melting the most refractory substances. Though we are mainly dependent on these sources for maintaining our temperature, there are mechanical and chemical sources which are of great importance to us, the most important being chemical action. Nearly all chemical combinations are attended with the production of a greater or less degree of heat, and it is the chemical combination termed "combustion" which we as engineers are mostly interested in. I will not touch directly on the subject of combustion as that will be dealt with in a separate paper.

The temperature of a body indicates how hot or how cold it is, and should be distinguished from the quantity of heat in that body; for example if a cup of water be taken from a vessel the temperature is the same, but the quantity of heat varies as the weight in each vessel, the temperature or intensity being measured by the thermometer, but the quantity of heat is the temperature multiplied by the weight in pounds.

The specific heat of bodies varies considerably, water being the highest of any (except hydrogen) it being the standard and considered as 1, while that of iron for instance is ·113=1/9, so that the quantity of heat that would raise one pound of iron through 9 degrees would only raise one pound of water through one degree. These properties are taken advantage of by the engineer to ascertain approximately the temperature of bodies beyond the range of the ordinary thermometer—the uptake of a boiler for instance. Nearly all bodies expand by the action of heat, and the mechanic and engineer have ever to keep in view this fact or disaster is the result. For instance, cracked boiler fronts and settings, broken steam pipes and leaky joints. At the same time this property is daily utilized in our workshops; cranks and pins are secured, locomotive tires shrunk on and many defects made good by the judicious application of heat.

The transfer of heat from one body to another may take place in any of the following ways: radiation, conduction or convection. Heat is given off from hot bodies in rays which radiate in all directions in straight lines; this is the process of radiation. Conduction is the process by which heat passes from hotter to colder bodies by contact. The conducting power of bodies varies considerably. Iron and copper are good conductors; wood and some mineral substances are bad ones. The engineer uses good conductors to transfer the heat from the furnace to the water in the boiler, and the poor ones to prevent loss of heat by radiation from steam pipes, cylinders, etc. Convection or carried heat is that which is transmitted from one point to another by currents; the freer and more direct the currents the more readily is the heat transmitted; steam boilers should be so constructed as to secure a free circulation of the water.

Before quantities of heat can be measured, we must have an unit of heat, just as we require an unit of weight or length as the pound or foot; and the unit of heat is the quantity required to raise one pound of water through one degree Fah. But the all important point with the engineer is the conversion of heat into work; we will therefore consider the relations between the two. By the term "work," is understood the overcoming of a resistance through space, and the amount of work done is measured by the resistance in pounds overcome, multiplied by the distance through which it is overcome in feet; thus if seven pounds be lifted through ten feet, 7 × 10=70 foot pounds. Thus it will be seen that work is not measured by the pound or foot, but by the product of the two, and the unit of work is the lifting of one pound through a vertical height of one foot, and is termed the foot pound. It will also be noticed that the unit of work has no reference to the time taken, as the same amount of work is done whether it takes one second or one hour. The power of an agent is measured by the rate it can do work, and is represented by the lifting of 33,000 pounds one foot high in one minute. In the case of pumping engines, the work done is measured by the foot pound, and is termed "duty" per pound of coal.

We will now consider the effect of heat in producing a change of state in different bodies, as ice, water and steam. The temperature of a body ceases to rise while it is melting. An illustration of this fact may be obtained in this way take equal weights of water at 32 degrees and 174 degrees, and mix, the temperature of the mixture will be the mean of the two, 103 degrees. Now take equal weights of ice at 32 degrees and water at 174 degrees and mix as before, the temperature will be only 32 degrees instead of 103 degrees, all the ice however will be melted The 142 degrees of heat have evidently been consumed in melting the ice and are now latent in the water, as this heat would require to be given off again befor the water could be transformed into ice. Were it noted for this provision, as soon as a body of water had sunk to 32 degrees, it would immediately become a mass of ice. A simple experiment which may easily be tried will enable any one to determine exactly the quantity of heat which becomes latent when ice is converted into water or water into steam Procure a uniform source of heat, and place a pound of water over it to ascertain the exact amount its temperature rises in a given time. Assume it rises 10 degrees in one minute; now remove and place one pound of ice at a temperature below 32 degrees, the temperature will rise to 32 degrees and remain at that point until all the ice is melted, which will be in about 14 minutes Now in this time the amount of heat would have raised one pound of water 10 degrees × 14 minutes = 140 degrees—but the water is only 32 degrees—then the 140 degrees have been rendered latent Continue the heat, and in 18 minutes it will have attained the boiling point 10 × 18 + 32 = 212 degrees. Still continue the heat, and in 95 minutes, or about 5⅓ times as long as it took to raise it from 32 degrees to 212 degrees, it will have all boiled away, and yet the temperature of the steam has at no time exceeded 212 degrees. All this heat, nearly 1000 degrees, has been rendered latent. It is this large amount of latent heat in steam that renders it so useful as a heating agent, and were it not for this property the moment water attained the boiling point would be one of extreme danger, as it would be immediately converted into steam with an explosive force akin to gunpowder

I will continue this subject at a future meeting, and also internal and external work of steam and rejected heat.

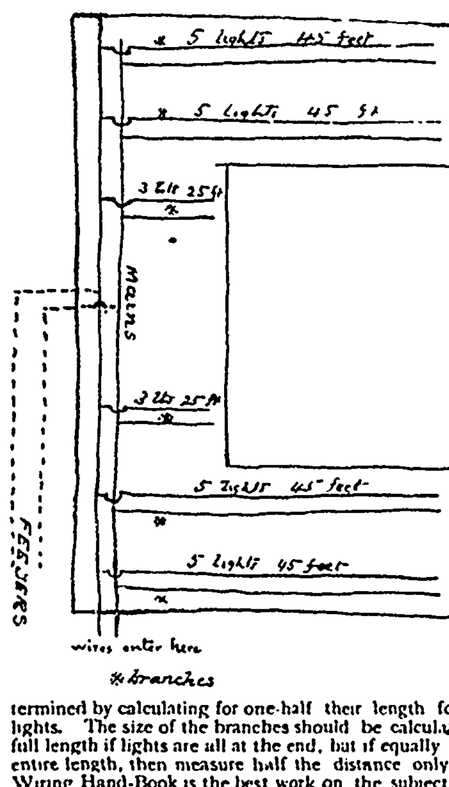
* Paper read before Toronto Association No. 1, C.A.S.E.

QUESTIONS AND ANSWERS.

Mr. A. H. M., Morrisburgh, Ont., writes We are using a Leonard Ball engine and a boiler 54 in. diameter (74 flues 2⅜ in.), length of boiler 14 ft., length of grates now in use for wood or sawdust, 5 feet = width of fire place 3 ft. 6 in., and would like to get some information to burn soft steam coal, and what span there should be between grates and boiler, and the best grate to burn soft steam coal. Have plenty of draft for to burn coal or wood, saw-dust, &c., without any trouble. Any information you can give me will be gladly received.

ANS.—To burn soft coal under boiler described the grate bars might be placed 20 inches or 22 inches from the bottom of the boiler. Make grates about 4½ feet long and furnace from 3½ to 4 feet wide. The common grate bar about ⅞ of an inch thick at top and with ¾ inch air spaces between, answers well if coal is not too small. A flat bar with slots across it making ribs about ½ in. thick and air spaces ¼ in. is used for small coal. There should be a dead plate between furnace door and front end bars and a brick bridge wall at back end built up to within eight inches of bottom of boiler.

"Subscriber," London, Ont., writes Will you kindly inform me through the NEWS the proper way of determining the size of feed wire for the case shown in the accompanying diagram? In order to ascertain the number of C. M.'s should the distance be taken from the far end of furthest branch, or simply to where the last branch connects with the feeder? What is the title of the best book you know of on incandescent wiring, and where is it to be had?



ANS.—In the first place the main wires shown on sketch are not "feeders," but "mains" The proper way to distribute current for lighting this number of lights and distributed as they are, is by running a set of feed wires or feeders to the centre of the mains (as indicated by dotted lines and marginal references). The size of such feeders will vary according to the voltage of the lamps being lighted. The size of the mains can be determined by calculating for one-half their length for half the number of lights. The size of the branches should be calculated by measuring their full length if lights are all at the end, but if equally distributed along their entire length, then measure half the distance only. Badt's Incandescent Wiring Hand-Book is the best work on the subject of wiring. It may be obtained at this office. Price, $1.00.

T. O'Connor, Durham, Ont., writes: Kindly give me a receipt for a good leather belt cement.

ANS.—Fish glue, or a good quality of common glue.

CANADIAN ELECTRICAL NEWS AND STEAM ENGINEERING JOURNAL

PUBLISHED ON THE FIRST OF EVERY MONTH BY

CHAS. H. MORTIMER,

OFFICE: CONFEDERATION LIFE BUILDING,

Corner Yonge and Richmond Streets,

TORONTO, - - CANADA.

Telephone 2362.

64 TEMPLE BUILDING. · MONTREAL.

Bell Telephone 2299.

THE "CANADIAN ELECTRICAL NEWS" HAS BEEN APPOINTED THE OFFICIAL PAPER OF THE CANADIAN ELECTRICAL ASSOCIATION.

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WE publish in the present issue two papers read before the Montreal Electric Club, which has resumed its meetings with a membership of about 25, and with every indication of a continuance of the interest which has marked its meetings and history in the past. We believe that the material is available in Toronto and in several other of the larger cities throughout Canada for the establishment of Clubs of similar character, and we hope to see steps taken in this direction. In Toronto the matter is already being discussed amongst those interested in electrical matters, and if some one will take the initiative, there is no reason why a Clubs hould not be at once formed and hold meetings at regular intervals throughout the winter. As we have previously pointed out, the formation of such local Clubs would have a tendency to greatly increase the interest in electrical matters, and should also tend to strengthen the membership of the Canadian Electrical Association.

