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ELECTRICAL NEWS

AND

STEAM ENGINEERING JOURNAL

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

TORONTO AND MONTREAL, CANADA, APRIL, 1893.

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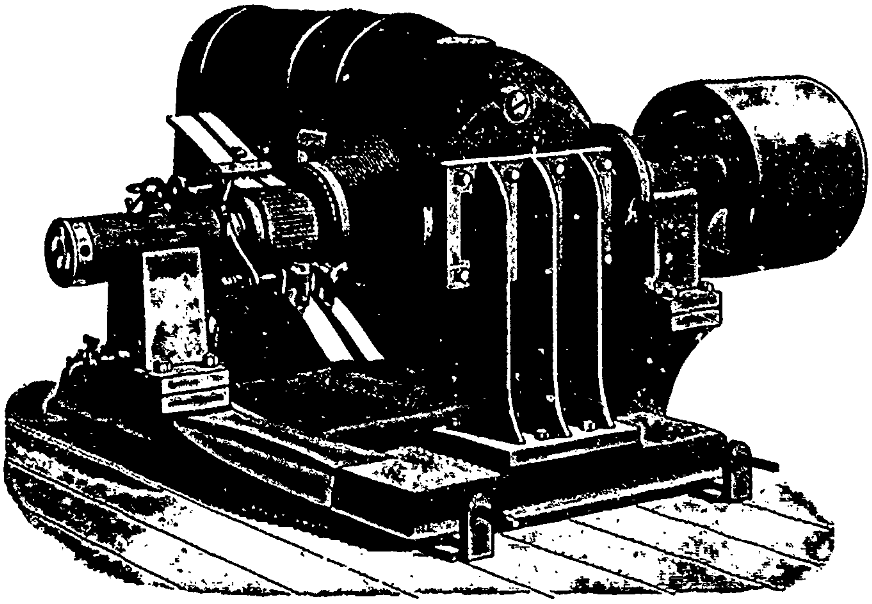

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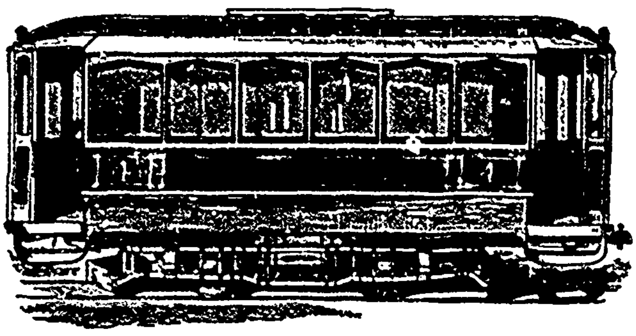

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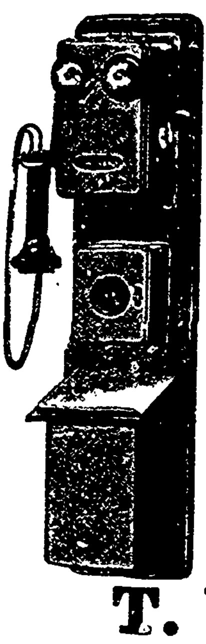

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ELECTRICAL NEWS

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STEAM ENGINEERING JOURNAL.

VOL. III. TORONTO AND MONTREAL, CANADA, APRIL, 1893. NO. 4.

THE NEW WESTINGHOUSE STOPPER LAMP.

IN our last issue mention was made of the invitation extended by the Westinghouse Company to its friends to inspect the machinery to be exhibited by it at the World's Fair, and also to inspect the new stopper lamps, a large number of which are burning at the shops in Alleghany.

We have fully described the machinery and have also had occasion to refer to and describe the new lamp in our issue of Oct. 26, 1892, but we think our readers will be interested in some exact photographic reproductions which we give on this page and which, for the first time, show accurately all the details of the new lamp. It will be noted that the stopper, consisting of glass, has the leading in wires passed through it for a distance of an inch and a quarter. This length allows of a perfect seal being obtained. The leading-in wires are of iron, and a special glass is employed, the coefficient of expansion of which is practically the same as that of the iron; thus the use of platinum is avoided. The iron leading-in wires, it will be observed, are thickened at the bottom, making two stubs which are quite stiff, upon which the contracts in the base bear.

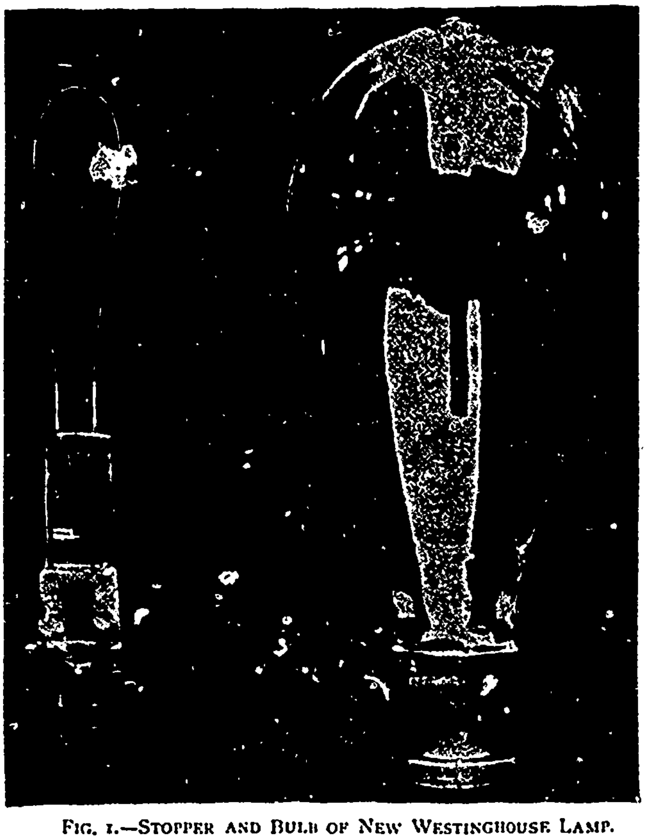
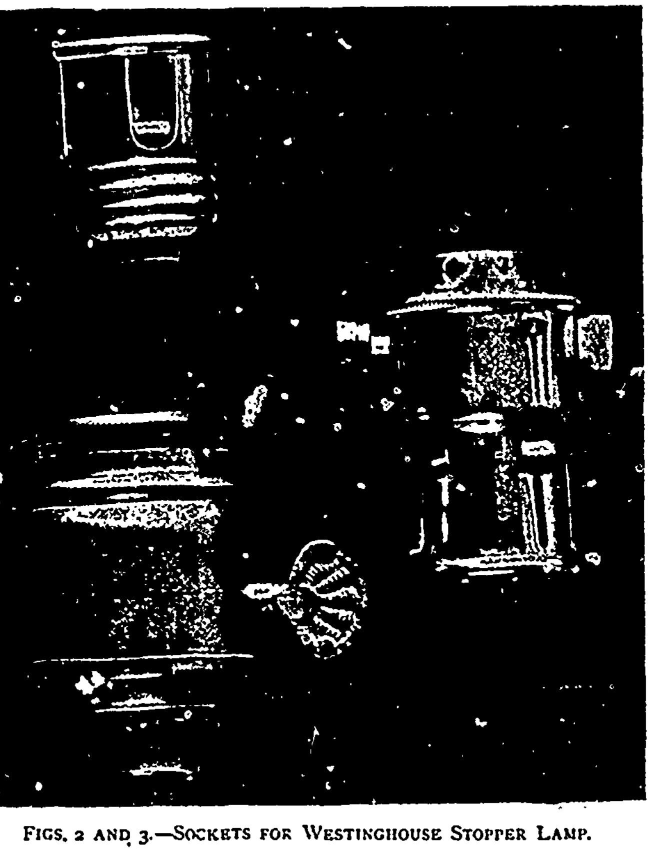


FIG. 1.—STOPPER AND BULB OF NEW WESTINGHOUSE LAMP.

The stopper is ground in a special machine and fits into the corresponding neck in the bulb of the lamp. When the stopper is inserted, a cement is applied which aids to maintain a perfect seal. When it becomes necessary to renew the filament, the stopper is removed, a new filament is attached to the leading-in wires, the stopper is re-inserted, and the lamp is again exhausted. This operation can be accomplished at a very small cost, and hence there ought to be no excuse for the continued use of blackened lamps.

During the exhausting of the lamps, the Westinghouse Company introduced nitrogen gas at intervals, for the displacement of the oxygen of the air, so that the residual atmosphere, when exhaustion has been carried to the last point, consists largely, if not entirely, of nitrogen.

As will be seen in Fig. 1, the lamp is complete in itself and can be readily adapted to any type of socket. The lamp is pushed into the base by which contacts are made into the



FIGS. 2 AND 3.—SOCKETS FOR WESTINGHOUSE STOPPER LAMP.

leading-in wires; the base is then pushed into the socket, no screw motion being employed. Fig. 2 shows the base employed for use on Edison sockets.

A special and very simple form of pendant switch has also been designed for use with the lamp, as illustrated in Fig. 3. By merely pushing in the white or black button, the lamp is switched on or off, and this can be readily accomplished by the the use of one hand.—*Electrical Engineer.*

After spending several million dollars on their cable street railway, Philadelphia is about to abandon the system for that of the trolley.

In operating street railway plants by electricity generated by water-power, says *Engineering*, the excessive variations of load unavoidable in such service has rendered the problem of efficiency regulating the generating power an extremely perplexing one. The inertia and incompressibility of water render it impossible to control the flow with sufficient promptness to follow closely the sudden changes of load. In a street railway plant at Oswego, N. Y., this difficulty seems to have been met quite successfully by the use of an artificial resistance of iron wire of a capacity nearly equal to the maximum output of the generators. This makes a compensation which may be automatically varied so as to maintain a constant load on the generators, notwithstanding the fluctuations of the live load.

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

The Toronto Association No. 1 held its second open meeting this season in the Shaftesbury Hall, on Friday, the 10th ultimo, Mr. W. G. Blackgrove, the President, presiding.

Mr. George C. Robb, chief engineer of the Boiler Inspection & Insurance Co., delivered an interesting and practical lecture on "Boiler Explosions" which was greatly appreciated by the large number present. The speaker, in opening his remarks, stated that he was unable in any dictionary to find a good definition of the word "explosion." In one book it was defined as "a sudden bursting of noise" and in another place it was explained as being "a sudden expansion of a substance or an elastic fluid, but neither of these or other definitions in such books gave a technical meaning of the word.

Boiler explosions, he thought, could arise from one of four causes, but before dealing with these, he would like to speak of two reasons often given, but wrongly accounting for, these occurrences, viz: Electricity and gas from decomposition of water. As regards the first, that theory had been knocked on the head by the experiments of Prof. Faraday, which proved that electricity supposed to be in boilers was only produced by the friction of escaping steam and water, and was not inside the boiler at all. If anybody could prove electricity to exist in boilers, they could make their fortunes, as that would do away with the necessity of using steam engines and dynamos to produce electricity. As to the second erroneous reason commonly given, no gas would be found in a boiler that could bring about an explosion by itself. The question therefore was, what force produced these calamities? The lecturer considered it was the energy stored in the water, and the more water there was in the boiler, the greater and stronger was the explosion, although many still believed in the old idea, that if a boiler had enough water it could not explode. The energy in water at a temperature of 100 pounds pressure or 337° F. in falling to 100° F. has an escape of 237 units of heat from each, and a unit equals 772 pounds raised one foot. If all the energy stored in the water over 100° F., could be utilized, each pound of water would yield enough to lift 90 tons one foot high.

The speaker went on to show how this great force, once an opening was made for a commencement of its escape at any weak point in the boiler, would first rupture the parts of the boiler, and then, as it reached the outer air, would momentarily displace the pressure of the atmosphere. This displacement would be quickly followed by condensation of the escaped steam and a return of the atmospheric pressure. When the force suddenly escaping from an exploding boiler was thus considered, and the power of a return shock from the atmospheric pressure, taken into account, it was no wonder that such disastrous results were often produced by boiler explosions.

The four actual causes of boiler explosions were then considered.

1. Defective Construction—either from faulty design or bad workmanship. Defective staying of flat surfaces was alluded to as a common cause.

2. Corrosion, and consequent weakening of some part of the boiler, if the boiler was exposed to pressure.

3. Over-heating of Plates.—Low water or the presence of some form of deposit would cause over-heating. With many, low water was considered a fine explanation of nearly every boiler explosion. As a matter of fact, it was not a common cause. There was a general belief that if the plates became red hot and water was caused to flow over them, explosion would follow immediately. Experiments recently made in England with a large boiler, in which the plates over the surfaces were made red hot and water pumped on them, failed completely to produce explosion; the plates were injured and the joints leaked, but that was all.

4. Over-pressure, which was generally brought about by defective safety valves.

In support of these statements the lecturer referred to several cases that had come under his personal notice in Ontario, and explained clearly by means of sketches on a black-board the reasons of the several explosions he referred to. The prevention of explosions was next referred to. The necessity for careful attention to this matter was proved by the statement of the Hartford Steam Boiler Insurance Co., that in the United States during 1893 there were 269 boiler explosions, causing the death of 298 persons and injury to 442.