IN his address to the students and friends of the Toronto Technical School, at the recent opening ceremonies of that institution, Prof. Galbraith warned the students against fancying that there was much money to be easily made by working with electricity. He said: "It is a wrong idea to say that the time will soon come when men will disregard the steam engine and devote their attention entirely to developing turbines and water power. If it is possible to carry electricity long distances it will have the effect of developing water power, but will also do away with small steam plants and encourage the growth of large steam plants near coal mines and oil and gas engines near oil and gas wells. Consequently it is necessary for students in a technical school to study not simply the conveyance of power in the form of electricity, but also steam, heat, thermo-dynamics and chemistry. Chemistry is most closely involved in all applications of power. It is wrong to run off in one line because it happens to be popular. All branches must be carried out side by side. I think myself that the steam engine has reached a very high state of perfection. It is one of the most perfect examples of the development of machinery. Electricity is simply the means of conveying the power developed by engines and cannot take their place. Anyone who understands these engines will always have as good a chance as the electrician." These opinions, it will be noticed, coincide to a large extent with those expressed by several members of the Canadian Electrical Association in the discussion which took place at the recent convention on Mr. Merrill's paper on "The Education of the Electrical Engineer," and are without doubt well-founded.

IT is often the case that parties as well as individuals, have reason to wish to be saved from their friends. This is true at the present time of the opponents of Sunday street cars, to whom, after the amount of effort made a month or two ago to prevent the running of cars on Sunday in Toronto, it must have been a matter of great annoyance to observe two or three Hamilton clergymen going with a petition to the street railway company of that city, praying for the inauguration of a Sunday service. We observe that the Ministerial Association has since unanimously repudiated the action of these gentlemen. It appears that a selfish motive was behind the action, there having been a falling off in the receipts of one or two of the churches lately, as compared with the time when a limited Sunday street car service was in operation. In a city covering so small an area as Hamilton, there does not appear to be any pressing necessity for Sunday cars. Evidently the street railway company do not see much profit in the undertaking as they decline to establish a Sunday service unless a bonus sufficient to cover expenses is promised. This is in striking contrast to the action of the Toronto Railway Company who in view of the certainty of a large addition to their receipts, were so anxious to have Sunday cars established, that they willingly undertook to pay the cost of submitting the question to a vote of the citizens.

THE electric companies of Toronto are brought face to face with a difficulty which threatens to make serious inroads upon their profits, if indeed it does not in some instances wipe them out altogether. We refer to the action of the city assessment department in placing an assessment for the first time this year on the plant of these companies. In the case of the Toronto Electric Light Company, this assessment amounts to about $300,000, and calls for the payment of $7,000 yearly in taxes, or about one fifth of the company's total income. It is not difficult to realize what a tremendous burden this would be on almost any class of business, and on none perhaps would it fall more heavily than on electric lighting companies, as it is a well known fact to all who are familiar with the conditions, that excessive competition has reduced the profits of the business to a minimum. Electric lighting companies are under contract with the municipalities to furnish light at a certain fixed price for a definite number of years, and therefore it will be impossible for them to make good their loss by increasing prices, at least so far as street lighting is concerned. Even were this not the case they are obliged in many instances to maintain a price which will compete with gas. A most serious injustice with which the electric companies have to contend in competition with gas companies is, that under the assessment law the underground mains of the gas companies are exempt from taxation. Thus even in cases where, as in that of the Incandescent Light Company, of Toronto, the distribution of current is done by means of underground conduits, the electric light company's mains will be taxed while those of the gas company's will escape assessment. In a variety of ways therefore the electric companies are placed at a serious disadvantage, and unless in some way they can be relieved of this latest burden their already slender profits will as already stated in many instances be wiped out altogether. Another hardship is, that there is but one appeal from the decision of the Court of Revision, viz., to the county judge, whose decision is final. Should the efforts which will be made by the electric companies in Toronto to be relieved of this method of assessment, prove unavailing, then a united effort on the part of all the electrical companies of the province should be made at the next session of the Ontario Legislature to have the matter remedied.

THE very rapid progress that has been made during the past year in alternating current motors seems to make it clear that this method of utilizing the electric current for the supply of power, will be the one most used in the near future. Particularly will this apply to operating street railway motors. By means of it one of the most expensive features of the operation of these motors by the present direct current system will be entirely done away with, that is the use of a commutator on the motor. It is a well known fact that the frequent turning down of and the occasional renewal of the commutators is quite an item in the operating expenses of the present system. We do not wish to be understood as referring to the many two-phase or tri-phase, or poly-phase motors that are from time to time announced as being the only successful ones, our reference being to the single phase motor only as being the coming one for this use. There are now on the market stationary motors of this type operating as high as 10 or 12 horse power which we are informed are perfectly practical machines and which give an efficiency of from 70 to 80%, being self starters, and in every way the equal of direct current motors of the same size. It would seem then that it should only be a short step to applying them for the purposes mentioned above, particularly as no change in supplying the current to them would be required other than the putting up of a few circuits and mains to supply them with current. In fact there are various ways in which it would prove considerably superior to the present method; the opposite side of the converter could then be connected directly to the rails, making a much easier path for the return current than as now used. The current now has to traverse miles of poorly bonded rails or else find its way into the ground by way of water and gas pipes, causing in consequence any amount of annoyance to the companies or corporations who have the good keeping of these in their charge. With the present system this is becoming quite a serious matter indeed, one in fact which electrical engineers and scientists generally are doing their utmost to overcome, and so far with little result. Our opinion still is that the proper grounding of the rails will almost if not entirely remove the trouble. There would be absolutely none of this with the alternating current, particularly if it was returned to a converter every few hundred feet, as it would be if this system was being used. The trolley wire could then be one continuous wire as at present and the converters connected in multiple with it and the rails; or the trolley wire could be divided into sections with an insulating device of some kind between. Each converter would then be operating its own section entirely, and when there were no cars on it, its consumption of current would be next to nothing. For operating stationary motors of this type it would only be necessary to put a converter of sufficient capacity on the ordinary lighting mains; a separate system of power supply would then be unnecessary. Another point about the alternating system for street railway use would be that a current of primary wires and could be reduced to an absolutely safe one high voltage, say 2000 or 3000 volts, could be used on the for the working of the motors. This is a point of considerable importance, and one which would make the handling of either the wires or the motor even safer than under present methods. The possibility of underground trolley or contact wires would also be much simplified. The voltage could be kept so low on the trolley or contact wires as to almost preclude any possibility of its jumping its insulators in wet weather and thereby crippling the entire system for a short period, this trouble being one of the principal ones in underground systems that use a direct current of 500 or more volts. The only drawback at the present time to the adoption of stationary motors of this type is their very high price as compared with direct current motors. That is a matter which will right itself and very shortly if the demand can but be created for them and they become universally used.

NOTES FOR ENGINEERS.

A boiler feeding apparatus forms one of the most important attachment to a steam boiler. Whether a pump or injector be used there should always be at least two methods of getting water into the boiler while steam is up, and both should be in order, so that if one should suddenly fail, the other may be used before water has got too low in the boiler.

The injector in some of its many forms, is probably the most convenient style of boiler feeder. It is convenient, because with even a low pressure of steam it can be started to work and made to feed water into a boiler or into a tank. Steam from a low pressure boiler may be used to pump water into a boiler carrying a high pressure. The injector may be set to work without having to start an engine, or to run any shafting. For these reasons it is convenient, but let any one compare the cost of running one as compared with a pump, and it will be found that the injector uses far more steam. The injector is virtually a steam engine, in which the steam acts upon a water piston. It is the simplest form of engine, but probably the most expensive for fuel.

A steam pump if well arranged can be made as convenient as the injector, especially for large plants where there are many boilers, and will be found to be much more economical.

An ordinary plunger pump driven by shafting from the main engine of the factory is the most economical boiler feeder. Its advantage is, that it can only be used when main engine is running.

A good plan is to have a plunger pump driven by main engine for regular use when factory is running, and to have a steam pump or an injector for times when engine is standing.

If the feed water is hot, an injector will be found unreliable, as the water coming to injector must be cold enough to at once condense the steam.

If the pump is to be supplied with hot water, it must be placed at a lower level than the tank from which the hot water is supplied. A pump cannot lift hot water by suction, because as a vacuum is formed in the pump barrel, the pressure of the atmosphere is removed from the surface of the water in the suction pipe, and boiling takes place, and the pump barrel is filled with vapour. By putting the pump down lower than the tank, the water will flow into the pump.

Water at the atmospheric pressure boils at 212 degrees, but if the pressure is increased it will not boil till the temperature is much higher. If however, the pressure be reduced, and a partial vacuum formed, boiling and evaporation will take place at a much lower temperature.

* * *

In the transmission and diffusion of heat, three distinct processes are known, possibly there may be others: *Conduction* is the passage of heat from a hotter to a cooler portion of the same body. *Convection* is the term used to convey the idea that a hot body is put in motion and carries the heat with it. A current of hot water inside of a tank or boiler may be started by application of heat to one part of the tank, and by convection the whole of of the water will in time become heated. *Radiation.*—This term implies that a hot body loses heat and a cooler one absorbs it, while the air or other medium between the bodies is not heated by the transmission of heat from the one body to the other. It is by radiation that the heat from the sun reaches us. It passes through millions of miles of space, the temperature of which is estimated to be much lower than the lowest ever produced on the earth. The sun's rays do not seem to produce heat till their motion is stopped. Hence on a bright winter day, the sun shining into a room through a clean window, will raise the temperature upon which it shines, but it will not heat up the glass of the window nor the air in the room. The air by coming in contact with the heated carpet will absorb heat by a kind of conduction, and by convection will convey it to the other parts of the room.

TORONTO TECHNICAL SCHOOL.

LATE in the fall of 1891 the City Council passed a by-law establishing the Toronto Technical School, providing the means and appointing a Board, giving them full powers to obtain a building and equipment, to select a staff of teachers and to draw up a scheme whereby might be placed within the reach of mechanics and artisans and the employed of the city generally, the means of acquiring those elements of an education which would be of most value to them in the pursuit of their various avocations.

The preliminaries were attended to by the Board, but it was well on in January before the school could be opened. They had succeeded in securing for temporary use the building formerly occupied as Wycliffe College, on the north side of College street at the head of McCaul. It needed some refitting. From the start the school was well attended. The work of the first term was naturally to a great extent experimental, though by considering the special needs of the students and comparing the work done at various similar schools abroad, a programme was followed out which has not had to be materially altered excepting in the way of enlarging upon it and co-ordinating more thoroughly the different parts. This term extended to the first of May. Classes met five nights a week between eight and ten o'clock each night.

In October, 1892, the school re-opened, and again with a good attendance. This was expected to be the trying year. It was thought that the novelty of the appearance of this institution in Toronto might accounted for the good attendance during the opening term. If it tided over this year it would indicate that such a school could be of use. The register went up during the year to over three hundred and thirty, more than realizing the hopes of its most sanguine supporters. The school continued to thrive, though in cramped quarters, and with temporarily equipped class rooms. The students meant business, they came to learn, and the teaching staff worked with a will. The results were most satisfactory.

Again at the beginning of last month the school re-opened. The classes were crowded from the very start. As compared with a similar period last year the attendance this year has been multiplied by four. In the first week last year somewhat over 100 were registered, in the first week this year four hundred and fifty, and at the end of the second week five hundred and fifty were registered.

It is no longer a question whether there is room for such a school in Toronto. The experimental stage is past. It has come to stay. It is now for the city to show its appreciation of the value of such a school for the education of its mechanics and artisans by assisting it in its development, by providing it with more commodious quarters, and when necessary, by increase of staff or equipment. The sooner it is provided with better accommodations the better will be the results accomplished. It is now in a building greatly inadequate for the purpose. Why should not steps be taken at once to acquire for it better and permanent quarters? As long as it is cramped for room, and unable to separate the different grades and classes of work in the draughting room, as long as some of the elementary classes are three or four times their proper size, as long as chemistry, hydrostatics, light, heat, sound, electricity and electrical testing and laboratory work wait their turn in one small room, so long will the school be unable to accomplish the work that is evidently cut out for it in this city.

The ground at present covered by the course is comprised under the following heads. Mathematics (including arithmetic, algebra, Euclid and trigonometry), draughting (including practical mechanical, architectural and geometrical drawing and copying, as well as classes in practical geometry, orthographic and oblique projection, perspective, etc.); mechanics (including statics, kinematics and dynamics), physics (including hydrostatics, heat, sound, light and electricity and magnetism), and chemistry (inorganic). There are two classes, a junior and a senior, in algebra, Euclid, mechanics, draughting and descriptive geometry, electricity and chemistry. The junior course in electricity is a course of lectures which deal with the elementary principles and their practical applications, while the senior work will be to a great extent laboratory work, and will give the student the opportunity of becoming familiar with the ordinary relations between potential current and resistance by the individual use of the measuring instruments in various practical tests. The running conditions of generators and motors will also form a considerable part of the work.

The students in chemistry also have the opportunity of doing practical work in a chemical laboratory which has lately been fitted up for the purpose.

While the course as outlined is as extensive as can be expected under the present conditions, there are still channels along which it might be still further developed—even while keeping along the same general lines—which would be of great benefit to a considerable number of students. Some of these extensions have already been proposed, but cannot be carried out for lack of accommodations. Classes in decorative design, freehand drawing, etc., have often been asked for. There are a number of subjects that would be of value to engineers and mechanics, such as the working principles of the steam engine, the testing of materials for strength, etc, foundry and machine shop principles, etc., etc. Other extensions would suggest themselves if the school were allowed to develop freely.

The Toronto Technical School has started well, and we hope to see it continue to prosper. We are satisfied that the city which has generously supplied it during its earlier days when its existence was an experiment, will not now allow it to stop short of its full possibilities.

A VISIT TO THE CANADIAN GENERAL ELECTRIC COMPANY'S FACTORIES.

By invitation of the Canadian General Electric Company, a number of gentlemen prominent in electrical and business circles in Toronto and elsewhere, visited Peterboro', on Wednesday the 11th of October, and inspected the Company's works in that town. Among those who took part in the visit were: W. R. Brock, President; H. P. Dwight, First Vice-President; Frederic Nicholls, Second Vice-President and Managing Director; Robert Jaffray, J. K. Kerr, Q. C., W. D. Matthews, Hugh Ryan, Directors; W. S. Andrews, Comptroller, and the following guests:—T. Sutherland Stayner, President of the Bristol & West of England Loan Co.; Wm. McKenzie, President of the Toronto Railway Company; G. H. Campbell, Manager Winnipeg Electric Railway; Thos. Long, J. J. Wright, Manager Toronto Electric Light Company, Henry Lowndes; James Hedley, *Monetary Times*; W. J. Baines; E. A. Wills, Secretar Board of Trade; D. Creighton, the *Empire*; John F. Ellis, Managing Director Manufacturers' Life Insurance Co.; James Marwick, Westminster & Vancouver Tramway Co., Vancouver; W. R. Strickland, W. L. Symons, A. P. Poussette, Secretary Peterboro' Street Railway Co.; A. B. Smith, Superintendent Construction Great Northwestern Telegraph Co.; R. W. Ryan and John Taylor.

The factories consist of three brick and iron buildings, each 272 feet long and 80 feet wide, designated respectively the "Machine Shop," the "Compound Shop" and the "Wire Department." The site of these factories is 30 acres in extent, and switches from both the Grand Trunk and Canadian Pacific Railways have been built right into the yards thus affording facility for prompt and easy shipment.

These factories are thoroughly equipped with the latest improved machinery for the manufacture of the largest as well as the smallest devices and articles used in the electrical business. The machinery plant is operated by electric motors, the power for which is supplied from a 250 horse power triple expansion engine and boiler. The company were very much pleased and instructed by their visit. After having gone through the various departments of the works, they were carried by the newly completed electric street railway to the Oriental Hotel, where luncheon had been provided for them, and where they were joined by Messrs. James Stevenson, M. P., James Stratton, M. P. P., Mayor Kendry, members of the Town Council and prominent citizens. The party were next taken in charge by members of the town council, and shown the various points of interest, after which they re-embarked for Toronto.

THE HEAT UNIT.*

BY WM. NORRIS.

The object of this paper is to show the value of heat to actual work. I do not pretend to say that what is contained herein is by any means all that could be said on this very important subject. The part I wish to call your attention to, is that portion of the heat which is very often thrown away in the form of exhaust steam, and to impress upon the minds of my fellow engineers the great importance of securing a perfect understanding of principles.

I only intend to trace the heat from the time it enters the cylinder of a steam engine until it is exhausted into the atmosphere.

In the first place it would be as well to see what heat really is. It has been found by scientific reasoning that heat is the manifestation of motion in matter. Heat may be termed the foundation of power, or power itself, and heat is also life. Heat can be measured, and the standard of that measurement is called the heat unit. One heat unit is that portion of heat which will raise one pound of water one degree Fah., while in mechanical work one heat unit is equal to 772 foot pounds—that is, one unit is capable of lifting 772 lbs. one foot high, or in any other direction one foot, or one lb. 772 feet. Although heat is so powerful, yet a very small portion of it can be utilized for work, as will be seen before the end of this paper is reached.

The mechanical work performed by heat can only be produced by means of other substances, such as gas, air, water, steam, etc.; but in my opinion there can and will be more mechanical work produced from the heat stored up in carbon, than there is at the present day.

Heat may be expressed in two forms, namely, sensible heat and latent heat. Sensible heat is that portion of heat that can be felt or measured by means of a thermometer; while latent heat is that portion required to overcome the cohesive force of the water and raise it in temperature sufficient to overcome the pressure of the atmosphere. To convert one pound of water into steam at atmospheric pressure, from a temperature of 32 degrees, would require 1,146 units. Now the sensible heat of steam at that pressure would be 212 degrees, while that of latent heat is 966 degrees. If we were able to utilize all the heat stored up in one pound of carbon, which under perfect combustion contains 14,500 units of heat, we would be able to convert 12.65 pounds of water from a temperature of 32 degrees into steam at the pressure of the atmosphere. But in practice we come far short of that, for the common evaporative capacity of 14,500 heat units is from 6 to 9 pounds of water, although under most favorable circumstances better results might be obtained. I will not be able to deal with that part of the subject in this paper. However, we will suppose that 9 pounds of water is being evaporated for each pound of carbon containing 14,500 heat units, from a temperature of 32 degrees into steam at the pressure of the atmosphere. We would then lose 3871 heat units for each pound of carbon consumed. No work could be produced with steam at that pressure unless in a condensing engine and then with an energy of from 10 to 12 pounds per square inch.

Supposing we were using in a steam engine steam at 90 pounds pressure above that of the atmosphere, which would be 105 pounds per square inch absolute pressure, we would require an increase in temperature of 121 degrees of sensible heat, while that of latent heat would be decreased to 879.7 degrees, for as the pressure increases so does the sensible heat, but not in the same proportion as the latent heat decreases. Hence the total heat units required to convert 1 pound of water from 32 degrees into steam at 90 pounds per square inch, would be 1,181.

In the process of expansion we have given up 333 degrees of sensible heat, and discharged that steam at the pressure of the atmosphere, which is 212 degrees. So we have only used for work 121 degrees. We had a total of 1213 degrees and we have only used 121 degrees. So that nearly 90 per cent. of the heat entering the cylinder is thrown away unless used for other purposes. We have only used 121 degrees, while having lost 1060. So in this case only one tenth of the heat entering the cylinder would be utilized for work.

We will now take an engine of the following size, from which I will endeavor to show as nearly as possible the amount of lost heat in a given space of time under the conditions mentioned.

The diameter of cylinder is 20 inches; length of stroke 36 inches, number of revolutions per minute, 80; average pressure of steam throughout the stroke, 45 pounds per square inch; boiler pressure 90 pounds per square inch.

In one minute the cylinder has emptied itself 160 times. The temperature of the steam at 90 pounds pressure is 333 degrees of sensible heat, and in the process of expansion it gives up 121 degrees of its sensible heat each time it empties itself; then it would give up 19360 degrees in one minute.

Again, during the process of expansion there is considerable loss caused by condensation which is not the same in all engines, as it is greatly reduced when the cylinder is covered with a good non-conductor of heat. But in order that the exact amount of condensation caused by cooling of the cylinder walls and conducting the heat of the steam to the outside and by the expansion of the steam lowering the temperature and pressure, thus causing it to become saturated, special means must be applied.