The speaker thought the first step was to be sure that the boiler was well made and the proper material used, designed so as to be strong enough for safety at the intended pressure. The boiler should be managed by a competent engineer who realized the dangers to be guarded against. Frequent and thorough examinations of the boiler should be made by some one in a position to judge of its condition. There is in England a law, which requires the user of every steam boiler to report every accident of the nature of an explosion, within twenty four hours after its occurrence. Investigation follows, and the court, formed generally of two engineers and a lawyer, has power to punish whoever is proved to have been at fault. This act has worked well in England and, he thought, a similar one in Canada would be productive of good results.

At the close of the lecture several questions, put by the members of the Association, were answered and additional explanations given in regard to the points raised.

A vote of thanks to Mr. Robb, proposed by Mr. A. M. Wickens and seconded by Mr. G. C. Mooring, having been carried unanimously, the meeting was brought to a close.

TORONTO STREET RAILWAY COMPANY.

Rapid progress has been made with the new power house for the Toronto Street Railway Company, situated at the corner of Frederick and Front streets. The necessary alterations to the premises cost the large sum of $50,000, which includes $9,000 for the chimney shaft, which is 175 feet high and is said to be the tallest in Toronto. The twelve boilers with their furnaces are fixed; each has a diameter of 72 inches and is 18 feet long. They were built by the Polson Co., of Toronto. The smoke breeching to these was executed by Mr. John Abell, Toronto. It is of heavy boiler plate and is about the finest piece of work of its kind on this continent. The foundations to carry the engines took over a million and a half of bricks, and each has a base of solid concrete underground ten feet deep.

There will be four double cross compound engines and a a single one having an 18 inch stroke with 21 and 36 inch cylinder. These were made by Messrs. Armington & Sims, Providence, R. I. It is to be regretted that the company did not get this part of the work also done in Canada.

The Corliss cut-off allows for an expansion of the steam by means of five large gigantic condensers fixed in the basement; a vacuum will thus be caused at the end of every stroke. The supply from these condensers will come direct from the bay by means of a 30 inch main now being laid, and after cooling, the steam will be dischared into the sewer.

One of the engines is already fixed, and is expected to be in use very shortly. Ten carloads of machinery have arrived and by the beginning of June next the whole of the works will be completed, when we hope to give some further details and illustrations of what promises to be one of the finest power houses in America.

The company are also making extensive preparations for the coming season. They have already fifty-nine motor cars fully equipped. Forty-six cars are at present running on the streets. Sixty new open cars are in course of construction, and many old ones are being overhauled and repainted. A private car is being built for the directors, and is being fitted up regardless of expense. It will be somewhat larger than the new electric cars now running, and is a rare specimen of fine workmanship. A storehouse capable of sheltering 81 cars has been built on Yorkville Avenue. It is a brick structure 250 feet long and 100 feet wide; there are nine tracks running full length of the building, three of which are excavated underneath to allow workmen to carry out repairs to the tracks without removing the cars. There is also a complete blacksmith shop in the building.

PUBLICATIONS.

The literary features of the *The Arena* for February are a carefully prepared biographical sketch of the "Life, Character and work of Charles Darwin" by the editor A second argument in favor of Shakespearean authorship by Dr. W. J. Rolfe, the eminent Shakespearean scholar. A story by the Canadian poet, William P. McKenzie, entitled "Was it Prophecy?" and a poem entitled "The Minority." This number is rich in able discussions of vital Social and Economic problems.

QUESTIONS AND ANSWERS.

"Young Engineer" asks :-

1st. How to work out indicator diagram?

This question is not very explicit. The indicator diagram is worked out for so many different purposes, that a whole volume might be written on this subject. If "Young Engineer" merely wants to know how to work out the horse power, the following will help him: The diagram should be divided into ten equal divisions lengthways. In the middle of each of these divisions draw a line at right angles with the atmospheric line. Measure on each of these lines the number of pounds pressure between the steam line and the exhaust line of the diagram. Add the ten numbers together and divide by ten, and the result is the average pressure of steam on the piston available for work. Then multiply the area of the piston in square inches by the average pressure in pounds and by the number of feet the piston moves in one minute, and divide by 33,000, and the result is the horse power.

2nd. Is the pressure on the slide valves equal to the area of ports, or is the total surface of valve to be considered?

If the valve is absolutely tight against the face on which it moves then the whole surface should be taken into account in estimating the pressure on the face. Very few valves are thus absolutely tight, and the area of ports covered by the valve will in most cases give more accurately the load when multiplied by the pressure of steam on the back of the valve. When making such a calculation the pressure on the other side of the valve must be taken into account, and if engine is a condensing one, the effect of the vacuum will add probably 12 lbs. per sq. inch to the pressure on an area equal to that of exhaust port.

3rd. Why will a long chimney give a fiercer draught than a a short one?

The velocity of draught is due to the falling of a body of cold air from a height equal to that of the top of the chimney above the grate bars. It is a well known fact that the velocity of a falling body increases with the distance through which it falls. The draught of a chimney follows this same law, but allowance for friction and for weight of the air inside the chimney has to be made.

4th. In calm weather, the sun not shining, the temperature of boiler and furnace the same as atmosphere, is there a draught in furnace?

This question implies so many hypothetical conditions that the best way to get an answer will be to go to a furnace when under the conditions stated and try whether or not there is a draught. In a general way it may be stated, however, that unless there be a difference of pressure there will be no draught, and the necessary difference of pressure is generally obtained by making a difference in temperature. If there is a higher temperature in the upper part of the chimney than in the furnace there will be a draught from the furnace and up the chimney.

Mr. T. J. Trapp, of New Westminster, B.C., requests through the ELECTRICAL NEWS, or any of its readers, information on the subject of the application of electricity to mining operations. We have in a measure complied with our correspondent's request, but would be pleased if our readers would supplement the information given by sending us contributions on the subject.

NOTES.

The trustees of the Montreal Association of the Canadian Association of Stationary Engineers are authorized to purchase a working model of a Corliss engine. This Association will on May 1st remove their quarters to the Oddfellows' Hall, Craig St.

At the weekly meeting of the Marine Engineers held in Shaftesbury Hall on March 1st, Mr. Crabtree exhibited a new valve regulating machine and explained its working. President S. A. Mills presided. The society appears to be prospering; several new members were elected at this meeting, and steps are being taken to amalgamate all the lodges. A report was also read to the effect that another branch of the Association had been formed at Halifax.

It is a matter of continual and increasing surprise to us, that any boiler maker of repute should be willing to send out boilers of over 30 inches in diameter, without the fullest provisions for gaining access to the interior. Corrosion, pitting, grooving, deposit of scale—these and many other defects can be detected and satisfactorily observed only by direct observation of the inner surfaces; and when a boiler is large enough to admit a man, it should always be provided with a manhole. To omit such an important opening is highly dangerous.—*The Locomotive.*

TESTING ARC CIRCUITS.

The following device, for locating faults, such as leaks, grounds, crosses, etc., and for determining the number of lamps burning on a circuit, says A. H. Manwaring, in the *Electrical World* may be of interest to central station managers. It consists of a series of resistances, as, for instance, a bank of sixty incandescent lamps of high voltage, and a switch arranged to cut off circuit one incandescent lamp after the other, a double contact grounding switch, an automatic switch to protect the incandescent lamps from accidental swinging grounds, etc., and a special indicator to determine the number of lamps desired.

In making a test, the first operation is to determine how many arc lamps are burning on the circuit. This is done by connecting the two flexible cables (that are attached to the test board) one to the positive and one to the nagative side of the circuit to be tested. This connects all the sixty incandescent lamps in series as a shunt to the main or arc circuit, then the incandescent lamps are cut out of circuit, one by one, with the centre switch shown in the cut, until the indicator needle reaches the standard mark on the scale. The number of incandescent lamps remaining in circuit is equivalent to the number of arc lamps burning on the main circuit. After having determined the number of lamps burning, the operator moves the grounding switch marked P which disconnects the negative side of the test board from the main circuit and connects it to ground. The test is then made the same as before, by cutting out the incandescent lamps, and if a ground exists the indicator needle is brought up to the standard mark on the scale, and the number of incandescent lamps remaining in circuit is equivalent to the number of arc lamps on the positive wire between the dynamo and the ground.

To determine the number of arc lamps on the negative side of the main circuit between the dynamo and the ground, the operator reverses the grounding switch and repeats the test. If the number of lamps on the positive side and those on the negative side to ground do not equal the number of lamps indicated on the first test, the ground is not a perfect one, but offers a resistance, and the difference should be added equal to the number of lamps on each side, to locate the ground accurately. Thus, if he gets 40 lamps across on first test, 20 lamps P. second test, and only 10 lamps N. on third test, he adds 5 to each of the positive and negative sides, locating the ground between the 25th and 29th lamps of the positive side of the circuit. A ground on underground cable is located in the same way as on an air line, between two lamps.

A swinging ground is located by cutting out of circuit only a few of the incandescent lamps at a time, and watching the deflection of the needle when the ground swings on, continuing to cut out the incandescent lamps until the swing of the needle reaches the standard mark on the scale.

To locate a cross between two different circuits, first see that both circuits are free from a ground connection; then substitute a ground on one, and measure the other circuit, and the cross can be located. If a ground should exist on one circuit, it is not necessary to add another.

If in making a ground test where two or more circuits are run on the same dynamo and the needle of the indicator is deflected in the opposite direction from other tests, it denotes that the circuit under test is clear, and that one of the other circuits is grounded; or if the number of lamps on ground tests exceeds those across the circuit on first test, it indicates that the ground is on one of the other circuits.

To determine if the current is reversed in a circuit, connect the flexible cables to the circuit marked, P to P and N to N. The needle should be deflected to the right if the current in the circuit is travelling in the proper direction, but if it is diverted to the left it denotes that the current is reversed.

A high voltage lamp is prepared so that the carbon only becomes red, thus making the test-board a high resistance through which it is perfectly safe to ground a circuit. By this arrangement only one-fifth of an ampere is shunted to ground when testing a grounded circuit.

This device, it is found, saves a great amount of time in locating trouble, and a man can be sent direct from the station to repair the same; it also lessens the danger from accidents and fires caused by unknown grounded circuits, as circuits can be tested as often as desired and trouble removed in a short time. This testing device is already in use in several central stations.

POWER TRANSMISSION FOR CENTRAL STATIONS.*

By Louis Bell.

So far as distribution is concerned, we may divide electrical power transmission into three classes: first, the transmission of single units; second, the transmission of power to a centre of supply, from which point it is to be distributed in various ways; third, supply the power for lights and motors throughout the length of the transmission line. Each of these classes of work imposes conditions on the possible methods of transmission, and requires special consideration. In new plants, hampered in no wise by existing stations, any one of these three cases may exist, perhaps the last two more frequently than the first. Where a single motor is to be employed, the problem is exceedingly straightforward. Where a new centre of distribution is to be organized, some complications are encountered, but not serious ones. Where power is to be scattered along the line, however, conditions arise which are not altogether easy of fulfillment and require a good deal of special care and skillful engineering. In a general investigation of the methods which may be employed, the case stands somewhat as follows, so far as the central station man is concerned:

First, if the distance over which he is to transmit power is moderate, he may use the ordinary direct current generator and motor, displace his engine with the motor and go ahead. But unfortunately, direct current machines of any considerable capacity are practically limited in voltage by the existence of the commutator, an article on which central station men in general waste no love. Dynamos and motors of large size cannot, individually, in the present state of art, be satisfactorily built for more than about 1,200 volts. Machines for greater voltage have very generally broken down in the experimental stage. For very small power units, arc machines might be employed, but for the purpose of the central station man, it is better to move his arc machines directly to the distant point. For voltages much in excess of that mentioned, we are then driven to the use of either direct current machines in series or alternating machines.

Where generators and motors are to be used as a single unit, direct current machines in series may be and are employed quite successfully, but as the voltage desirable on the line rises, the system contains a greater number of units and becomes more complicated and difficult to apply to central station practice. For instance, it is highly desirable for the successful operation of motors in series that they should be, practically, coupled to the same shaft, and should run under similar and uniform conditions, so while there are cases in which the method of coupling in series may be both convenient and cheap, it is in my opinion better general practice to employ *alternating currents, after passing the ordinary limitations of direct currents.*

Here we encounter a complicated state of affairs, for the central station man who attempts to investigate the subject is immediately surrounded by a cloud of mental dust, through which he sees dimly the outlines of plain alternators, bi phase, tri phase, and multi phase generators and motors, condensers, Geissler tubes, six foot fuses, electrified wall paper and the other properties of a well equipped modern high voltage electrician. The substance of the matter, however, is something as follows:

We want to use power transmission by alternating currents for two good and separate reasons: first, because we get rid of the commutator and can therefore use as high voltages as we can safely insulate in the machine; second, because by the use of transformers, we can obtain for the transmission line itself any voltage which we can insulate, and thereby enormously decrease the cost of the copper which must be stowed away as permanent investment in our line.

Multiphase currents—and by this I mean currents having more than one phase—are subject to the same general laws as any other alternating currents. Their most valuable peculiarity lies in the fact that for alternating currents of more than one phase excellent motors can be built which will run at a steady speed, start under heavy load, and in general possess very much the same qualities as a well organized shunt motor of the ordinary kind. Incidentally, certain of the multiphase systems, more especially the three-phase, enjoy the advantage of effecting something of a saving in copper, under favorable circumstances up to 25 per cent. from what would be required by a plain alternating current of the same nominal voltage. This saving is merely from the fact that in the three phase line, the currents do not have their highest value at the same time, so that at any particular instant two of the wires may serve as a sort of multiple return for the third. This advantage would be immediately thrown away, if for the three currents of different phase three separate pairs of wire were employed, as it is thrown away where for two currents of different phase two independent circuits are used.

The fundamental difference between single and multiphase systems, then, is mainly the adaptability of the latter for driving motors, and multiphase are better than single phase motors principally in their ability to start under load, and somewhat larger output for the same weight.

Wherever, then, single motors are to be driven for operating, we will say, an electric light station, it is largely a matter of convenience whether we employ single or multiphase motors. If the former can be conveniently started, they are fully competent to take care of the work, except in one special case which I will mention presently. The multiphase motors, whether synchronous or otherwise, start very freely, and may or may not be economical in cost of copper, according to the arrangements of the circuits.

A single case in which multiphase transmission becomes of great importance when the object is to work an existing central station is in that case where railway circuits are to be supplied. A railway machine is subject to so great and violent variations of load, that if it were driven by an ordinary synchronous alternating motor, the latter would run great risk of being pulled out of phase by a sudden short circuit, when it would stop and stay stopped until deliberately started up again. The multiphase motor can also be pulled out of phase, but not quite so easily, and it can be more readily started. We can, however, where railway currents are necessary, do much better than to drive the dynamos directly by motors of any kind. We can for this use start with the multiphase current, and through the medium of a single machine scarcely more complicated than an ordinary railroad dynamo transmute this multiphase current into a direct 500 volt current of the ordinary sort. This very valuable result has been brought about through the ingenuity of C. S. Bradley, who invented the device half a dozen years ago. It has remained dormant, principally because there has been no special call for power transmission of any kind until recently, but to its thorough practicability I can personally testify, as a 100 kilowatt tri phase direct current transformer which I recently tested, operated in the manner described showed an efficiency of over 95 per cent. at full load, stood sudden variations from no output up to 100 kilowatts and back again without even a wink at the brushes, and bore up under heavy load without difficulty. Whenever it is desirable to operate railway circuits by power derived from a distant source, these machines fulfill the practical requirements, and I believe are destined to come into very extensive use, and play an important part in the development of very long electric railroads.

To sum up this point, where single motors are to be employed for driving other electrical machinery, either synchronous, alternating or multiphase motors can be successfully employed. Where railway dynamos form a part of the load a particularly good result can be obtained by using for this particular portion of the work the multiphase direct current transformers.

So much for the operation of existing plants by electrical transmission of power, where it is merely intended to substitute a motor or motors for an engine.

Now take up a case where the centre of distribution is to be fed, consisting it may be in part of an existing station and in part either of extensions and new circuits from this plant and subsidiary centres of distribution having other districts of the same town. Here the problem becomes more complicated and it is almost impossible to lay down any general procedure. Each case is best handled by itself. We can, however, enunciate certain principles which will aid in the discussion of any definite case.

First, we can feed all existing railway circuits and extensions very effectively and economically by use of the tri phase direct current transformer just described.

Second, we can handle all direct current incandescent systems, whether two or three wire, *by means of the same type of apparatus, the tri-phase* direct current transformers.

Third, we can successfully operate any existing alternating incandescent circuits or any extensions thereof by feeding alternating current from the distant point directly into them through banks of transformers.

Fourth, if any new centres of distribution are to be made with circuits independent of those already in existence, we can operate these circuits very effectively for both lighting and motor service, if both be necessary, by employing multiphase apparatus, and right here let me say that there is one widely spread error which I desire most emphatically to contradict.

It has been asserted that incandescent lighting cannot be successfully done on multiphase systems, especially tri-phase, since this system happens to have been most talked about. This statement is absolutely false, to my own personal experimental knowledge. Lamps can be as successfully operated on systems of two, three or more phases as on an ordinary single phase circuit, provided equal pains be taken with the distribution of copper in the lines and the regulation of the voltage at the dynamos. If these conditions are observed, a two phase circuit with separate wires acts substantially as if fed from two ordinary alternating dynamos. A tri-phase circuit gives a similar result, and if more phases were concerned, the same would be true. If the condition of constant voltage at the centre of distribution be fulfilled, as it can be and must be for successful operation on any system whatever, two and three phase incandescent lighting systems can and do work admirably. Furthermore, if we combine circuits, for example, if we use but three wires instead of six for the three phase system, there is no exact equality of balance required between the lamps placed in different connections across these circuits. On the three-phase system we would place between each possible pair of the three wires this arrangement, gaining in copper wire enough to compensate for the slight inconvenience in connecting three sets of lamps instead of one or two. Branches can be run from any two wires of the tri-phase arrangement, and lights placed on them will act exactly as if they were placed on any ordinary alternating circuit. With such an arrangement you should be able to throw off all the lights on one side of the circuit, without producing any noticeable variation in the lights of the other two branches; no more variation, for example, than you would get, if on a given set of secondary mains from a common transformer, you were to turn off or turn on one-third of the total number of lights. If any man comes to me and says that a three-phase system will not run lamps successfully unless there is careful balance between the lights on different sides of the circuit, I have in that statement sufficient evidence to convict him either of ignorance of the principles of wiring and dynamo regulation or of wilful misrepresentation of the facts. I lay stress upon this matter of incandescent lighting in defence of multiphase systems, because it is the one upon which they have been most often misrepresented, chiefly through foreign experiments, which I do not hesitate to denounce as clumsily conducted.

In taking up the condition I have just mentioned—that of new centres of distribution—I may briefly refer to the properties of multiphase motors,

* Read before the National Electric Light Association, St. Louis, March 1, 893.

which have been the subject of all sorts of misstatements. A multiphase motor, I do not care whether it has two or more phases, should if properly built have very nearly the properties of a good shunt motor, and not far from the same efficiency. Incidentally it has the advantage of having no commutator and no necessity for any moving contacts. It starts under two, three or more times the running torque, just as a shunt motor does, and by virtue, if the torque is extreme, of a heavy starting current, just as a shunt motor would. It comes rapidly up to nearly fixed speed, and remains nearly at that speed under variations of load. If overloaded it stops, like any other motor. In addition, it has one great merit that shunt motors do not have, that of running at nearly constant speed independent both of load and moderate variations in voltage. It is on the whole less thin-skinned than a shunt motor. I have experimented with a considerable number of multiphase motors of the induction type, to which I here especially refer, and although I have seen some terribly severe tests in the way of overload, I never yet saw any symptoms of a burn-out. The efficiency of these machines should be and is at least within one or two per cent. of ordinary shunt motors.

There has been much discussion as to the relative merits of two and three-phase induction motors. In general the more phases the smoother action of the machines in various respects. I have never yet seen a two-phase motor any better than a three phase motor. I should want a pretty careful series of tests to convince me that I have seen one as good. The difference between them with proper design, ought not to be very great, though the three-phase has the advantage in cost of wire. There are two important points in which multiphase motors have been misrepresented, which I shall mention:

First, it has been said of them that they take an enormous current when running light, and second, that they introduce a very large and most objectionable lag in the circuit, so that the apparent current on the line is much greater than the energy current. Such facts have doubtless been observed. Broadly speaking they have been due to faulty design. A multiphase motor will always take a somewhat larger current when running idle than the corresponding direct current motor, but it takes very little more energy, as the phenomenon of lag then becomes noticeable, so that of the apparent current running light only a portion represents energy. It is a perfectly simple matter to cut down the current required by a multiphase motor running idle to twenty or twenty-five per cent. of the full load current, still retaining a motor excellent in its other properties. As motors where power is sold by meter are usually cut off when not needed, the whole system of this idle current sinks into insignificance. The same is true of the alleged lagging current. If a multiphase motor (I speak with certainty at least regarding the three-phase) of 10 or 15 horse power should show at full load more than 10 or 12 per cent. of lagging current, I should consider it to be badly designed, so that these two questions of so called idle current and lagging current as distributing factors in a multiphase line can be and are reduced by proper care in designing to comparatively insignificant quantities. It has been very ingeniously suggested to give them a further shove down into oblivion by means of condensers, but it is a commercial rather than an electrical question as to whether leakage current and lag had be thrown quite into the abyss by the added complexity of condensers or left hanging on the ragged edge without them.

In case, then, of working a central station from a distant water power where necessity for extensions or new centres of distribution exists, we have plenty of methods available: Tri-phase direct current transformers for railway and direct current lighting service, alternators to feed into the existing mains or to supply extensions for them and for new centres where light alone is to be employed, ordinary alternating currents, or where both light and power are necessary, multiphase apparatus which, as I have shown, is entirely applicable for such a mixed system.

I may add that there is a possibility that we may have before long practical motors to run on an ordinary alternating circuit constructed after such methods as were suggested by Prof. Thomson a few years ago. In very small sizes they are already practicable. Brown, abroad, has been making a desperate effort to exploit these very methods on his own responsibility and has obtained motors which run successfully but as yet do not start well under load. From what I can learn of them, I doubt very much if they are any improvement on the motors of the same type shown by Prof. Thomson at the Paris Exhibition or on Mr. Tesla's motors for running on a two-wire circuit.

Whatever the methods which may be employed, several serious questions must be confronted when one attempts to transmit power for supplying central station or any other apparatus. One of these which presents itself immediately is whether or not in an alternating transmission it is advisable to use step-up and step-down transformers. The principal determining factor in this is cost. The higher voltage we can supply direct from the machine without increasing its cost considerably, the cheaper we can make the installation. Unfortunately in building dynamos, the armature coils have to be insulated, and where the voltage is very high, the insulation is correspondingly thick, so that with a given amount of material, we must in building a high voltage machine take up with insulation the space which would otherwise be available for copper. The result is that a dynamo wound for 4,000 or 5,000 volts is intrinsically more expensive, unless the size be very large, than a machine would be for 1,000 or 2,000 volts, besides being considerably less reliable. Machines of such voltages as these have been built in this country and abroad and some of them have given very fair results, but they are expensive to manufacture, at whatever prices they may have been sold in individual instances, and it is my personal opinion that where it is necessary on the score of economy to raise the voltage as high as 4,000 or 5,000 volts, it is better and cheaper, unless the units be very large to use step up transformers and carry the voltage up to 10,000. Assuming 2,000 or 3,000 volts as the available potential obtained from the machine direct and then estimating the cost of a given installation, first using these machines and second using the low voltage machines with step-up transformers, we find that at prices ordinarily charged for apparatus and copper, the two methods become of equal cost at a distance of somewhere about seven or eight miles. Above these distances, the step-up transformers cheapen the plant, below it, they increase the expense. We can draw the line at no specified given distance in the general case, but can very easily for any specified case.

The amount of drop advisable in these long distance lines will depend of course principally upon the relative prices for copper and the apparatus necessary. If copper be relatively cheap, it pays to employ a good deal of it. If apparatus is relatively cheap, it is better to use larger generators and allow more drop on the line, 15 to 20 per cent. will hit the large majority of cases on the score of economy and convenience. It should be remembered, however, that for such drops as these good regulation is most essential, but good enough is available with direct, alternating or multiphase machines, to make these drops thoroughly practicable. The approximate figures I have just given on the limitations of the step-up transformer and on drop are the result of the investigation of a large number of concrete cases which I have had occasion recently to examine in detail, and for a number of which the apparatus is now in process of manufacture. I therefore feel personally convinced of their practicability, both theoretically and otherwise.

But for the central station man who desires to decrease his operating expenses by the employment of electrical transmission the court of last resort is the balance sheet and the fundamental question is, "Agreed that it is practicable, will it pay?" I can give no general answer to this question, for each problem necessarily must be considered by itself. It is possible to formulate equations which will connect all the variable factors of cost and annual charges, so as to enable one to derive from them an answer to this all important question. But the character of such formulæ is necessarily so complex and involves so many quantities that it is generally easier to take a short cut to the result by making a few approximate estimates. I have, however, looked into the profit and loss probabilities of a large number of plants of all description and in a general way one can say that power transmission to a central station will, unless the cost of developing the water power be very great, almost universally pay at distances of 10 or 12 miles or less. It will frequently pay up to 20 or 25 miles; now and then, under extraordinary conditions (very expensive coal and very cheap water power), up to 40 or possibly even 50 miles. In using alternating currents at these long distances one naturally fears the effects of inductance in the lines and of static capacity. In very long lines, operated at high frequency, these difficulties may rise to formidable magnitudes. Knowing the dimensions of the line, the frequency and the currents, it is, however, possible to calculate the effects of these distributing elements with great accuracy. From these calculations I feel safe in saying that within the distances mentioned inductance and static capacity constitute no serious obstacles to success, if the frequency employed be moderate; such, in other words, as one would be led to select in considering the operation of motors alone. Large generators are as readily and nearly as cheaply built for frequency of 50 or 60 as for higher ones, sometimes more easily under these circumstances. I think cases would be rare where transmissions, the advisability of which would be dictated by commercial consideration, would encounter serious difficulty from inductance and capacity. I have never personally investigated a proposed transmission of over 50 miles that gave any promise whatever of financial success, but the time may come when such a case will appear, and if it does, the work can be done successfully so far as the electrical part of the matter is concerned. I think the greatest difficulty in surmounting long distances is the difficulty of keeping a long line in proper repair.