With the engine in question we will assume that the loss by condensation is 10 per cent. A cylinder of this size and rate of piston travel would require 1047 cubic feet of steam per minute, and as there is 10% loss by condensation, it is necessary to add that amount to the total if we wish to ascertain the amount of water that is passing through the cylinder in one minute. So then we have 1151.9 cubic feet of steam used in one minute, and as there are 3.7 cubic inches of water in one cubic foot of steam at a pressure of 45 pounds per square inch, we would have 2.46 cubic feet of water evaporated in one minute, the weight of which would be 153.75 pounds. As we have found as nearly as possible the number of pounds of water used in one minute, we will proceed by the same method to find the number of heat units required to evaporate that amount into steam at a pressure of 45 pounds per square inch.

To convert one pound of water into steam at a pressure of 45 pounds per square inch from a temperature of 32 degrees, we would require 1.171 units of heat. Hence we have a total of 180,041 heat units per minute. But the steam when entering the cylinder had a pressure of 90 pounds per square inch, and with a temperature of 333 degrees of sensible heat, and we have utilized for work 121 degrees, then we have 19360 degrees that have performed work; subtract that amount from the total heat units per minute, and we have 160,681 units thrown away, unless used for other purposes, thus showing the great necessity of making use of the exhaust steam or the employment of a condensing engine. But before a decision of this sort can be arrived at, there are a great many things to be taken into consideration. I do not, however, intend to dwell on that feature of the subject.

As will be seen from the foregoing, the object of this paper is to show the amount of heat thrown away when an engine is exhausting into the open air. It is very seldom they exhaust with so little back pressure as I have allowed in this case, there would not otherwise have been such a good showing as is here made because had there been more back pressure the steam when exhausted would have been of a higher temperature; but I am allowing that the engine is doing its best. The average pressure of steam you will notice to be also in excess. What I wish to do is to bring as much of the heat as possible thrown away into practical use, such as heating buildings, etc. In heating buildings there are a great many things to be taken into consideration, especially when a system is to be calculated and laid out for heating with steam.

There are two methods of heating buildings, the direct and the indirect. The direct method consists of pipes in the room which heat the air already in the room, while the indirect method is the air heated in a separate chamber and conveyed by pipes to the room to be heated. The direct method is what we will now deal with, it being used mostly in mills. It consists usually of pipes around the wall near the floor. Where there are belts to circulate the air, the pipes are placed overhead. All buildings cannot be heated alike; for instance wooden buildings require more heating surface than stone, and stone more than brick. Then the size, location and character of construction of the building must be taken into consideration. Where a large number of windows is employed, more heating surface will be required. A long narrow room requires more heating surface than a square room of equal area.

The following figures are sometimes used for a general estimate, but good judgment must be exercised when these figures are to be employed: For heating dwellings from 40 to 50 cubic feet of air space to one square foot of heating surface, to heat to 70 degrees from an outside temperature of zero and low pressure steam. For large stores, 125 cubic feet of air space for one square foot of heating surface. Small stores, 100 cubic feet air space for one square foot of heating surface. Hotels, 125 cubic feet air space for one square foot heating surface. Churches, 200 cubic feet of air space for one square foot heating surface.

The rule I will make my calculations upon can be applied to condition and will give more direct results. The amount of exposed surface, the desired temperature of the room, the temperature of the outside air, the temperature of the steam with which the room is to be heated are all concerned.

It has been found by careful experiments that one square foot of wall space will transmit from 70 to 1.25 units of heat per hour for every degree difference in temperature between the inside and the outside, the difference being caused by the action of the wind. In order to ascertain the amount of heat that will be transmitted through one square foot of wall space it will be well to take the lowest probable outside temperature and the highest transmitting capacity of the wall. Then from the desired temperature of the room subtract the lowest probable outside temperature and multiply the remainder by 1.25. This will give the number of heat units transmitted by each square foot of wall space for the space of one hour, multiply that amount by the area of the wall exposed in square feet, and the result will be the total heat units for one hour.

To find the heating surface we proceed as follows:—From the temperature of the steam subtract the temperature of the room; square the difference and divide by 100, which will give the number of heat units for each square foot of heating surface. Divide that into the total heat units required, and the quotient will be the number of square feet of heating surface for that pressure of steam. A three foot length of one inch pipe equals one square foot of heating surface. When a whole building is to be calculated the roof must also be included. All steam pipes act as heating surface. The diameter of the main in inches should be one-tenth the square root of the heating surface in square feet. It is as well to use one inch pipes for heating with live steam. For heating with exhaust steam two inch pipes are preferable. Return pipes should never be less than three-fourths the size of the mains.

In this paper we have been dealing with an engine from which we have got 158,606 heat units per minute, or 9,516,360 heat units per hour, after ten per cent. has been allowed for loss by condensation.

In concluding this paper it will be as well to read the results from beginning to end; also the working out of the rules, in order that the paper may be plainly understood. In the first place it required 1.146 heat units to raise the temperature of one pound of water to 212 degrees sensible heat, while that of latent heat is 966 degrees.

Steam at 90 pounds pressure requires 1181 units of heat for each pound of water from a temperature of 32 degrees, the sensible heat of steam at 90 pounds per square inch being 333 degrees and that of latent heat 879.7 degrees. The difference in temperature of steam at the pressure of the atmosphere and 90 pounds per square inch is 121 degrees.

When 9 pounds of water are being evaporated for each pound of carbon containing 14,500 heat units, only 315 units would be required to raise it from the pressure of the atmosphere to 90 pounds per square inch, and 10314 units to the pressure of the atmosphere. There would be 3871 heat units lost for every pound of carbon containing 14,500 units, and only 10 per cent. of the heat entering the cylinder would be utilized for work. The area of the cylinder was 314 square inches, number of cubic feet of steam for one minute 1047.2, while the total with 10% of condensed steam added, is 1151 cubic feet.

The number of cubic inches of water per minute was 4258.7. Number of cubic feet of water was 2.46. Number pounds of water 153.75. Number heat units required to convert one pound of water from a temperature of 32 degrees into steam at 45 pounds per square inch is 1171 degrees. Total heat units for that many pounds of water is 180,041 degrees.

There are 158,666 heat units carried away with the steam per minute, or 9,516,360 units per hour. The desired temperature of the room is 70 degrees. The temperature of the steam is 212°. The difference in temperature between the heat of the steam and the heat of the room is 142 degrees.

Number of heat units that one square foot of wall space will transmit per hour is 87.5. The total number of heat units that can be used for heating purposes is 1,179,168 degrees per hour. The number of square feet of wall space is 13476.2. Number heat units transmitted by one square foot of heating surface, is 201 degrees. Number of pounds of steam from which heat can be taken 138.4. Number of square feet of heating surface, 5847.88.

The diameter of main, 7.64 inches. The diameter of return, 6.5 inches.

The following will show plainly how the aforesaid results are obtained and with careful examination will be easily understood: 1146 − 212 = 966 degrees of latent heat. Heat units in one pound of steam when water is 32 degrees, 1213; then 1213 − 333.3 = 879.7 degrees latent heat. 966 − 879.7 = 86.3 degrees of latent heat and shown as sensible heat. So 333.3 − 212 = 121.3 − 86.3 = 35 × 9 = 315 additional heat units to raise 9 pounds of steam from the pressure of the atmosphere to 90 pounds per square inch—showing that the 121 degrees rise of temperature of steam at 90 pounds per square inch, is made up of the 86.3 decreased latent heat and 35 degrees from the coal, for 86.3 + 35 = 121.3 degrees.

It has required to raise 9 pounds of water from 32 degrees to the pressure of the atmosphere, 1146 × 9 = 10314 degrees, and to 10314 + 315 = 10629°. 14,500° = 3871 heat units lost for every pound of carbon containing 14,500 heat units. Then for the volume of the cylinder per minute, 20 × 20 = 400 × .7854 = 314.16 × 36 = 11309.76 × 160 = 1809,561 ÷ 1728 = 1047.2 cubic feet per minute; and 1047.2 ÷ 100 = 10.47 × 10 = 104.7, ten per cent. of volume for one minute; then 1047.2 + 104.7 = 1151.9 cubic feet, had not 10 per cent. been lost

*Paper read before Hamilton Association Canadian Association of Stationary Engineers.

by condensation, and 1151 × 3.7 = 4262 ÷ 1728 = 2.46 × 62.5 = 153.75 pounds of water per minute.

The average pressure 45 pounds per square inch. Total heat units for steam at that pressure is 1203; the sensible heat is 294 degrees, latent heat 909 – 1203 – 32 = 1171 heat units for one pound of steam at 45 pounds per square inch. *Only he minute volume of the cylinder can be calculated* upon, which is 10% off 153.75 lbs. water or steam altogether at 45 pounds per square inch; then 153.75 ÷ 100 = 1.53 × 10 = 15.3 – 153.75 = 138.4 pounds to be calculated upon at the pressure of the atmosphere. Thus 1146 × 138.4 = 158606 × 60 = 9516360 heat units per hour are being lost; and the number of heat units that can be used for heating purposes is 212 – 70 = 142 × 138.4 = 19652.8 × 60 = 1179168 heat units per hour.

For the heating surface 212 – 70 = 142 × 142 = 20164 ÷ 100 = 201.64 heat units transmitted by each square foot of heating surface: and 201.64 ÷ 1179168 = 5847.88 square feet of heating surface.

For square feet of wall space 70 – 0 = 70 × 1.25 = 87.5 ÷ 1179168 = 13476.2. Diameter of main steam pipe, 5847.88 – 70.46 ÷ 10 – 7.6 inches. Diameter of return pipe, 7.6 × 7.6 = 57.76 × .7854 – 45.36 . 4 – 11.34 × 3 – 34 . .7854 – *43.29, the square root of which is 6.5 inches.*

CANADIAN ASSOCIATION OF STATIONERY ENGINEERS.

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

TORONTO ASSOCIATION NO. 1.

At the last meeting of the above Association, the doors were thrown open to the public, and a paper read by Mr. Charles Heal on "Sundry Notes on Heat", was followed by an interesting discussion. The paper will be found printed in the present issue of the ELECTRICAL NEWS. A committee was appointed to make arrangements for the annual association dinner, which is to be held on the evening of Thanksgiving Day. Bro. Wickens promised a paper for the first meeting in November, which will be an open one also.

MONTREAL NO. 1.

The last meeting of the above Association, held on the 19th of October, was well attended. A large amount of business connected with the winding up of the convention affairs, was transacted. The souvenir committee reported a surplus of $300. This amount is to be invested in scientific books, which will form the nucleus of a library in the future. Mr. Laine, of the firm of Carrier, Laine & Company, Quebec, was elected an honorary member.

HAMILTON ASSOCIATION NO. 2.

The regular meeting held on Oct. 6th was well attended, and there seems to be a growing interest among the brethren. One of the most interesting events of the evening was the report of our delegates to convention, which was presented in glowing terms by Bro. Robertson. This Association is very grateful to the Montreal brethren for the way they treated our representatives, and trust that the results of the convention will long be felt in Montreal. Bro. Robertson also read a letter of condolence which this Association sent to the family of the late Bro. Angell, of Guelph, who was so suddenly called away after his return from the convention; and another to Bro. J. Nie, of Hamilton No. 2, who had the misfortune to lose his little son.

Bro. Binnington was elected Vice-President to succeed Bro. Johnson, who has gone to Laprairie, Quebec.

Bro. Arthurs was also elected Assistant Financial Secretary. *This Association intends holding special meetings for reading* of papers discussion, etc., during the winter months.

WM. NORRIS, Rec.-Secretary.

ST. LAURENT NO. 2.

Editor ELECTRICAL NEWS AND S. E. JOURNAL.

SIR,—I was present at the last meeting of St. Laurent No. 2, C. A. S. E., in Montreal, and as we very seldom see any report of their meetings in the NEWS, it may be interesting to Ontario engineers' to know how they are getting along.

No. 2 is flourishing in every sense of the word. Their membership has decreased somewhat since they were organized, but they themselves expected that, as many of the members took no interest in the work and so they fell out of the ranks in time. But those who remain number about 70, and they are determined to carry on the work of educating and helping each other in their profession.

On the evening in question there were several problems figured out on the black-board, including the safe working pressure of boilers and the thickness of plate required for a boiler to carry a certain pressure, and several others. There were several discussions on the above problems, but as they were carried on in the French language, (this Association being composed entirely of French Canadians,) I did not get much good from it myself, but judging from the numerous questions asked and answers given, I feel sure that it resulted in some of the brothers learning something about boilers and their strength.

No. 2 St. Laurent meets in the Engineers Hall, 662 Craig St., and they hope before next convention to have another association in Montreal.

At the meeting the news of District-Deputy Bro. Angell's death was announced, and the brethern of No. 2 expressed their sorrow and regret by passing a resolution of condolence with the family of their late and esteemed brother, who was so suddenly removed from our midst, and ordered their charter draped for three months.

Executive President Bro. Geo. Hunt was also present for the first time, in his official capacity, and addressed the meeting in his usual happy manner, asking them for their earnest co-operation during the present term, in pushing on the work of organi*zation of new Associations.*

I remain, yours truly,

A. E. EDKINS,

Prov. Dep. C. A. S. E.

LONDON ASSOCIATION NO. 5.

A valued correspondent who is a member of the association writes: No. 5 is progressing favorably, and the officers are filling their posts to the entire satisfaction of the members, and are helping the younger engineers in their practice as well as enlightening them in their studies, which are hard, especially to those who have not had the benefit of early educational advantages.

We have a large blackboard which is used to illustrate methods of setting of boilers, engines, making calculations, etc. One of our members got up 25 paste board cards 20 × 24 inches, 10 of which contain diagrams, ranging in size from 10 to 20 inches, showing the theoretical curve, the different cut-offs and pressures, influence of clearance, under and overloaded engines, calculations of h. p. therein, etc.

Others show how to find the M. E. Pr., T. Pr., N. H. P., J. H. P., how to figure out the h. p. of diagrams; explanation of the indicator. Reducing motions of all descriptions have been discussed and by means of wooden patterns every brother can try his hand at setting a slide valve. Piston distortion caused by the angularity of the connecting rod is also well shown on one of the cards, and shows itself just as plain on the pattern.

Safety-valve calculations, heating and grate surface, are subjects which are not forgotten. Interesting discussions have taken place in regard to firing boilers, showing the good results obtained by a good fireman as well as the great loss that can be caused by an ignorant one.

Personally I may say, I joined the C. A. S. E. 15 months ago, before which time I had never read an engineering book, but encouraged by ex-president Mitchell and Bro. A. E. Edkins to study, I have found out that books are the needed companions of a practical engineer. Every engineer should know the laws laid down for steam. As a result of my studies I have improved my old fashioned plant with the least possible outlay, reaping now better results with less fuel and less water consumption having no shut downs, diminished repair accounts, an easier day's work for myself, a pleasant face on my employer, and more wages.

GUELPH ASSOCIATION NO. 6.

At the regular meeting of Guelph Association No. 6, C. A. S. E., held on the evening of Oct. 4th, the following resolutions pertaining to the death of Bro. J. A. Angell were adopted.

Whereas it has pleased our Heavenly Father to call from our midst, our esteemed friend and brother, John A. Angell, be it resolved that, while we bow in humble submission to the Divine will, at the same time deploring the loss of so eminent an engineer, we extend our sincere and heartfelt sympathy to the *bereaved family in their hour of trouble and sorrow.*

Further, be it resolved that a copy of this resolution be sent to the deceased's family, and that it be spread on the records of our Association; also that a copy of the same be sent to the CANADIAN ELECTRICAL NEWS for publication.

Furthermore, be it resolved that our charter be draped for the space of three months.

H. T. FLEWELLING Rec-Sec.

C. JORDAN, President.

KINGSTON ASSOCIATION NO. 10.

The engineers of Kingston who formed themselves into an independent Association about a year ago, have within the last month thrown in their lot with the C. A. S. E., and will be known as the Kingston Association No. 10. The new Association, which has a membership of upwards of 30, has elected the following officers: President, James Devlin; Vice-President, H. Youlden; Treasurer, H. Hoopins; Secretary, A. Strong; Conductor, James Lohern; Doorkeeper, James Gascoine.

Difficulty has already arisen between the Kingston Electric Street Railway Company and the City, resulting in an action by the Company for damages on account of loss of business through the failure of the City to keep the streets in proper repair.

Messrs. Ald. Savignac, Achambault, H. Laporte and R. T. Corbeil have been re-elected as the board of directors of the Merchants' Telephone Company of Montreal. The Company have erected 155 poles, and announce that their lines will be in operation by May next.

Over 400 tons of mica of various grades, are said to have been shipped from the Ottawa district during the months of July and August, and the first week of September. There is reported to be an increasing interest in and development of trade in the European market for mica of this district.

Captain Alex. H. Gunn, of London, England, has recently visited Montreal with the purpose of establishing a factory for the manufacture of a new electric cutting machine. This machine, it is said, will cut fabrics of every description and of many thicknesses, and with remarkable rapidity. It can be operated on any incandescent circuit.

SIGNALS AND TELEGRAPHY.*

By Jas. A. Douglas.

It is not my intention to present to this society to-night, anything more than merely a brief outline of the history of the transmission of messages from place to place, and to this end I have divided the subject into three parts: 1st, early attempts to signal to a distance; 2nd, development of the electric telegraph and telephone; 3rd, modern forms of signalling.

1st.—Early attempts to signal to a distance.—Probably the first good attempt to transmit messages by the aid of apparatus, was the employment of semaphores mounted on the top of high towers, these were erected in prominent positions, and in plain sight of each other. A large and well trained staff was necessary to observe and transmit, notwithstanding which the work was slowly done, besides the semaphores were useless in foggy weather or in storms.

Both of the two agents, sound and light, were used. Bells, guns, etc., form a convenient method for short distance work. Light, though more ready and rapid than sound, is by no means a docile agent, since it proceeds only in straight lines, and will not bend round the ball of the earth, or inequalities on its surface; and so the third agent, electricity, soon became recognized as docile and trustworthy; it rivals light in speed and can be adapted to any distance.

As far back as 1753, proposals were made to set up an electric signal line, consisting of a set of parallel wires, one wire to each letter of an alphabet, and make the wires attract light bodies, or strike bells corresponding to letters. Later on, Sommering, a German professor, carried this into effect to a certain extent, and he is sometimes regarded as the maker of the first practical electric telegraph.

The next step was the discovery of the deviation of the magnetic needle, through the action of an adjacent galvanic current, and Ampere, in 1820, showed how this could be used for telegraphic purposes. His plan was to use 30 needles and 60 wires, for at first it was supposed that there must be a separate needle for each letter or sign signalled, but this attempt reached no practical result.

The Paris Exhibition of 1881, contained the original first electro-magnetic telegraph apparatus of which practical use had been made. The credit belongs to Gauss and Weber, who erected a line 3,000 feet long at Gottingen in 1833. The apparatus consisted of a large galvanometer frame, in which a magnet carrying a small mirror was suspended by a silk thread. The sender consisted of a vertical inductive arrangement, which allowed a secondary coil to be raised vertically by means of a double lever. A quick motion of the coil generated an induced current which reached the galvanometer frame through wires, and caused the magnetic rod to be deflected. The direction of deviation was determined by the direction in which the coil was moved and a combination of these movements formed the alphabet. The call signal was given by means of a bell and clock-work.

Although this was the first accomplishment of electric telegraphy, yet their invention was regarded as only an appendage to their magnetic observatory, and several years passed before the electric telegraph was an actual fact.

2nd.—Development of the Electric Telegraph and Telephone.—The year 1837 saw the realized, practical, electric telegraph. We cannot claim the exclusive invention for any one individual, but of the several inventors, none seem to have shown greater skill and perseverance than Mr. Wheatstone, whose system of deflecting a single needle right and left, also using two needles, was in general use in England before Von Steinheil obtained similar success in Germany.

Steinheil later on improved the Gauss-Weber system and in his hands it became the first writing telegraph we have. He also made the very important discovery of "earth return," but this was received by the public as a "singular paradox," and Steinheil does not appear to have exerted himself to remove the prejudice against it, leaving it to an ingenious inventor, Mr. Bain, to independently discover this principle later on, and proclaim it, and also for M. Mattineci to make an entirely convincing experiment at Pisa in 1843. Then the double wire of the needle telegraph was dispensed with, and a single wire with ground return, was employed.