Throughout this discussion I have take the position that no one method of procedure is applicable to all cases. Personally I am decidedly eclectic in my taste, believing that it is better to put in for each individual case such apparatus as on the whole proves to be cheapest and best rather than to advocate, on any fine drawn theories, methods which might be applied to the perfectly general case of transmission of power. It is the concrete rather than the abstract that we have to consider when proposing apparatus on which the success of large commercial affairs depends, and although some methods are better than others, it is well to remember that while the electrical pharmacopœa may have its calomel and paregoric it contains no elixir of life.

The ten electric machines for the compilation of statistics used by the Dominion Government cost $625 per month for their operation, but they are declared to be more accurate than other methods.

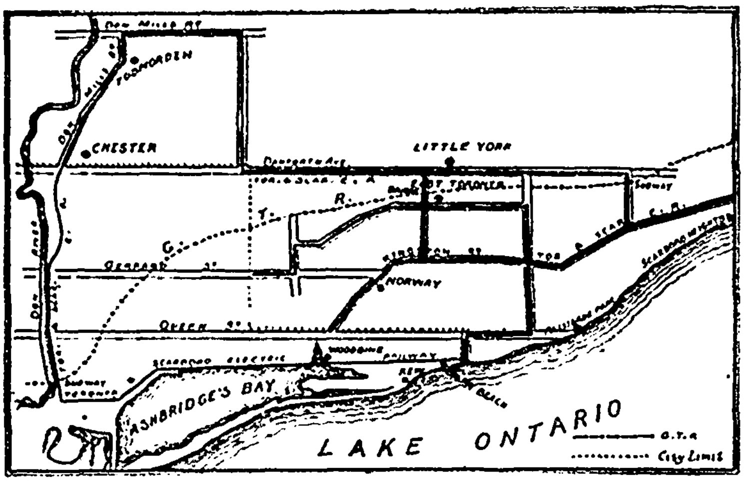
A convention of the Telegraphers' Association of North America will be held in Toronto on the third Monday in May. It is expected 500 delegates will be present. The City Council have already arranged to extend the visitors several courtesies.

Applications for the street railway franchise of Peterboro', have been made by three companies, viz., Messrs. Ahearn and Soper of Ottawa, the Canadian General Electric Company, and the Peterboro' & Ashburnham Company. The Town Council have given their decision in favor of the Canadian General Electric Company, and a franchise has been granted to that company for twenty years from July 1st.

THE TORONTO AND SCARBORO' ELECTRIC RAILWAY.

RAPID transit is an absolute necessity for a growing city and its suburbs. It is therefore not surprising to find that there are several enterprises on foot in different outlying districts of Toronto with the object of providing electric railways for these locations.

In our present issue we show a diagram of the proposed route and illustrations of scenery on the line of the Toronto and Scarboro' Electric Railway, the construction of which will be started as soon as the frost is out of the ground. When completed there will be from 15 to 20 miles of road, connecting East Toronto, Little York, Todmorden, Chester, Norway, Scarboro' Heights and the summer resorts in that locality with the city. Thus a belt line will be provided in the east similar to the one in the west of Toronto belonging to the G. T. R.



PROPOSED ROUTE OF THE TORONTO AND SCARBORO ELECTRIC RAILWAY.

It is expected that the first section of the road along the Kingston road, Blantyre ave. and Queen street will be in operation by June. The line will not only be devoted to passenger traffic, but purposes doing also a local freight business, which no doubt will prove a great benefit to the locality, as the line will bring the district into connection with the city cars and the railways.

The line promises to open up the country and encourage industries to the locality, while the picturesque scenery of the neighborhood through which the line passes will no doubt be the means of establishing many summer residences, and make the district a favorite spot in the excursion season. We hope later on to refer to the appliances and working of the line.

ELECTRICAL TERMS.

At the present time electricity depends upon steam engineering for its generation. Therefore it behooves every live engineer to acquire all the knowledge regarding its generation and application that he possibly can. At the present time nearly all our ocean, river, and lake steamers are equipped with dynamos for electric lighting, and the engineer who does not acquire knowledge necessary to care for the dynamos and its appliances will find it hard work to procure a position. Engineers will find herein the electrical terms so clearly defined that any person can easily understand them: Volt, unit of pressure, called electro motive force, same as pounds of steam; ampere, unit of quantity, called current, same as gallons of water; ohm, unit of resistance, similar to friction, watt, unit of energy consumed, similar to foot pounds, and thus 746 watts equal one horse power, same as 33,000 foot pounds.

The whole question of electrical distribution may be popularly illustrated by its analogy to hydraulics. The dynamo is essentially a rotary pump, but pumping electricity instead of water.

If the discharge pipe of a rotary pump be carried around through a given circuit and connected with a suction, both pump and pipes being full of water, the movement of the pump will obviously cause the water to flow in one direction, producing a continuous current of water. Subsitute dynamo for pump, wire for pipe, and electricity for water, and conception of electrical transmission by the continuous current is at once clear as to its elementary phenomena. We will bracket the analogous electrical terms; then we may say that a certain number of pounds (volts) or pressure are required to overcome the friction (resistance) of the pipe (wire) in order that the water (current) may flow at the rate of so many gallons (amperes) per minute. The larger pipe (wire) the more water (current) can be carried and the less will be the friction (resistance) or per contra, the smaller the pipe (wire) the less the quantity (amperes) per minute and the greater the friction (resistance). Manifestly the pipe (wire) might be so small that the friction (resistance) would absorb a very large proportion of the power of the pump (dynamo), leaving but little remaining for useful effect, therefore the two horns of the dilemma are: if the pipe (wire) be too large, it will cost too much; if too small the loss will be too great.

The electrical appliances are also analogous to engineering appliances. The switches are valves, the fusible strips are the safety valves, the contacts are the pipe fittings. If the contact is insufficient to carry the current, there will be a leak (drop) in the current. The voltmeter is the pressure gauge; the ammeter is the same as the water or the gas meter, the recorder of the quantity consumed.--R. G. Davis, in *Marine Review*.

SOME POINTS ON ENGINE REPAIRING.

BY C. H. RICHARDS AND V. L. STOCKSTON.

THE engineer not having much experience, is often at a loss to know just what to do in case of his engine wearing, and it happens not infrequently that when some repairs are necessary neither the engineer nor the machinist who is to do the work knows how to do it.

It is always well—in fact it is the duty of an engineer that can not be neglected except at much cost and possibly accidents—to look carefully to lubrication and keeping set-screws and keys properly tightened and an eye generally upon every part of the plant. The cups should all be kept feeding nicely, the crank-pin brasses and cross-head should be frequently examined and felt of to see that they are not too warm. The valves should be examined frequently—also the piston and cylinder. Unless this is done, trouble may arise and get far advanced before noticed in the working. This should be done once a month in any case.


ALONG THE LINE OF THE TORONTO AND SCARBORO ELECTRIC RAILWAY.
A STRETCH OF SAND BEACH.

Therefore we send to the editor of the *Scientific Machinist* some hints to repairers of engines, and the engineer can often act as such himself, especially when the difficulty has not become serious.

When the valve faces wear, or become abraded, we recommend that they be filed crosswise of the cut. It will be found that they will then wear down evenly and make a good seat. A part of the seat, as every engineer knows, is never uncovered, and is very difficult to lubricate on that account. We have for years cut grooves in this valve face, almost but not quite through, about one inch apart. This lets in the steam and the seats become lubricated. There are some builders making their valves this way now. They should all be made so.

The piston and cylinder quite often get scratched and cut. The priming of the boiler will carry grit and sediment into the cylinder and it may get there in other ways. When the rings become cut, take them off and file, as before stated, across and not with scratches. When replaced, make a nice bearing. Many make them too tight. They had better be too loose than too tight.

ALONG THE LINE OF THE TORONTO AND SCARBORO ELECTRIC RAILWAY. THE PALISADES (SCARBORO).

The rod will cut if the packing is left in too long, or if the glands are not properly tightened. When this occurs, scrape the scratch, lengthwise of, or with it. If no scraper is at hand, use a file, but be careful to do a neat job. Be sure and repack and see that the glands are right—neither too loose nor too tight—and do not bear on the rod.—*Scientific Machinist.*

LEGAL DECISIONS.

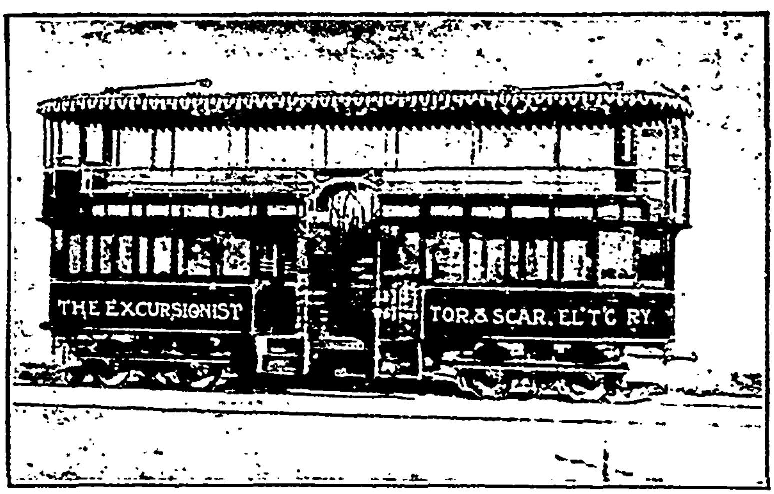
In an action of the Kerr Engine Co. against the French River Tug Co. the plaintiffs claimed $1,350 balance of contract and $428 extras. The contract was for putting engine and boiler in a tug of the defendants. The price agreed upon was $7,400, and the work was to be done by 18th April, 1892. the plaintiffs undertaking to pay $20 per day as liquidated damages for every day's delay after that date. The work was not completed until about 18th June. The defendants paid $750 into court, asserting as a set off $1,200 for the delay. The court only allowed 14 days delay to the defendants, as they held the defendants were responsible for the rest. In an appeal the plaintiffs were allowed the money paid into court, but had to pay costs of the actions.

ARMSTRONG VS. TORONTO STREET RAILWAY COMPANY.—Judgment on appeal by the plaintiff from an order of Galt, C. J., in Chambers, reversing an order of Winchester, Master, directing production by the defendants of a report made by the driver of the car on which the accident happened to the assistant superintendent of the defendants' railway regarding the accident, in respect of which the plaintiff claims damages. The defendants claimed privilege on the ground that the report in question was made in view of impending litigation; but on examination for discovery their manager agreed to allow inspection of the report provided that the names therein mentioned of witnesses of the accident were kept covered. This offer being declined, production was refused. On this motion the plaintiff contended that there had been no production of the report; that no such privilege as that claimed could be relied on by the defendants, inasmuch as the report had been made in April, 1891, and no claim for compensation was made by the plaintiff till September of that year; and that no case had been made by the defendants for withholding discovery of the names of persons mentioned in the report, as it was not sworn that they would be called at the trial. Order appealed from affirmed, with costs to the defendants in any event.

The Supreme Court of Pennsylvania held, in the recent case of Smith vs. Western Union Telegraph Company, reported in the supplement to the Philadelphia Legal Intelligencer, that in a case of unintentional delay in the delivery of money by a telegraph company, because of which the plaintiff's note was protested, there could be no recovery for a mere loss of credit by reason of the protest, and that the rule in the case of the refusal of a bank to pay a customer's check where his deposit was sufficient to meet it did not apply. The court said: "It is true that in an action for the breach of a contract to pay money for a special object, which was known to the party agreeing to make the payment, damages directly and naturally resulting from the breach, and therefore supposed to have been in contemplation of the parties, may be given in addition to interest, but such damages must be shown by the evidence. It is also true that a bank which refuses to pay the check of its customer when his deposit is sufficient to meet it may be held for substantial, without proof of special damages. Patterson vs. Marine National Bank, 130 Pa., 419. It is contended by the appellee that the case at bar falls within the principle of the case cited, but we think there is a broad and substantial distinction between them. The powers, privileges and duties of a bank and its relations to the business transactions of the commercial world are essentially different from those of a telegraph company. Banking institutions are indespensable agencies in these transactions, and it is a wise policy which extracts from them fidelity to and a prompt performance of their agreements with their depositors. A bank's refusal to pay on demand the check of its depositor who has a sufficient fund with it for that purpose is not like the unintentional delay of an individual or a corporation in the fulfillment of a contract to pay the debt of another, and a measure of damages appropriate to the first is not necessarily applicable to the second."

TELEGRAPHING WITHOUT WIRE.

Since June last constant electric communication has been maintained between the Needles lighthouse, England, and the shore without any direct metallic connections. An ordinary submarine cable has been laid in Alum Bay to within sixty yards of the Needles Rock, where it terminates with its copper conductor attached to a small anchor. This anchor is five and a half fathoms at dead low water. The shore end of the cable is attached to the signalling instrument: while to establish a circuit a simple earth plate is immersed in the water close to the shore on the lighthouse rock. Two strong bare wires dip into the sea about ten yards apart, which are in connection with the signalling instruments in the lighthouse. Thus through the intervening space of sixty yards the men on the rock can call the attention of those on shore or vice versa by means of an electric bell, and communication can be established by means of a single Leclanche battery cell.