The needle system was much altered and changed by Wheatstone and others later, but it is to Morse that we owe our present efficient system of electro-magnetic telegraphy. The first registers or receivers ticked the message on a narrow roll of white paper, but this was soon dispensed with, as operators easily learned to read the instrument by sound alone.

To Prof. F. A. Petrina we owe the invention of duplex and multiplex telegraphy, which invention enables us to send two and more messages along the same wire, at the same time, in opposite directions, which makes the greatest use of a single wire.

Sub-marine cables were proposed as far back as 1774, but it was not until 1843 that the introduction of gutta-percha made this branch of the industry start into life. Many attempts and many failures resulted before the Atlantic ocean was successfully cabled, but the task was persevered in until in 1866 the Trans-Atlantic Telegraph Line was declared open for business. There is now no practical limit to the length of cable which could be laid if required, beyond the contingencies of severe weather.

The Telephone.—Perhaps the most wonderful, and certainly one of the most useful applications of electricity, is the telephone. It was discovered by Page in 1837 that an iron bar when magnetized and demagnetized at short intervals, emits sounds, and on this basis, Phillip Reiss constructed his first telephone. This must have been a curiosity, for according to Dr. Messel, it consisted of a beer-barrel, with a small cone placed in the bung-hole, covered at its smaller end with an animal membrane, upon which a small platinum strip or wire was fastened by means of sealing wax. The receiver was a violin, upon which a knitting needle, having a coil wound round it, was fastened. The receiver was afterwards made in the form of a human ear in which the platinum wire was fastened to the membrane and to the spring by means of sealing wax, and a platinum contact was placed opposite with a screw for adjustment. When sound waves made the membrane vibrate, the circuit was made and broken.

For a long time efforts to improve the telephone gave very crude results, Elisha Gray succeeding in making a fair speaking system, which answered for short distances, the sender and receiver were funnel shaped and differently constructed. Bell also at this time made one, but the sender and receiver could not be used for the same purpose. This instrument was shown at Philadelphia in 1876, and satisfactory effects were obtained from it.

But before the telephone could be made of commercial importance, a problem had to be solved, which Hughes, an inventor, first applied—this was the principle of the microphone, an instrument with a conductor capable of changing its resistance with the sounding vibrations, this principle was discovered by du Moncel in 1856. Carbon was first made use of by Edison in his carbon telephone, and this was the beginning of a new era in this art, many forms of microphones and microphone telephones being tried and used by different inventors and improvers.

No instrument is so delicate as the telephone for the detection of small and sudden currents. It is admirably adapted for showing the currents of induction set up in contiguous coils. It also exploded the notion that iron takes time to magnetize and time to demagnetize. The notion of time is due to the action of induction in coils producing reaction and extra currents.

While it is possible to speak through a cable 100 miles long laid out straight in the sea, it is impossible to speak through 20 miles when coiled in a tank.

The first public experiments for telephone transmission of music were made in Vienna, in 1877. Bell's telephones were used both as senders and receivers. Also at the Paris exhibition in 1881, the music of one of the theatres was heard in distant rooms fitted up for the purpose.

From the first Bell had been working hard to perfect his idea of a proper telephone, and his ultimate form consisted in the well known present type of receiver.

Berliner's patent of 1877 is a miscrophone system. Each station, both receiving and sending, is similar in construction, and consists of a battery, an induction coil, and carbon contacts. The primary coils are in circuit with the battery and carbon contacts. The secondary coils being in circuit with the line wires, which system is in use to-day.

And so we see that the perfection of the telephone like that of the telegraph, was of slow but steady growth, and is the result of the experience and labor of many minds. As regards the efficiency of a telephone, it depends on the careful and exact workmanship with which the parts must be fitted.

3rd.—Modern forms of Signalling.—These are rather numerous, a description of which would fill a few good sized books.

We are all familiar with the electric bell, which summons us to the front door, the telephone, a fire, and sometimes dinner; also the telegraph and telephone, which convey our thoughts, wishes and news to all parts of the world, delivering their messages almost at the precise instant they are sent, to the office, parlor or side-tracked freight car, with equal facility.

Electricity in the form of incandescent lights and flashes, is used to signal between vessels at sea; also to warn them off dangerous coasts, or to signal from baloons to besieged cities, and other uses of military warfare in which the portable telephone is also playing its part.

Flags, by day, are used by army and navy for short distance work, and the heliograph, a tripod arrangement, is serviceable in sunshiny weather for signalling up to about 60 miles.

Limelight lanterns can also be used for short distance night work. These are constructed to emit short and long flashes corresponding to the dots and dashes of the telegraph code. Electric resonators are used as whistles on small boats without steam. These are merely a powerful buzzer at the bottom of a hollow funnel-shaped vessel.

Loud sounding horns blown by steam are used by light-houses during foggy weather, which the lights will not pierce through to a sufficient distance to give warning.

As regards signalling generally, electricity by the aid of proper apparatus, can be made to perform any desired duty, and as nothing seems impossible to this subtle force, and with the many able minds at work on the problem, it is not too much to expect, that some day in the future, even the continents, separated as they are by vast oceans, will yet be able to converse as easily, as we in this city can ring each other up, and remind one another not to forget the next meeting of the Montreal Electric Club.

* Paper read before the Montreal Electric Club, Sept. 25th, 1893.

ELECTRIC RAILWAY DEPARTMENT.

ELECTRIC RAILWAY EQUIPMENT.*

BY H. O. EDWARDS.

I propose, to-night, to call your attention to some distinctive features in the electric railway equipments of to-day, and to make some few comparative statements. It would be useless for me to go back to the birth of the electric street car motor, for you are, probably, as well acquainted with its history as I, or if not, and yet are interested in this branch, the information can be found properly expressed and concisely stated in the works of Crosby, Bell and others.

At the risk of being thought clannish I will narrow my remarks to such apparatus as may be found in operation to-day in this fair country of ours, though I am sorry to say that much of it is made under another flag, and almost all the ideas come from abroad.

Since the first electric car was run in Canada, some eight years ago in Toronto, to the present day, great strides have been made.

The first road equipped and, regularly operated, was in Windsor, and the Vandepoel suspended trolley system was used about a year. Later a road was started in St. Catharines, using the Vandepoel double trolley system with a small motor on the platform of car connected by a chain with the axle, and I believe, is still in use in that city.

The Sprague motor, which was the first motor especially designed for *street cars to be made and used in this country, is a small compact motor* of light weight, capable of doing good work with a small amount of current, starting on 40 amperes. It had a double reduction gear, and is governed with a controller or switch-box, by commutating the fields. It was only rated at 15 h. p. and soon gave place to a heavier type of motor. The next motor was known as the Edison machine. This design followed closely on the lines of the Sprague. Unfortunately it was made to be controlled by the same method as the Sprague, and met with the same difficulties, namely, short-circuiting in the fields and grounding in the switch-box.

There is no kind of machine built, which is handled by such ignorant help as the car motor, nor any apparatus used more roughly and with less intelligence than the electric street car. A little more than a year ago our two largest cities, Montreal and Toronto, commenced to equip their street car systems with electricity, and, since that time our knowledge of the difficulties of keeping the cars on the rails and *on time* has been developed wonderfully. Toronto was the first to get under way, with cars equipped with the Edison system made in Peterboro'. These were supposed to be 20 h. p. motors, as already described. They gave very good satisfaction until they were overloaded with trailers, when the fields began to give out and the rest soon followed. Some cars equipped with Sprague motors rated at 15 h. p. gave the same results. Then came the call for heavier motors, and the Westinghouse 25 h. p. machines climbed to the front, where they still remain. This well-known type of machine needs no description, for these photos will give you a much better idea of it than I could hope to convey by words. The distinctive features of this system are, first, that the speed is governed by resistance in the field circuit, gradually cut out by a controller, somewhat similar to that used with the Sprague system. Second, the motor has four poles instead of two, as all other motors herein referred to have. Third, by a peculiar system of winding the armature the brushes are only 90° apart instead of 180°, as is necessary in all two pole motors. Fourthly, the mechanical details of this machine are very carefully designed and well made. All the wearing parts are made to last, and devices for taking up the wear are numerous. One of these cars has a record in Toronto, of thirteen months use without being brought into the shop for motor repairs. The draw-back in this motor is, that it takes from 80 to 100 amperes to start on a level, and about 40 amperes to run. The resistance is made up of coils of iron wire arranged in wooden frames, of which two are used in parallel on each car, giving a total resistance of 5½ ohms. The wire is No. 13, and is apt to become red hot, and burn off, sometimes setting fire to the frame and then to the car. The cylinder of the controller occasionally becomes grounded or open circuited, when it is necessary to take it all apart to remedy the defect.

The next machine to be tried was the T. H., also a 25 h. p. machine, known as W. P. 50. This was used with a semi-circular resistance box, over which runs an arm connected by a wire cable, with spindles on each end of the car, so that the resistance may be cut out as gradually as is desired. This machine is a standard and gives very good satisfaction, starting with 60 amperes and running on 25, making it a more efficient motor than its rival, the Westinghouse. In mechanical details it is not so well made, nor as convenient of access as the former. The wire cable by which the rheostat is operated, often breaks or gets foul of the one connected with the reversing switch, which is worked by a separate handle, thus differing from the controllers before referred to. You will readily understand that any ordinary man having three distinct systems under his control would not be satisfied until he had tried his hand at modifying or combining these. The electrician having charge in Toronto was no exception to this rule. His changes resulted in scrapping the Sprague controllers, using T. H. "J" controllers instead, and re-winding the fields of the Edison motors with No. 6 wire, thus doing away with the two weakest points in the Edison system. *This gives a slow car taking a small amount of current, but, as weakening* the fields does not strengthen the motor, it is not capable of doing very heavy work.

About the time that the first combination car made its appearance on the streets of Toronto, a car equipped by the Royal Electric Co., of Montreal, made its debut in that city. This equipment was designed and made in Montreal, and contains many of the good points of the T H., Short, and Westinghouse systems. The inexperience of this company showed itself in many poorly constructed mechanical details, which have later been improved, so that shortly we may look for a standard electric railway equipment made right in our own city.