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KINGSTON ASSOCIATION STATIONARY ENGINEERS.—Meets twice each month over No. 1 Fire Station. J. Devlin, President; W. Gilmour, P. O. Box 699, Secretary.

IN "Pickwick Abroad" we find the following given as a stoker's explanation of the steam engine: "This 'ere furnace, gen'lmen, heats that 'ere water, and that 'ere water is in this 'ere biler; and that there pistern rod is moved up and down by the steam from this 'ere biler; and them 'ere pisterns acts upon them rods, which turns the axles of the paddles, and the paddles their selves in consequence."

TELEPHONIC communication between Boston and Chicago, a distance of 1,200 miles, was established during the past month. The line is constructed of two No. 8 hard drawn copper wires, which weigh 435 pounds to the mile, and the whole circuit contains 1,044,000 pounds of copper. A circuit of the weight generally used would only weigh 413,000 pounds. There were 54,000 poles used with an average of 45 to a mile.

THE advisability of inaugurating a special cheap service between the hours of 12 and 2 o'clock for the accommodation of business men who might desire to lunch at home with their families, is worthy of consideration by managers of city electric street railroads. It is partially for want of such a service that down town lunch counters have of late done such a thriving business. It is a question worth considering whether some of their profits might not be directed into the pockets of the street railroad companies.

IT is surprising that riders of bicyles persist in running their machines on the car tracks in front of trolley cars. The dangers from this foolhardy practice are great; in the case of a mishap, such as the wheel catching in the rail or the machine colliding with a vehicle crossing the tracks at a crossing, the cyclist is left a poor chance of escaping with his life. Many, if not all, the sad calamities that have happened to people from the electric cars in Toronto have been the result of thoughtlessness and carelessness, and the practice complained of may have to answer for many more.

IN one of the earlier issues of the ELECTRICAL NEWS we referred to the electric railway constructed to carry passengers from Strachan Ave. to the Toronto Industrial Exhibition grounds, as being one of the first attempts at electric car propulsion on this continent. We observe that a gentleman residing near Fort Erie, is said to have recently purchased the train which was used on this line. We are not informed what his purpose is with regard to it, but we may express the hope that it will be preserved an an interesting memento of the beginning of things in the field of electric railway development.

DRY sand is used to a considerable extent on electric street railroad lines for the purpose of increasing the traction and enabling the cars to surmount heavy grades. In Toronto the conductor on lines where such grades exist keeps a pail of sand at his side and throws it in handfuls upon the rails as required. This antiquated method seems to be so entirely out of keeping with everything else electrical, that we hope soon to see it abolished in favor of some mechanical device which will perform the duty automatically, and allow the driver to give his undivided attention to the brake and rheostat.

THE accumulation of snow and ice on the streets of Toronto has been greater during the winter which is about to close, than for many years previously. This coupled with the fact that the company had barely time to get some of its lines into running order when winter set in, placed them at a serious disadvantage so far as preparation for keeping their tracks clear and maintaining an efficient service are concerned. Many of the citizens, appreciating the unusual difficulties against which the company have had to contend, have been both greatly pleased and astonished at the energy and skillful management by means of which a first class service has been provided throughout the winter. It is safe to say that more serious difficulties are never likely to be met with in the future operation of the system.

THE opening of the overhead electric railway at Liverpool docks by the Marquis of Salisbury, on the 4th ult., is an interesting event to the electrical world, marking the first instance in which electricity has taken the place of steam for overhead locomotion. While there can be no objection to the use of electricity on overhead roads there are certainly many advantages. The cars can move without the noisy accompaniment of an engine, the atmosphere will be free from fumes from a furnace, and the thoroughfares below the track will be clear of showers of cinders. The cost of the new line, including equipment, was about $450,000 per mile and the distance covered is 6½ miles. The journey can be easily accomplished at the rate of 50 miles an hour.

A FLOURISHING electric club is in existence in Montreal, the members of which meet regularly at frequent intervals to discuss papers on electrical subjects and the technical phases of electrical work. The idea is one that should prove exceedingly helpful to workers in the electrical field, and promotive also of public interest in the science. We should be pleased to see clubs of similar character established in the larger cities throughout Canada. The members of the Canadian Electrical Association in the various cities might well take the initiative in this direction, as the benefits arising from the formation of such clubs would not be local only, but would extend to the national organization as well. Which city will be the first to follow the lead of Montreal in this matter.

THE thirteenth annual report of the Bell Telephone Co. shows that company to be in a flourishing condition. The gross revenue for the year was $875,526, and expenses amounted to $653,139 leaving a net revenue of $220,386. When it is borne in mind that the lines operated by this company now comprise 10,455 miles of wire on 4,836 miles of posts the large amount of expenses can easily be accounted for; in fact the company are to be congratulated upon being able to show so large a surplus. There is no doubt that during the coming year the subject of placing wires underground in all places where the trolley system is established, will have to be seriously considered, as the telephone service is greatly disturbed owing to induction. Already the company have placed 126¾ miles of wire underground.

FREQUENT complaints have been heard with regard to the hindrance to the work of the firemen in cities, caused by the numerous electric wires strung in front of buildings used for business purposes. In view of this, it is with pleasure that we report an instance in which the life of a fireman was saved during the recent fire in Boston, by means of an electric cable. One of the district chiefs of the fire brigade, who had gone inside the burning building became shut in by the flames, and could be seen at an eighth story window; from this dangerous position he made his escape by seizing one of the large insulated cables, and crossing hand over hand, to the opposite side of the street. A life saving net was stretched beneath him, as he slowly and with great difficulty made his way, and at last, utterly fatigued, was swung into the arms of his friends.

MR. E. O. Champagne, official boiler inspector in Montreal, has issued his report for [illegible]2, which contains several interesting items. As the city now covers an area of 5,979 acres, and Mr. Champagne's work extends over this large territory, his office is a very important one, and it is gratifying to find the results so satisfactory. He made 1,397 visits of inspection during the year, and condemned 8 boilers and reported 46 as imperfect. There were 59 new and only seven second-hand boilers erected. The number of candidates examined to take charge of engines and boilers was 385, and of these 23 failed to pass the examination. In spite of all this work, Mr. Champagne rendered many services to the road, water, fire and health departments. He hopes during this year by the assistance of amendments to the by-laws governing his work to make his department one of the most perfect of its kind on this continent.

IN the controversy which took place in Toronto and Montreal, prior to the adoption of the trolley system, the advocates of the accumulator system stated that in Birmingham it had proved successful. A correspondent has sent us an article from the Birmingham *Post*, with regard to the substitution of the trolley electric system for steam traction on the Staffordshire Tramway Co's lines between Walsall, Bloxwich, Darlaston and Wednesbury. In this article the following sentence occurs:—"There is nothing new of course in electric traction, but the method adopted hitherto involves the use of accumulators in the cars themselves. The defects of this system, both from an engineering and commercial standpoint, have been sufficiently plain in the case of our own Bristol Tramway, that we are not surprised that Mr. Dickenson thought he could improve upon it." Thus it appears that in a much less rigorous climate than that of Canada, the storage battery system has proved a failure. In referring to this matter, we do so without any prejudice against the storage battery, which would certainly be the ideal system if the difficulties connected with its operation could be overcome.

THE annual convention of the National Electric Light Association of the United States was held on March 1st and 2nd in the city of St. Louis, and is described as having been very successful in point of attendance and interest. Papers were read as follows: "Long Distance Transmission of Power," by Chas. S. Bradley; "The Incandescent Lamp from a Commercial Standpoint," by Calvert Townley, "Power Transmission for Central Stations," by Dr Louis Bell, "Remarks Concerning Power Transmission from an Economic Standpoint," by L. B. Stillwell; "Wrought versus Cast Iron for Filled Magnet Frames," by A.D. Adams; "Morals of Corporations," by E. A. Armstrong; "Relation of Insurance to Electric Lighting and Power," by Wm Brophy; "The 'Vulcanizing' Process for Preserving and Strengthening Poles, Cross-arms, Ties, Etc.," by Harry C. Myers; "Underground Conduits and Conductors, and the Experiences of Electric Lighting Companies in New York City," by Wm. H. Browne; "Thermal Storage for Central Stations," by Geo. Forbes; "Some Experiences with the Alternating System," by R. H. Sterling. Dr. Bell's paper, which we regard as being of the greatest value to central station owners and superintendents, is printed in another place in this issue.

THE business community in the United States has been for some time past awaiting with pleasant anticipation the arrival of the 7th day of March, 1893, as the date on which the Bell Telephone Company's patents would expire. The hope was indulged that with the expiration of these patents, competition in the manufacture and sale of telephones would immediately set in, and telephone users would receive the benefit of reduction in rates. All these bright expectations, however, were disappointed when it became known that the Bell Telephone Company had recently been granted a new patent, known as the Berliner patent, under which the company might continue to enjoy a monoply of the business for a further period of years. The latest and most interesting piece of news on the subject is that on behalf of the United States Government, the Attorney General has entered an action to annul the Berliner patent, on the ground that it was procured by fraudulent means. It is alleged that the Bell Company were the means of delaying the issue of the patent from June, 1877, until November, 1891, greatly to their own advantage; and the demand is made for such a revision of the patent laws as would make it impossible for their objects to be defeated by individuals or corporations for their own benefit.

A BILL for regulating electric lighting throughout Canada was introduced in the Dominion Parliament shortly after the publication of our last issue. Information having been received by the President of the Canadian Electrical Association that many of the provisions of the bill would be likely to prove extremely burdensome to the electric lighting interests, a meeting of the Toronto members of the Executive Committee of the Association was hastily summoned, and it was decided that the President should go immediately to Ottawa, with the object of endeavoring to have the proposed measure amended in such a way as would remove its objectionable features. The President and some of the members of the Association resident in Ottawa, had an interview with the Comptroller of Inland Revenue regarding the matter, and pointed out to him that the lighting companies of Canada were not as a rule making even a fair profit on their investment, and therefore were not in a position to be saddled with the cost of the proposed inspection. It was also pointed out that it would not be possible for the Government to employ inspectors who would be competent to make an inspection of both electric light and gas plants, and therefore that two distinct staffs of inspectors would be required, which would necessarily involve a considerable expenditure. Since the interview referred to, the Government has seen fit to entirely withdraw the measure. Their reasons for so doing have not been made public, but we may fairly assume that the information furnished them has served to place the matter in a different light from that in which they had previously regarded it, owing to lack of information necessary to enable them to arrive at a proper conclusion.

THE officers of Montreal No. 1 C. A. S. E. met by invitation at the residence of Mr. Nuttall a few evenings ago, and considered means for raising the necessary funds to suitably entertain the delegates to the annual convention of the Association, to be held in Montreal next September. It was decided to recommend that the members resolve themselves into a committee of the whole to solicit subscriptions from friends and steam users.

IN December last the Toronto Incandescent Electric Light Co. reduced their price to customers from one cent per hour to eight tenths of a cent per hour for 16 c. p. lamps. This step, the company state, resulted in almost doubling the volume of their business. Thus encouraged they have announced within the last few days their decision to further reduce the price to six-tenths of a cent per lamp per hour. At this price incandescent electric lighting should displace gas in business establishments at least. It is said to be the intention of the gas company to meet this cut in rates for electric lighting by a corresponding reduction in the price of gas.

IT may be of interest to some central station managers to know how an alternating current meter's record of light used or current consumed is measured and charged for, and to make it plain to those who may be groping in the dark, we will endeavour to point out the why and wherefore of it. To begin with, then, we have the ampere hour recording meter, whose dails are supposed to show the numbers that have passed through at a fixed voltage, prominent among which are the Schallenberger and Slattery, both being fairly accurate meters provided the voltage is maintained at 50, but with any greater or less amount of voltage, they vary in registering considerably more than the greater or less amount of current that may be forced through them from the increased or diminished voltage, the moving parts seeming to respond too freely to any increase or decrease of the pressure. They can be called accurate meters at 50 volts, but variable ones under other conditions. They measure the amount of current that passes through them by means of coils, between which is revolved, in one case a disc of metal, and in the other case a copper drum, the velocity depending on the amount of current traversing the coils. A small worm gear transmitting the motion to the clock work mechanism of the registering dials. These, as mentioned before, are made to read ampere hours at 50 volts, and as the general run of 16 candle power lamps consume about one ampere of current in one hour, it has been customary to tell the users that the price is so much per 16 candle power lamp hour, and in some cases the current is billed thus that is, so many lamp hours at such a price. The best meter in use to-day is probably the Thomson Recording Wattmeter, and we are firmly of the opinion that the system of measuring the watts consumed and charging for them at so much per thousand watts is the right thing to do. In this case the central station is paid for all that is consumed and the watts are measured no matter what the voltage may be. Without wishing to discourage the use of other meters, we are fully satisfied that this system of selling current for incandescent lighting is the right one, and where a new plant is being installed should be the one selected. With plants that are already established and using other make of meters it would be quite a difficult matter to make use of this class of meter, simply because it would complicate matters considerably to have some meters registering amperes and others watts. Then again a customer with a watt meter might happen to have a next door neighbor who is using an ampere meter, in which case the wonder on the part of both of them would be why it was so, and each one would have his private opinion that his meter was put in different to his neighbor's to enable the company to try some scheme on him which would result in his paying more money for his lighting than his neighbor was doing.