Before turning to note the progress of Montreal's electric road, we must take a glance at the admirable power house of the Toronto Railway Co. This is centrally located on Front st. at the corner of Frederick, and was designed by Mr. W. E. Davis, who deserves great credit for the thoroughness with which every detail is carried out. The steam equipment consists of four high speed compound Armington & Sims engines of 600 h p. each, supplied by a battery of Babcock & Wilcox boilers, so arranged that any boiler or any engine may be cut off at will. Each engine is belted direct to two Edison generators of 200 kilowatts each, these giving a total output of 3000 amperes at 500 volts line pressure. There is also a spare engine and pair of generators. The station is well lighted by incandescent and arc lamps run off the power circuit, as well as by other lights run from the local mains, to be used when the power house is shut down. The switch-board is a piece of work which might stand as a model for any company to follow, and is far ahead of any that the writer had before seen. The switches were designed by Mr. Davis, and made in the company's workshop. They are on the horizontal blade principle, similar to the Edison main cut-out. They are strongly and handsomely made, and mounted on a finely finished slate switch board of large size. They are so arranged that all or any machine may be thrown on all or any set of feeders, or that, in case of need any set of feeders can be loaded with 600 volts or more, if necessary. Standard meters are in circuit with each machine and a large tell-tale voltmeter can be used on any machine by a simple twist of the wrist.

Circuit breakers and lightning arresters are provided, and in every detail the power house shows the result of much study and careful consideration. I understand that the capacity of this station is soon to be doubled

Now let us see what Montreal has been doing during this year, or more, heavily handicapped as she has been. The first cars operated here were equipped by the Royal Electric Co., with a motor made after the T. H. W. P. type rated at 20 h. p., and with controller and rheostat made from the Short patterns. Considering the limited time that the company had to get these out, their inexperience in this line of work, and the rail that the cars had to run on, as well as the way the cars were handled, this equipment was not such a blank failure as might have been expected, for some of those cars are still running. The snow made "Short" work of this style of controller, *which has since been abandoned. Then came the Westinghouse, with the* usual satisfactory results. At the same time cars having Edison motors with the T. H. "J" controllers were put on. These were also 20 h. p. machines, and the snow and ice played havoc with the wire cables, causing innumerable breakages, while water caused many burn-outs in the machine. Some T. H. equipments made in Lynn were also put on, but the "J" controller did not stand any better than on the Edison cars. Then began the combinations, in which local controllers and rheostats made at the railway company's shops at Hochelaga after the Westinghouse patterns, and the different types of motors, took part. Some of these combinations have been very satisfactory, notably on car No. 13, with rewound Edison motors, Royal rheostat and Westinghouse local controller.

During this time the Royal Co had not been idle, but not discouraged by their first lack of success, had b ought out a new equipment, which I will describe at some length, for it is not so well known as the others, having been born on the 8th of June, and has not yet stopped growing to maturity.

Prefacing these remarks of the Royal motor, I would say that tests taken in Montreal and Toronto, by different parties, greatly differ in the results. I will vouch for the accuracy of those in which I took part in Toronto and will give them, hoping to be able at no distant date to prove the Montreal tests to have some other cause for their results than the apparent *inefficiency of* the Royal motors. These motors are practically water tight, for when the covers are closed water may be thrown on the motor and not a drop will enter. The shell consists of a cast iron box, somewhat rectangular in shape, with two pole pieces. It is made in two pieces. The lower part is hinged below the centre, and swings open, carrying the lower field and pole piece, when the armature may be readily removed by use of a hydraulic, or whiskey jack. The fields are wound on heavily insulated square brass spools with No. 5 wire and covered with cord, they are connected in series. The armature is of the Gramme ring variety, with an exceptionally heavy insulation, and wound with No. 10 wire. It, as well as the fields, is boiled in P. B. Compound and thoroughly baked. They are subjected to a test of 2000 volts alternating. The commutator is made of heavy copper segments, with a thick mica insulation between, this is tested with 250 volts between segments. The brush holders are placed diametrically opposite, and were designed to use two carbon brushes, 3 x 1½ x ⅜ placed side by side. This has been modified, and one brush 3 x 3 x ⅜ is now used instead with better results. The armature runs about 600 R. P. M. The reduction is about 5 to 1, giving a speed of 22½ miles per hour or 25 miles per hour with a light car and no stops. The motor is supplied with interchangeable gun metal bearings. The rheostat used was designed by Mr. Burnett after the principle used in the Short system. Layers of thin sheet iron plates between asbestos arranged in piles on a frame, the total resistance, cold, being about 3⅔ ohms. The controller differs from that used by the Westinghouse Co., first in having an independent reversing device operated by a separate handle, second in the roller being formed on a wooden core, thus leaving small chance for grounding and no possibility of an invisible open circuit as often occurs with that design, third, in having six notches instead of five, giving another section of resistance; fourth, in having the terminal board inside of the car instead of under the roller on the platform where dirt and moisture, as well as metal dust may fall on it.

When properly handled, the rings of the Royal controller need cleaning once a fortnight, and the tips have worn five weeks on a belt line route, equal to ten weeks of ordinary use. The Westinghouse needs to be cleaned once a day and tips changed once a week. Habirshaw wire and Okonite cable is used throughout the car. The usual fuse blocks, lightning arresters and motor cut outs were especially designed for this system.

I will read you the synopsis of a test taken by Messrs Davis, Smith and others, through the King street subway in Toronto on a car equipped with Royal motors:

Maximum current used to start on level,	60 amp.	or	37½ h. p.
Minimum " " " " " "	40	"	23½ h. p.
Average " " " " " "	45	"	25 h. p.
Average " " " run " "	22	"	12 h. p.
Minimum " " " " " "	15	"	8 h. p.
Maximum " " on 8% grade	42	"	24½ h. p.

The daily average run of the car on which this test was made is 150⅔ miles, hauling a trailer 137⅔ miles at a rate of 8% miles per hour, including stops. During the Exhibition this car drew two closed trailers all day, carrying about 100 passengers on each car, mounting the 8½ grade of the subway with ease. Owing to the crowd it was impossible to make any tests as to amount of current used, but the usual fuse did not blow at any time.

To give you an idea of the difference of tests in the two cities, it has been reported that a car in Montreal similarly equipped, took 150 amperes, or 44 h. p., to climb the 8% grade on Windsor street; that is about double the power used on the same grade in Toronto.

I think it can be safely said that up to date, the Westinghouse is the most satisfactory equipment in use, for although the electrical efficiency is not so high as some others, the mechanical details are almost perfect, and this *counts for something at the end of the year.*

There is one other system in use in Niagara, Toronto and Kingston, which must not be omitted. It is the T. H. Series-Parallel or K. controller, and the W. P. 50 machines. By this system the motors are first in series and afterwards in parallel. On level roads a saving of one third of the current is claimed. The controller is rather complicated, but well made

* Paper read before the Montreal Electric Club.

with blow-out magnets under each brake, and a separate roller for reversing the motors. The Niagara installation is looked upon as a model of this system, and has given most satisfactory results during the time it has been running.

I intended to say something about the troubles met with in having the cars well inspected, as well as a few remarks in regard to the minor details of brushes, trolley-wheels etc., but I have already, occupied too much time. Trusting that you will all take part in discussing the points in this paper, wherein your views differ from mine, I will stop and give you a chance.

THE MONTREAL ELECTRIC CLUB.

The following meetings of this Club have been held.

The first meeting of the season was held at the rooms No. 55 University street on Sept. 15th, with a good attendance. The most interesting features of the evening were the exhibition by the inventor of Pinolet's Annunciator System and a paper on Signalling and Telegraphy, by J. A. Douglas, which is printed in the present issue. It is understood that this winter a committee will be appointed to draft out a set of underwriters' wiring rules for the guidance of architects and wiring contractors, the want of which has been much felt. A reliable system of inspection of wiring is to be recommended for the protection of house proprietors.

October 9th—The most important business on this evening was the presentation of the Constitution and By-Laws by the committee appointed for that purpose, the adoption of which was, however, left over till the next meeting. An instructive and interesting paper was read by Mr. H. O. Edwards on "Electric Railway Equipment," which is also printed in this paper.

October 23rd—Besides the transaction of other business, the revised Constitution aud By-Laws submitted at the previous meeting were adopted. Mr. J. A. Douglas read a paper by Prof. Elhiu Thomson on "The Electric Arc and its Use in Lighting" which had been delivered by the author at a convention of the National Electric Light Association. The reading of this paper led to a considerable discussion on the part of the members of the Club.

TRADE NOTES.

Messrs. Quintard & Packard, dealers in electrical supplies have opened a branch of their business at Vancouver, B. C.

Mr. James Clark, in charge of Canadian Machinery Department at the World's Fair, has telegraphed the Robb Engineering Co. that their engine has been awarded medal and diploma.

We wish to congratulate the Penberthy Injector Co., of Detroit, Mich. on the fact, that to their justly celebrated Penberthy Automatic Injector has been awarded the medal for merit by the judges of awards at the World's Columbian Exposition. This injector has been on the market only six and a half years, yet nearly 75,000 of them have been placed on boilers in all parts of the world.

The Penberthy Injector Co., of Detroit, Mich., who have heretofore confined their efforts principally to injectors are as fast as possible getting out patterns for several new specialties to combine with their present business. Unless some complication unlooked for occurs, they will put on the market this coming season, a Sight Feed Lubricator, an Automatic Starter for Pumps or Injectors, a Low Water Alarm and a Lawn Sprinkler.

A circular has been issued announcing that the Ball Electric Light Company, Limited, of Canada, have sold to the Canadian General Electric Company, Limited, their entire electrical manufacturing business, including patterns and good will, and that the General Electric Company will continue the manufacture of Ball apparatus at their Peterboro works. It is also announced that Mr. W. A. Johnson, late manager of the Ball Company, will be the head of the arc lighting department, while also giving his attention to the special apparatus with which, as manager of the Ball Company, he is so familiar.

The Dodge Wood Split Pulley Co. are now doing an extensive trade among the makers of electric motors and dynamos. They supply a special dynamo and motor pulley made with iron centre and hardwood rim which is becoming very popular among the first class makers. They claim for it all the strength of an all metal pulley, its arm, hub, and inner rim being iron, while the outside rim is built up of hard maple segments perfectly turned and highly polished, thus giving the user all the benefits of a wood belt surface. The Company show numerous samples of their special pulleys at their new and handsome city warerooms, 68 King Street West, Toronto, and are pleased to give information and prices to those interested.