THERE seems to be considerable agitation in different parts of the world as to the practicability of conveying power by means of the electric current over long distances. While we do not desire to enroll ourselves on the list of those who make the positive statement that power can in this manner be transmitted successfully from a commercial standpoint, yet we are decidedly of the opinion that the agitation is one in the right direction. True, high tension currents and dangerous to life would have to be employed, in most cases perhaps as high as 25,000 volts would be necessary; and it might require that the cross arms and poles have a death's head and cross bones painted on them to warn the unwary. Notwithstanding, these features of the proposal should not be sufficient to put a stop to experiments in the direction indicated. The same objections would apply to a steam road on which fast trains are being hourly operated, yet no one would think for a moment of resisting the building of such a road on account of any possible accidents that might happen on it, or on account of any deaths which might arise through such accidents. There is no doubt that a line can be built to carry such a high voltage as that mentioned; of course extra precautions would be required in its construction. The insulators would have to be of a special pattern, made to carry oil as an insulating medium. The wire would require to be well insulated with thick solid rubber core and ample covering to prevent abrasion. There would have to be some special method of fastening it to the insulators, and again the poles would require to be set not more than 75 ft. apart, so as to make the weight of wire between poles comparatively light, and thereby prevent any liability of the wires letting go between poles and falling to the ground. Guard wires both below and above would of course be an absolute necessity in districts where there would likely be any crossing of them by falling wires of other companies, as also to prevent their being brought in contact, should a new wire be strung under the high tension ones. We predict that it will not be many years before some such project will at least be attempted to be carried out.

ENGINES FOR ELECTRIC LIGHTING.

III.

THE frequent change of load and demand at certain hours, or rather at uncertain hours, for a much heavier load than the average are found in most power stations to be serious difficulties. A commonly adopted plan has been to have several steam engines, and to run one or more of these as required. At first sight this method seems very simple and effective; it is, however, attended with a very unsatisfactory result.

The engine is not the original source of the power, and when it is necessary to maintain steam pressure on a number of boilers in order to be able to meet sudden demands for power, there is considerable loss. The loss due to merely keeping fires banked with pressure on the boilers amounts to a considerable sum. The boilers and machinery are idle for a longer time each day than they are in use, and the expense of maintainance is about the same as if they were in steady or continuous use. These and other details, when carefully considered, show that what at first seemed such a simple solution of the problem, is at best but a make-shift.

Various schemes have been proposed and tried to overcome the loss. One plan recently proposed in England is to enable those having their plant arranged with a number of engines to save the loss caused by keeping steam up on the boilers. The author of the plan referred to is a well known professor of engineering. He suggests having a certain amount of power generated by the steam boilers in the usual way, and alongside of the steam boilers have a number of hot water reservoirs with furnaces under them. If 100 lbs. pressure be carried in the steam boilers, the hot water reservoirs would be loaded to a pressure of about 300 lbs. per sq. inch. Heat would thus be slowly accumulated in the water and stored there. When an extra demand came for more power another engine would be started, and to supply the steam hot water would be allowed to escape into the steam boilers from the hot water reservoirs. This water being at such high temperature would at once form steam, and so meet the supply for the extra demand. The proposal seems a good one, and one likely to meet the difficulty which has to be got over. It is a well known fact that water has a great capacity for receiving and retaining heat and under the plan suggested a great quantity of energy could be stored up in the hot water ready to be converted into steam for use in the engines.

Another plan which is in use is to have the engine considerably larger than required for the average load, and collect the surplus electricity in an accumulator, from which it could be drawn to meet the demands. This plan is in actual use in some places, but has a number of disadvantages arising from the first cost of accumulation and from losses in the storage and distribution of the electricity.

A modification which has been suggested is to have the engine larger than necessary for the average load, and to utilize its surplus power in pumping water into an elevated tank; when extra demands had to be met the water to be run back into a lower tank, and in doing so drive a water wheel. The same water would be pumped up again and used repeatedly. By this means an almost constant load could be maintained on the engine and boilers, which could thus be run in the most economical manner. In some places the power distribution is effected by means of water distributed in mains and delivered at a high pressure, in some cases as high as 700 lbs. per sq. inch.

A combination plant using electricity for lighting purposes, and to some extent for power, and water at high pressure for the main power supply, seems to be one which in some situations would be not only practicable but one which would prove convenient and economical.

The loss of efficiency in distribution of the water is due to friction in the pipes and to leakage at joints. These difficulties are now well understood, and the means required to keep them down to the lowest point are known. Water is not like unseen electricity or the subtle heat, both of which seem so difficult to manage in storing and transmitting.

In a power station combining these two systems the electric machinery would be driven by triple expansion vertical engines adapted to the average load, and a similar engine could be used to drive the water pumps by means of gearing. The water would be pumped into an accumulator loaded to maintain a uniform pressure in the mains. In ordinary cases the demands for light and for power would not be at the same hours. The main demand for light would be at night, and for power the demand would be during the day. The average of the two combined would be more constant and consequently the firing at the boilers would be more uniform and more economical.

The attention of engineers is at the present time much occupied with schemes for convenient and economical distribution of power. The electric system is not yet accepted as the best in all circumstances, and it is proposed in another article to give some information regarding some other methods.

Convenience, safety, economy and reliability or durability have all to be taken into account in considering the merits and demerits of any system. The steam engine and boiler are, however, at the foundation of nearly all the schemes and systems, and with all their faults they are as yet indispensable for civilized convenience and comfort.

PERSONAL.

Mr. G. Pink, M. E., has been appointed chief engineer at the main pumping station of the Toronto waterworks. His predecessor, Mr. Baxter, takes the post of assistant engineer.

There is said to be a likelihood that Mr. James Gunn will resign the position of superintendent of the Toronto Street Railway Co. and accept the management of a large financial institution.

Messrs. Wright & Garland have purchased Mr. Paul's interest in the electric lighting business at Carberry, Man.

Advices from St. John, N. B., state that the wires have been strung, the machinery put in the station, and it is announced that electricity will soon supersede horses on the street railway of that city.

TRADE NOTES.

The Reliance Electric Manufacturing Company, Waterford, Ont., have shipped to the Keegans-Milne Company, of Montreal, a 150 light incandescent plant.

Prof. Ellis, of the School of Practical Science, Toronto, after having made an analysis, certifies to the usefulness as a disinfectant and deodorizer of the compound "Phenyle," manufactured at Port Hope, Ont., by Mr. Alonzo W. Spooner.

The Eugene-Phillips Electrical Works, Montreal, have received an order from the Montreal Street Railway Company, for 60 tons of copper wire. This is believed to be the largest single order for wire ever given in Canada. The same Company have received from the Bell Telephone Co., orders to the amount of over 100,000 feet of aerial and underground cable.

The McGuire Manufacturing Company, of Chicago, has established a Canadian branch at St. Catharines, Ont., where it will manufacture all the specialties of the company, and particularly the well known McGuire trucks for electric railway service. By establishing this branch the McGuire company saves a duty of 35 per cent. imposed on American built trucks, and at the same time is in closer relation with the Canadian trade.

Mr. C. F. Medbury, the Montreal representative of the Canadian General Electric Co., has closed the following contracts for that company. -A 540 light plant for the Montreal Cotton Mills at Valleyfield; a 350 light plant for Knowlton, where the three wire system will be used with continuous current, as the station is located directly in the centre of the district to be supplied, and a 650 light plant for Waterloo. Here the station is located 3½ miles from the town, and alternating current at 2,000 volts pressure will be used with 10 volt transformers connected upon the three wire system.

On the 20th Feb. last, an extensive conflagration, which originated in some manner not yet elicited, upon the premises of the Keegans-Milne Co., Montreal, completely destroyed both building and stock, extending also to adjoining establishments. J. Ross, Son & Co's. Electrical Works suffered much damage to building, chiefly caused by the smoke-stack tumbling upon the roof and crushing in one half of it. The Messrs. Ross with business like promptitude immediately removed all their plant to other premises close at hand, and are now running as usual. Their loss, outside of removal, will be small.

The Reliance Electric Mfg. Co., of Waterford, Ont., report the following recent sales: St. Thomas Gas Co., 100 H.P. 500 volt generator. The Brantford Electric Light and Power Co., 80 H.P. 500 volt generator; Lakefield Electric Light Co., 35 light arc dynamo; Wm. Cooke & Sons, St. Catharines, 40 H.P. motor; S. Taylor & Sons, St. Catharines, 5 H.P. motor; Walker & Co., Guelph, 10 H.P. motor; Lawson Bros., Toronto, 15 H.P. motor, H. R. Stewart, Toronto, 5 H.P. motor; Dominion Show Case Co., Montreal, 5 H.P. motor, John M. Poole & Co., Toronto, 7 H.P. motor; Wm. Gordon Osgoodby, Toronto, 10 H.P. and 2 H.P. motors; T. W. Ness, Montreal, 5 H.P., 7 H.P., 10 H.P. and 2 H.P. motors.

The Montreal Electric Co. is a new aspirant for public patronage in the electrical construction and supply line, being composed of Mr. John Shaw (late office manager for Messrs. J. & C. Hodgson) who assumes the general management, and who is perhaps one of the best known men in Montreal hardware circles. Mr. Wm. B. Shaw, whose name will be familiar to many of our readers, and who is deservedly popular with the electrical trade from his connection with T. W. Ness and the Royal Electric Co., is electrician for the firm, whilst Mr. Walter F. Taylor, the present able foreman for T. W. Ness, becomes mechanical superintendent for the new Company. With such a trio of hard and experienced workers there is no fear of the success which, with many friends, we heartily wish them, in their new undertaking.

For some time there has been considerable competition in Montreal among those wishing to handle the dynamos, generators, moters, &c., manufactured by the Reliance Electric Manufacturing Co., of Waterford, Ont. Mr. Slaght, the President of the Company, was in Montreal last week, and we understand decided to place the agency for the Province of Quebec, with the well-known electrical firm, T. W. Ness. We think this selection a wise one and a large business will no doubt be the result. A consignment of machines has already been received and may be seen at any time at the showrooms, which are centrally located, at 749 Craig St. The services of Mr. M. W. Corbitt, well-known in Montreal on account of having been for some years connected with the Edison General Electric Co. and latterly with the Royal Electric Co., have been secured by Mr. Ness for the purpose of looking after this branch, and the interests of the Reliance Co. will consequently be well looked after. Many firms are now putting in motors, thus avoiding the necessity of installing small engines and boilers, and we have only to look over the record of those installing private electric light plants to realize how rapidly this industry has developed.

The Toronto Incandescent Light Co., Ltd., have given notice of a further reduction in their prices of twenty per cent.

A charter of incorporation has been granted to the Hamilton, Waterdown & Guelph Electric Railway company, with a capital of $500,000. The incorporated members of the company are: Sir W. P. Howland, Toronto; W. Laking, lumber merchant, W. O. Sealey, accountant, Jacob Flatt and W. Deboss Flatt, timber merchants, all of Hamilton; Alex. Brown, shipper, John Ira Flatt, timber merchant, John Nicholson and Leopold Bauer, farmers, all of East Flamborough; John Owen McGregor, physician, and Chas Sealey, of Waterdown.

THE MOST ECONOMICAL BOILER AND ENGINE FOR CENTRAL STATIONS.*

By J. A. FARLINGER.

MR. PRESIDENT AND GENTLEMEN: The subject we are about to discuss this evening is a rather difficult one to handle in the time at our disposal. When we consider the amount of knowledge which science, theoretical and practical, has put at our fingers' ends, it seems a gigantic subject for me to handle at all, so you will kindly overlook the brevity with which I shall deal with the subject. As this is my first effort at preparing a paper, I hope you will kindly bear with me during the reading of it, and not expect too much.

At the outset let me say it is not my intention to boom some particular make of boiler or engine; I think I shall have done my duty and served a purpose, if I define the necessary points that should be found in the boilers and engines of every central station. I have been somewhat puzzled, not as to what I should put in this paper, but as to what I should leave out.

I shall commence by stating that there is no such a thing as "horse power" to a steam boiler, it is a measure only applicable to dynamic effect, but as boilers are necessary to drive steam engines, the same measure applied to steam engines has come to be universally applied to boilers and cannot well be discarded. In consequence, however, of the different quantities of steam necessary to produce a horse power with different engines, there has been and is a need of an accepted standard by which the amount of water required to provide steam for a commercial horse power may be determined. This standard as fixed by Watt was one cubic foot of water evaporated per hour from 212° for each horse power. This was at that time the requirement of the best engine in use; at the present time Prof. Thurston estimates that the water required per hour per horse power, in good engines is equal to the constant 200 divided by the sq. root of the pressure, and that in the best engines this constant is as low as 150. This would give for good engines, working with 64 lbs. pressure, 25 lbs. water, and for the best working with 100 lbs., only 15 lbs. water per hourly horse power. The standard, as adopted by the Centennial Exhibition of '76, of 30 lbs. water per hour, evaporated from 212° for each horse power, is a fair one for both boilers and engines, but as the same boiler may do more or less work with less or greater economy, it should be required that the rating of a boiler be based on the amount of water it will evaporate at its highest economy. Parties have been known, and are known to-day, who claim an evaporation of from 19 to 20 lbs. water per pound of coal, when the highest that is practically possible, I believe, is only 13 lbs. of water per pound of coal. Such boilers are dear at any price.

I am informed that the results of 30 tests made of certain water tube boilers, gave an average evaporation of 11.4217 lbs. water per pound of combustible, which is a very high efficiency, being within 4 of Rankin's standard, and within 7½ % of the highest theoretical efficiency. Prof. Thurston says, "The maximum conductivity or flow of heat is secured by so designing the boiler as to secure rapid, steady and complete circulation of the water within the boiler, and securing opposite directions of flow for the gases on one side and the water on the other."

The accumulation of scale inside and soot on the outside, will seriously affect the efficiency and economy of a boiler; only one-eighth of an inch deposit of soot renders the heating surface practically useless, only one-sixteenth of an inch of scale or sediment will cause a loss of 13 in fuel; a boiler must therefore be kept clean to secure the best results. The setting should be durable and kept in good order, as a loss of 21 has been known to be caused by poor setting. As an instance I might mention a case that came under my notice in a large town in Western Ontario where there was a saving of 25 effected in fuel, by a very simple thing, so simple indeed that the largest engine firm in the west made the error in installing the boiler, and I should not be surprised to learn they have made the same error in other places. Following are the requirements of a perfect steam boiler:

1. It should be simple in construction, and made of the best materials sanctioned by use.

2. It should have a constant and thorough circulation of water throughout the boiler, so as to maintain all parts at one temperature.

3. It should be provided with a combustion chamber, so arranged that the combustion of the gases commenced in the furnace may be completed before its escape to the chimney.

4. It should be provided with a mud drum to receive all impurities deposited from the water in a place removed from the action of the fire.

5. All parts should be readily accessible for cleaning and repairs, this is a point of the greatest importance as regards safety and economy, and has heretofore been possessed by plain cylinder and large flue boilers.

6. The heating surface should be arranged as nearly as possible at right angles to the currents of heated gases, and so break up the currents as to extract the entire available heat therefrom.

7. The boiler should have a large water surface for the disengagement of the steam from the water in order to prevent foaming.

8. It should have large and free passages between the different sections to equalize the water line and pressure in all.

9. It should have a steam and water capacity sufficient to prevent sudden fluctuation in pressure or water level.

10. It should have, if possible, no joints exposed to the direct action of the fire.

11. It should have a great excess of strength over any legitimate strain, and should be so constructed as not to be liable to require early repairs, or be strained by unequal expansion.

12. It should be durable in construction, perfect in workmanship and not liable to require early repairs.

13. The water space should be divided into sections, and so arranged that should any section give out, no general explosion can occur, and the destructive effects will be confined to the simple escape of the contents.

14. It should be proportioned for the work to be done, and be capable of working to its full rated capacity with the highest economy.

15. It should be provided with the very best guages, safety valves and other fixtures.

There are some six different classes or kinds of boilers in use to-day, which I have made a number of rough sketches of in order that you may better understand their different forms and constructions. The names of the different types are as follows: plain cylinder, flue, vertical tubular, tubular, locomotive and water tube boilers. Each type has its uses and likewise its abuses.

It is not my intention to go into the designing and proportioning of the different types of boilers, but rather to consider where the different types would be of efficient service, and in so doing we shall be able to pick out the type of boiler we require for any given power plant, whose surrounding conditions we are acquainted with.

Let us first consider the type of boiler known as the plain cylinder boiler, which is the simplest type of boiler in use, and is principally used in large iron rolling mills and coal mines—used in the first place because of the large amount of heat available from the heating furnaces, which would otherwise be wasted; again these boilers seem to meet the requirements in these places both as to cheapness of first cost, and being able to carry from 35 to 60 lbs. pressure to the sq. in., this pressure being sufficient to work the shear engines. In coal mines they serve the purpose because of the indifference as to the amount of fuel consumed.

The flue boilers, commonly known as the Cornish or Lancashire boilers, consist of a large cylinder with one or more flues passing through their whole length. Assuming many different arrangements as regards the flues, in this boiler there is considerably more heating surface than in the plain cylinder boiler, therefore from the form of its construction it is more economical in fuel; but it is hard to clean, and the design is poor, there being hardly two parts of the one temperature, therefore unequal expansion and contraction, and the fact that the greater the diameter of the flue the heavier metal and the more staying required, shows weakness; the circulation is poor because of the construction, which will cause wet steam and a tendency to foaming. This boiler would also be very serviceable where cheapness in first cost and a large supply of fuel to dispense with are necessary.

The vertical tubular type can best be defined by stating that it will serve the purpose in a way for a small steam plant of say 15 h. p. and under where economy in space is the only consideration. Apart from this, I would not use it or any other upright boiler, among which I include porcupine boilers, as the circulation is defective. They waste fuel in not being constructed to receive the full benefit of the flow of heat and are subject to foaming, to unequal contraction and expansion, are hard to clean, and have too many joints exposed to the direct action of the fire.

In the tubular we approach nearer the goal of perfection which it is ever our aim to attain. It has its defects though; the circulation is not as perfect as it might be; it requires careful attention, lots of cleaning, because of the position of its flues, is subject to a great variation in contraction and expansion of its different parts, is sometimes subject to severe foaming. On the other hand it has the advantages of a large heating surface, strong construction, fairly economical and steams well.

The locomotive boiler I shall not touch upon, as it is not used to my knowledgo for electrical purposes.

We now come to the most efficient type of boiler now in use—it is the water tube type. Its advantages are many, its efficiency is very high, reaching nearly the highest practical point of evaporation. Its circulation is perfect; it has few or no joints exposed to the direct action of the fire; is so constructed as to even the action of contraction and expansion in all its parts; is easy of access, easy to clean; no general eruption or explosion can occur; it utilizes the greatest amount of available heat, which flows at or nearly at right angles to the circulation of the water; is so constructed as to give as dry a steam as possible; is very durable, and will stand almost any amount of abuse.

What I have said of the sketches of boilers before you this evening will apply generally to the different makes of each type of boiler, with few exceptions.

Having considered some of the points in favor and against the use of the different types of boilers, let us turn our attention to some of the necessary fittings. We shall first deal with the

* Paper read before the Montreal Electric Club.

steam guage. About the year 1849 Eugene Bourdon, a Frenchman, discovered that the free end or ends of a flattened tube, with enough elasticity for use as a spring, would move when pressure was applied through the medium of a fluid, externally or internally; that the motion was in direct proportion to the pressure applied; and when the pressure was removed, it would assume its former position. He at once conceived the idea of a new pressure gauge, in which this should be the main spring or means of motion, and which, as originally designed, far excels any other instrument for sensitiveness and accuracy; but is best adapted for measuring low steam pressure and vacuums, or wherever a very delicate instrument is required. As it is more efficient to carry high steam pressures, so do we want a gauge to meet the demands for registering higher pressures; another point against it being the position of the tube; if we are not using it continually in winter the steam condensing in the lower end of the tube is either likely to severely strain or burst it.

There have been several improvements on this gauge by Crosby and others. It originated from observations made of the motions of the free ends of the springs or tubes already in use while under variable pressures. It was found that not only the horizontal motion of the springs could be utilized, but also that of the perpendicular or upward action of the same spring, if a given length, and that by uniting these motions by proper mechanism it could be transmitted to the pointer. This permitted and required stiffer springs for measuring like quantities of steam than any before used. Experience has shown that under no circumstances of pressure employed, within the amount indicated on the dial, can they be straightened or their original elasticity affected. This device also avoids and prevents any vibration of the pointer under action. Being held at their lowest points and having no dip, the water is allowed to return to the siphon, thus preventing and removing the danger of freezing by extreme cold. While these gauges partake of all the good qualities of the original Bourdon, the defects are carefully eliminated, and the use of springs 100% stronger than in other style gauges is permitted, so preventing its setting under any pressure that may be indicated on its dial. There are other style gauges which I shall not take up your time with describing, some of which have long since gone out of use, among them being Smith's gauge, the mercurial, the long barometer and the short barometer gauges.

We now come to one of the most necessary adjuncts of a boiler—the safety valve. The first one we shall deal with is Salter's spring balance. My reason for dealing with this one first is that where it has been used it has served the purpose of a safety valve and steam gauge combined. The principle is exceedingly simple; it is the ordinary safety valve and lever, and instead of a weight at the end of the lever, there is a threaded spindle brought up through the end of the lever with a nut on the upper side. On the lower end of this spindle is a spring, the bottom of which is anchored to a brace in some convenient place on the boiler front about 4 feet from the ground, and is incased in a brass tube on which there is a stationary scale, and on the outside of this is another casing fastened to the spindle just above the top of the spring.

The next is the ordinary safety valve with which you are all more or less acquainted. This valve has much to answer for, owing to the friction of its parts. It will not open until the pressure is above what it is set at; it will continue to blow off after the pressure of the steam has fallen far below the point of opening; it wastes large quantities of steam, which is enough in itself to condemn it.

We now come to a valve which is in common use to-day and seems to meet with a great deal of favor, belonging to a class of valves known as pop safety valves. The one before us this evening is Mr. G. H. Crosby's patent. The design is unique and the mechanism perfect. It is positive and direct in its action, and when properly adjusted and taken care of, is sensitive to act. Another valve of the same type, not so common, but which is probably just as efficient, is the Scovell safety valve. It is claimed for this valve that its relieving capacity is not restricted, and that it lifts to its full height with all pressures, presenting an opening equal to the area of its discharge pipe. Its seats are of the simplest form, and its precision of action is not subject to derangement by the wearing of its valves or their seats. No special adjustment is necessary. The seats can be reground or renewed without special skill. The friction surfaces are reduced to a minimum; the springs not subjected to violent and sudden compression. It is thoroughly self contained; exempt from the dangers of being tampered with; opens with promptness and closes with a slight loss of pressure. Of course these are only two of the several valves of this type, all of them more or less efficient.

There is another safety valve which I might call your attention to this evening, more because it is very little used to-day. The valve is known as the reverse valve, vacuum valve, internal safety valve or atmospheric valve. The purpose it was intended to serve was to prevent the boiler from collapsing from external pressure of air, because of the vacuum caused by the condensation of the steam. The idea is good, but it is doubtful if the boilers of to-day require such a protection, they being much more strongly constructed and of a different type from the boilers of a very few years ago.

In conclusion I might say of the boiler plant: on it depends two-thirds of the efficiency of our power plant; in it lies the power to destroy our dividends, our property and our lives. Can we therefore be too particular in our choice of a boiler and its construction, from the raw material to its setting, and the other fixtures necessary for its operation?

You will perceive I have not spoken of the furnace and chimney; these are worthy of a separate paper. With regard to injectors, there are a number in the market, most of them giving satisfaction if properly handled. I might say that some inventors claim that with the use of their injectors feed pumps and heaters are a useless expense, and in a majority of cases they are right. Concerning fuel economizers, heaters, and feed pumps, it would take up too much time to discuss their merits, which in many cases are very doubtful.

Let us now turn our attention to the second great factor in the utilization of steam power, namely, the engine, the economy of which is expressed in terms of the number of lbs. of water consumed per H. P. per hour. The rate of water consumption is the only expression which should be used, as applicable to the efficiency of an engine, as the amount of fuel used must depend largely upon the kind of boiler used, its condition, the manner in which it is set and fired, the quality of fuel, the draft, and numerous other conditions for which the engine is in no way responsible. This rate may be found by the following rule: Divide the constant number 859,375 by the volume of steam at the terminal pressure, and by the mean effective pressure—the quotient will be the desired rate. With non-condensing engines, the best possible economy, with a given boiler pressure, is theoretically obtained when the full pressure is admitted to the cylinder up to the point of cut-off, and the degree of resulting expansion is such that the terminal pressure is lowered to, or nearly to that of the atmosphere, provided that the construction of the engine is such as to combine with a free exhaust and induction the least possible loss from clearance, friction, leakage and condensation. Under such conditions the steam may expand until there is no more work in it, and no higher economy is possible with a given boiler pressure without a condenser. The best theoretical economy with a given load and boiler pressure is obtained when the cut-off takes place as early as possible in the stroke, consistent with obtaining the average pressure necessary to do the work and maintain the proper speed. A first-class boiler will deliver to the engine 75% of all the energy in the combustible, or say 10,875 out of a total of 14,500 heat units, or allowing 8% for ashes, 10,000 heat units for each pound of coal burned. This represents 7,720,000 foot pounds of energy, which, if all utilized by the engine, would give 3.9 H.P. for one hour, at the rate of .26 lbs. coal per H.P. per hour. But the most efficient engines yet built have only attained 1½ lbs. coal per hour, or the small amount of 17% of the energy delivered by the boiler, while the averge engine uses 3½ lbs. coal per hourly H.P., and discharges unused 93% of the energy delivered to it. Of course the greater part of this loss is in the latent heat of the steam which is exhausted into the atmosphere or condenser, as the case may be, and is unavoidable so far as now known.

Compound engines with high pressure boilers have an advantage over single cylinders, and under some conditions where a large amount of power is needed steadily, triple and quadruple expansion engines work with a saving, but I think it is safe to venture the statement that triple expansion or quadruple expansion engines are yet impracticable for central station work in Canada.

Let us turn our attention to engines that are suitable for our central station work. We shall first speak of the high speed engine, the theory of which is, the longer steam remains in contact with a cooler surface the more it will be condensed, therefore we require a short cylinder to use a little steam at a time, use it very quickly, and keep the temperature of cylinder and steam chest up as high as possible, the result being a high speed. Suppose we carry this theory a little further and compound one high speed engine; it would result in a saving of about 16% of coal and 14% of water; and if we go still further and add a condenser, we shall effect a still greater saving. Another thing in the favor of high-speed engine is that it dispenses with the necessity of a counter shaft, pulleys, bearings and extra belts, the cost of maintaining which is no small item in itself.