Probably the largest mining transaction of the past year was consummated on Oct. 14, when Mr. W. R. Elmonhorst, of Montreal, sold all his interest in the lands, mining rights, equipment and mined material, comprising "The Lake Girard Mica System" To Mr. Thomas J. Watters, of Ottawa. By this operation, it is said, Mr. Watters becomes the absolute owner of the largest, the most valuable area of mica deposits, and proved properties, known to be held by any single individual on this continent. The development of the series of deposits in question has been steadily continued during the past three years, and the conditions of the various properties are such, that with a renewal of the demand for mica, which will doubtless arise ere long, the output of this mineral, which has been greatly restricted for the past few months, can be enormously increased. We understand arrangements are being perfected, whereby under lease of all said properties, etc., the business of "The Lake Girard Mica System" will be operated vigorously for the future.

The Magnolia Metal Company, having offices at New York, Chicago, London and all over the world, has been allotted the highest award possible at the World's Fair, Chicago, Ill., on their Magnolia Metal. A medal has been granted and a diploma with following specifications allowed and set forth: 1. It prevents hot boxes; 2. It will not cut or heat journals, 3. Its lasting qualities are of the highest order; 4. It is a self-lubricating metal, saving large percentage of oil; 5. It increases the motive power; 6. It is the only metal that protects and does not wear journals—it enamels them; 7. It is adapted to high and low speed machinery; 8. It will stand the heavy work of sugar, rolling, saw and wire mills, 9. It is a success for main journal and crank pin bearings; also Gibs of steamships and steam tugs; 10. It is the best water metal.

PERSONAL.

At the seventh annual convention of the Boiler Inspectors Association of the United States and Canada, held recently at Chicago, Mr. Edwin O. Champagne, Inspector of Steam Boilers for the City of Montreal, was elected President. It was decided that the next convention of the Association should take place in Montreal.

Mr. D. Thomson, late manager of the Hamilton Electric Light and Power Company, has accepted a position with the Crouse-Tremaine Carbon Company, of Fostoria, O., and will represent the Company on the road both in the United States and Canada.

Under this heading last month it was stated that Mr T W Martin had been appointed "manager" of the Hamilton Electric Light and Power Co. We are informed that this is incorrect, Mr. Martin's position being that of superintendent.

Mr. W. T. Dean, formerly of the Thomson-Houston International Co., of New York, has been appointed agent of the Canadian General Electric Co. for the Province of Quebec. His headquarters will be in Montreal. Mr. A. W. Congdon who formerly held this position has been appointed assistant chief engineer of the Company at Toronto.

The name of Mr. C. F. Medbury, of Ottawa, was inadvertently omitted from the list of those in attendance at the Canadian Electrical Association Convention, published in the ELECTRICAL NEWS for October. Mr. Medbury took an active part in the discussion on Mr. Langton's paper on "Direct Connected Dynamos with Steam Engines, and showed that the tendency is in the direction of slow speed direct connected dynamos, with consequent reduction in belt-speed and saving in belts.

SPARKS.

The construction of an electric railway in the town of Collingwood, is being agitated.

The General Electric Company are endeavoring to introduce incandescent lighting in Petrolia.

The Bell Telephone Company is making improvements on its systems at Port Arthur and Fort William.

The Bell Telephone Company are engaged in re-constructing their lines between Toronto and Port Hope.

The large new organ recently placed in St. Peter's Cathedral, Montreal, will be operated by an electric battery.

Mr. J. A. Farlinger, of Morrisburgh, has been granted a Canadian patent, No. 44,248, for a compressed air motor system.

The Vancouver and Westminster Electric Light Company has succeeded the Vancouver Electric Light and Power Company.

The Canadian General Electric Company has announced a dividend of 6 per cent. per annum for the year ending 31st of August, 1893.

A new power house is to be erected for the Electric Street Railway Company, in connection with the Winnipeg Gas and Electric Light Company.

During the month of September the receipts of the Toronto Street Railway Company were $92,745, as against $86,887 in the same month of 1892.

Incorporation has been granted Messrs. D. W. Clark & Sons, of Lancaster, N. B., to carry on the business of manufacturing electrical appliances. The capital stock is $22,500.

The directors of the Galt and Preston Railway Company have unanimously decided that the road shall be operated by electricity, and the merits of the various systems are now being looked into.

The chimney in connection with the General Electric Company's new station at London, Ont., will be the highest in the city. Its height is 25 feet, and in its erection there were used 107,000 bricks. The flue is 4 feet in diameter.

The Toronto and Richmond Hill Street Railway Company have entered into a contract with Mr. James F. McMahon, of St. Catharines, for the construction of the first section of their road, which will extend from the city limits to Bedford Park, and is to be completed by the 20th of December.

The following gentlemen have been elected directors of the Ottawa Car Company —Messrs. Wm. Scott, W. W. Wylie, T. Ahearn, J. W. McRae and W. Y. Soper. The directors elected the following officers :—President, T. Ahearn ; vice-president, W. W. Wylie ; secretary-treasurer, J. D. Fraser; solicitor, Horace Pratt.

The street car conductor's life is not a happy one. If he fails to collect a fare he is liable to hear from the powers that be ; if he challenges a transfer passenger, that offended dignitary rises in his might in the Assize Court with a verdict of $500 damages. Moral : It is better to be a non-conductor just at present.—Toronto *Globe*.

It is reported that nearly all of the proposed $100,000 of capital stock of the Hamilton, Grimsby and Beamsville Electric Railway Company, has been taken up. Negotiations with the various municipalities, including the City of Hamilton, for the necessary right of way, have been going on for several months past. Mr. C. J. Myles is the President, and Mr. A. Rutherford, Secretary of the Company.

A messenger of the G. N. W. Telegraph Company surprised his employers by the celerity with which he delivered his messages, until the fact was discovered that his method was to tear up the messages and sign the name of the parties to whom they were addressed. The boy was brought before the Police Magistrate and sentenced to jail for 10 days. This it is hoped will serve as a sufficient warning to prevent the recurrence of so important a misdemeanor.

The following gentlemen have been elected directors of the Nelson, B. C., Electric Light Company :—James A. Gilker, President ; William Wilson, Vice-President ; Fred Richardson, Treasurer ; Geo. A. Bigelow, Secretary ; J. H. Matheson, E. R. Atherton and Fred. Williamson. The Company have expended upwards of $9,000 in obtaining a charter, purchasing land and making permanent improvements, and expect to have their plant in operation shortly.

While we would advise men not to rush heedlessly into the pursuit of electrical work with the idea that it is to extend into such a wide field in the future that there will be unlimited opportunities for profitable employment, we do think that since electricity is already applied to so many everyday uses, every one that has anything to do with it should understand as much as possible its elementary principles, so that he should know how to make use of it, what to do and what not to do, when there is danger and from what source. For those living in Toronto there is now an opportunity which a good many should avail themselves of, for thus becoming acquainted with electrical principles and their more common applications. Among other classes that have recently been started at the Toronto Technical School are a junior and a senior class in electricity, and we understand that the instructor in this department aims at treating the subject in a thoroughly practical way and in as simple a manner as the nature of the work will permit. His department is provided with a good equipment of electrical instruments, and generators, motors, etc., for practical tests and these with the assistance also of a projecting lantern, are continually used in the explanation of the principles.

SPARKS.

It is reported that the St. John, N. B., street railway is in the hands of a receiver.

The Wiarton Electric Light Company have recently purchased a new 36 horse power engine.

A deposit of mica of excellent quality, is reported to have been discovered at Jasper House, N. W. T.

The construction of an electric railway from St. Thomas to Port Stanley, and connecting with the adjacent villages, is mooted.

The City of Brantford has completed a contract with the Brantford Electric Light and Power Company for street lighting for a period of five years. The price is 23 cents per light per night, for 35 or more lights.

A suit for $25,000 damages is said to have been entered by Mr. W. J. Austin, of Milwaukee, against the Goldie & McCulloch Company, of Galt, for alleged infringement by the latter company of a feed-water heater patent.

Mr. Geo. H. Campbell, manager of the Winnipeg Electric Street Railway Company, is at present in Ontario arranging for the purchase of additional rolling stock and other apparatus required to insure the efficiency of the operation of the road in winter.

The Vancouver and Westminster Electric Tramway and Light Company, Limited, has been incorporated, and will take over the Vancouver City Tramway and Light service, and the interurban tramway service between Vancouver and New Westminster.

The City of London has invited tenders for street lighting for a term of three or five years, with 2000 c. p. lights. The specifications provide that the current must not vary more than 8½ to 10 amperes and that the lights, 250 in number, are to be in operation before the 15th of January, 1894.

The Standard Electric Light Company of Montreal has disposed of its gas privileges and is now considering whether to build a railway from the Champ de Mars to Lachine, or to sell the privilege for doing so to parties who have made offers for it.

The cars which have been specially built for the purpose of carrying the mails to and from the railway depots at Ottawa, are vestibuled at each end with double doors at each side. There are no windows, the interior being lighted with electricity.

It is reported to be the intention of the Niagara Falls Street Railway Company to substitute electricity for horse power, and extend their line to Chippewa and Niagara on the Lake, with branch lines to Lundy's Lane and Macdonald's Corners. Permission will also be asked to cross the Suspension bridges and connect with the street car lines on the American side.

The electric railway connecting the towns of Port Arthur, Fort William and West Fort William, a distance of 8 miles, went into operation on the 27th of September. An hourly service between the three towns is to be inaugurated. The road was built and will be operated by the town of Port Arthur. Fort William has a right to buy a half interest in the road, any time within five years. It is hoped that the construction of this road will lead ultimately to the consolidation into one of the three towns mentioned.

The St. Thomas Motor Company has instituted a suit against Graham Symington, of St. Thomas, to recover possession of electrical machines and for damages for holding them. The defendant leased certain premises in St. Thomas to the Featherbone Co., which is now defunct. This company had bought dynamos from the motor company, and they remained on the premises after the company assigned. The motor company has a lien upon the dynamos, but Symington would not deliver them up, as he had a claim against the lessee. The defendant sets up a counter claim and asks $500 damages for possession.