In a slow speed engine the cooling effect of the expansion penetrates further into the metal of the cylinder, requiring more condensation at each admission to reheat it, therefore is more wasteful of steam. If we compound it and then make it condensing, we add to its efficiency as in the case of our high speed engine, but the saving (though I could find no results of actual tests) I believe is less than in the case of our high speed engine. With a slow speed engine it is necessary to have a counter shaft, etc., together with the extra cost of maintaining it. In high speed engines the valve gear is positive and direct in its action, has a wider range of cut-off, is more sensitive to variation in load, governs quicker and better, therefore is more reliable under all circumstances.

In the best styles of slow speed engines, such as the Corliss, Wheelock and Brown engines, there is too much intermediate gearing upon which to depend for a positive action of the valves. I have personally noticed both on a Corliss and Wheelock engines, the valves miss action time after time.

I am not prepared to go into the principles and construction valves and valve gears this evening. The governors on these engines are very sluggish in their action and not to be depended on, under any circumstances. This is a broad statement, but a true one.

The repairs on a high speed engine, if thoroughly constructed, are decidedly less than on a slow speed engine of equal construction. I state the following as a fact, given me by the manager of a very large concern, having a number of engines in use, both high and slow speed, of different capacities; that his slow speed engines, though running only 10 hours per day on a steady load, required more attention, and the repair bills of slow speed engines were as 100 to 1 to the high speed engines He also stated that two Westinghouse high speed engines had yet to cost him five cents for repairs after five years' run, averaging 14 hours run per day Of course there are exceptions to this, as I know a case in this city where there is a Corliss and an Armington & Sims engine, in which the results I have just recited are reversed, but there was a reason for it.

It is my belief that within a very few years we shall see high speed engines of upright construction used entirely. The wear is less, and strains are taken more easily and less room occupied.

It might be well to put a limit to the foregoing statements by saying that I would advise the use of high speed engines up to 200 H.P., and a slow speed engine for any larger power plant, to be compound and condensing, except in the case of the high speed engine where you only require up to say 35 or 40 H.P.

Concerning condensers, I should very much like to read you Mr. J. H. Vail's letter on condensers in his article on "Increased Commercial Efficiency and Higher Economy in Central Stations," but I have already taken up too much of your time. In conclusion I might say it is impossible to lay down a fixed rule for making a choice of engine for a central station, as the requirements and demands are different in nearly every case—you should be governed by the work to be done, the cost and supply of fuel and water. First ascertain these facts, then make out your specifications accordingly.

Gentlemen, I thank you for your kind attention this evening and I am only sorry I could not make my paper more interesting I might also state that to Mr. Piuolet and Mr. H. R. Lockard are due the thanks of the club for the sketches before you this evening.

SPARKS.

Cairo in ancient Egypt is to be illuminated by electric light.

Mr. H. W. Petrie, Toronto is replacing his engines with an electric motor for running his machine shop.

Representatives of American oil firms are in Toronto seeking to establish petroleum as fuel for engines.

An electric light plant is being installed in Messrs. A. G. Van Egmund & Son's woolen mills at Seaforth.

A railway car-brake has been invented operated by electricity and is said to be as serviceable as an air brake.

A company has been formed in New Denver, B. C., to build a tramway, electric light plant and waterworks.

Letters-patent incorporating the St. Jean Baptiste Electric Company have been issued. The capital stock is $100,000.

The Royal Electric Co. is providing the whole of the plant for the new electric light company of Smith's Falls.

The council of Victoria, B. C. are going to take over the street railway of that place as well as the electric light service.

A complete set of electrical cooking appliances is to be placed on the new steamer Columbus. This will be the first vessel thus equipped.

Mr. Joseph Hancock, of St. Catharines, is said to be the first man to grind a saw by electricity. The event took place on February 28th last.

The Windsor and Amherstburg Electric Railway has been purchased by the Citizens Electric Light Company and others of Windsor for $156,000.

Great improvements are being made to the electric light works at Nanaimo, B. C. Many miles of new wire for the incandescent and arc light system are being fixed.

Messrs. F. Nicholls and J. H. Quinlan, of Toronto, and A. J. Corriveau, of Montreal, attended the National Electric Light Association Convention at St. Louis last month.

Messrs. Leitch & Turnbull, of Hamilton, have built an electric elevator for the Winnipeg warehouse of Messrs. James Robertson & Co. The power is supplied by a Kay motor.

A delicate and quick reading electrical thermometer has been introduced by a Frenchman. It is capable of showing a change in temperature of one-twentieth of a degree centigrade.

The Royal Electric Light Co. have provided the Pembroke Electric Light & Power Co. with an 800 light alternating dynamo. This addition to their plant is for providing light to outlying districts of Pembroke.

Belleville is likely to have an electric street railway system covering a distance of eight miles. Messrs. A. J. Close and R. H. Fraser, of Toronto, are to report as to the feasibility of the scheme and the probable cost.

The Northey Manufacturing Co. have fixed one of their plunging pumps upon the premises of the Allen Manufacturing Company. They also have sent two artesian well pumps to Montreal to pump from wells 140 feet deep.

A. E. Thompson pleaded guilty in Toronto police court to a charge of embezzlement from the Bell Telephone Co. He was committed to gaol for 60 days.

At a meeting of the Portsmouth, Ont., council a motion was passed for presentation to the Ontario Legislature asking that body to grant the street railway company power to substitute electricity for horses as a motive power.

The Dodge Wood Split Pulley Co. have provided the Ottawa Electric Light Co. with 300 h. p. rope drives. This latter company is said to be the first to transmit the whole of their power with rope drives instead of leather belting.

Electricity is to be used in the manufacture of bleaching powders, the amperage to be equal to affording sufficient heat to decompose common salt from which chlorine is obtained. Starch of the lower qualities can be bleached by electricity.

The following officers have been appointed by the directors of the National Electric Tramway and Lighting Co., of Victoria, B. C., for the following year: Hon. D. W. Higgins, president; T. J. Jones, vice-president; Major C. T. Dupont, secretary-treasurer.

Messrs. Cook & Son, of St. Catharines, Ont., have just completed, for supplying power to factories in that city, an electric power station having a 100 horse power generator 500 volt machine. The generator is loaded with Reliance motors and all the available power is being used.

An Ottawa electrician claims to have discovered a process for utilizing electricity to abstract the heat from cast iron blocks until they are reduced to the temperature of ice, and then using them as a substitute for natural ice. He claims that this can be done at a price to compare favorably with the latter.

An invention is being patented in the States and England of a new trolley pole. It is made to work from a point two feet above the car, and is so arranged that in case of accident and the connecting wheel missing the circuit wire it brings itself into a horizontal position by means of balance weights.

The Canadian Whitney Hoyt Electric Co., are about to open up the old Edison Factory at Sherbrooke, P. Q., for the manufacture of electrical instruments, especially ammeters and volt meters, for the Canadian market. Mr. F. T. Dunlap is president of the company, and Mr. Adam H. Hoyt, M. D., electrician.

An electric bit for vicious horses has been invented by a citizen of Hamilton, Ont. A small battery is carried in the vehicle and wires are connected from it through the head gear to the bit. When the animal begins to kick, a button is pressed to bring into operation the electricity, which, it is said, will speedily stop such dangerous business

An interesting paper was read by T. R. Roseburgh, B. A., lecturer in electrical engineering at a recent meeting of the Toronto School of Science Engineering Society on "Compensation as an Aid to Invention." Explanations of methods for solving telegraphic and telephone problems and other matters on these lines were dwelt upon. A discussion on the paper followed.

Excitement prevails in Cote St. Louis, near Montreal, over the claims of the two rival companies for the electric railway franchise. A council meeting was called recently for the purpose of signing a contract with the Montreal Street Railway Co., and Mr. A. J. Corriveau, the other claimant, has sued the municipality for $50,000 for alleged breach of contract. The meeting referred to broke up amid great confusion. Neither the Street Railway nor the Corriveau Co. have yet the contract, and the matter is at a deadlock.

In spite of the vigorous opposition against the Toronto & Richmond Hill Street Railway, the York township council has passed a by-law authorizing the construction of the proposed road. The Township Council have no doubt done what they deem to be right in the matter, and their decision will be welcomed by the people most concerned, who showed their approval of the new railway by granting to it a bonus of $60,000. The work is now to be pushed on, and in our next issue we hope to give some details concerning the railway itself.

TELEGRAPHING MR. GLADSTONE'S SPEECH.—In view of the telegraphic despatch of reports of Mr. Gladstone's speech on Monday evening last, great preparations were made by the postal telegraph officials. Extra Wheatstones and "punchers" were fitted up at the central telegraph office, wires were added to all the principal circuits of the kingdom, and several towns not normally in direct connection with London were put through. The main East Coast line of the Postal Telegraph Department carrying twenty important wires, was subjected to considerable damage near Hatfield on Monday morning. Some workmen engaged in cutting trees allowed a heavy branch to fall right across the wires, smashing all of them at that point, and breaking six wires and four wires in the two adjacent spans. The accident occurred between twelve and one o'clock. The sectional engineer, Mr. Parkinson, was at Welwyn at the time, and received intimation of the disaster at 1 p.m. He drove at once to Hatfield, a distance of 10 miles, taking with him a line man and some necessary stores. They arrived on the scene of the breakdown at 1:50, got three of the wires through by 3:15, and the whole 20 were again working by 4.10. This was sharp work, and enabled the line to carry its share of the very heavy traffic caused that evening by the introduction of the Home Rule Bill. Three-quarters of a million words were sent out on Monday evening from the Central Telegraph Office: this is a very high figure, but it has been exceeded on two or three occasions.—*The Electrician.*

SCALE FORMERS.

The following is a list of substances most commonly found in natural waters: Carbonate of lime, carbonate of magnesia, sulphate of lime, silica.

The above substances, when present in quantity, readily form scale, though it will be noted that some of them by decomposition very often aid in incrustation: Chlorides of sodium, potassium, calcium, magnesium, potassium; nitrates of sodium, calcium, and magnesium.

Carbonate of lime is most abundant in nature, and is found in nearly all natural waters, either in traces or in quantity. Carbonate of lime itself is soluble in water only to the extent of two or three grains per gallon, and this solubility rapidly decreases as the temperature rises; but when the water also contains carbonic acid in solution, the solubility of the lime salt is enormously increased, and as much as 85 grains per gallon may be dissolved. The bicarbonate of lime thus produced constitutes the contemporary hardness of water, so called, because on boiling, the carbonic acid is expelled and the carbonate of lime is deposited. Hence a water of this class can be partially softened by boiling. The precipitation of the carbonate of lime commences at a temperature of 150° Fahr.; and is complete according to M. Couste, at a temperature of 290° Fahr.—that is, at a working pressure of about 60 lbs. where there is little sulphate of lime; the incrustation resulting from the latter salt may be reduced to a minimum by the judicious use of the blow off cocks, as the carbonate of lime falls as a soft sludge, which remains soft for a considerable period, and may, therefore, be blown out. Many of the carbonate of lime scales are produced by emptying the boiler whilst the plates and brick-work are hot, and the soft sludge is thus backed on the plates.—*Industries.*

SPARKS.

Steps are being taken to provide Kingston with an electric railway.

A charter has been granted to the O'Kanagan, B. C., Telephone Co.

A new electric lamp has been invented by Mr. W. Grant, Embro, Ont.

Capt. T. G. Craig has asked for a franchise of the Kingston streets for an electric railway.

Messrs. S. Taylor & Sons, Merritton, Ont., have installed a lighting plant in their woolen mill.

The General Electric Co. has been granted a franchise for an electric street railway in Peterboro.

The business of making arc lamps for incandescent circuits is getting to be a big one in the United States.

The Davenport Street Railway Co. are asking for a franchise to extend their tracks from West Toronto Junction to Swansea.

The capital stock of the Chaudiere Electric Light and Power Company (limited) has been increased from $500,000 to $1,000,000.

Mrs. Collins has been granted $6,000 damages against the Hamilton Street Railway Co. for the killing of her husband by a trolley car.

The new Electric Street Railway Co. at Brantford will give eight tickets for 25 cents, from 6.30 to 8.30 a. m., 12 noon to 1 p. m. and 5.30 to 7 p. m.

An electric railway is to run between Hamilton, Grimsby and Beamsville. A company has been formed and arrangements made for commencing operations.

Mr. Charles Mosely is the new water and electric light engineer to the North Toronto Council. The late engineer, Mr. Wilford Phillips, has gone to Niagara.

The electrical exhibition at the Crystal Palace, England, was not a financial success, the total income being $45,000 less than from the exhibition the previous year.

The Bell Telephone Co. has been granted an exclusive franchise at Chatham for five years in consideration of a grant of $705 a year to that town, to be "taken out in trade."

A Frenchman has succeeded, it is said, in producing an excellent driving belt by parchmenting the leather instead of tanning it. The belts have greater durability and do not stretch.

A lively controversy has been going on between the Halifax council and its street railway over the removal of the snow. The company shovelled it off the tracks and the city shovelled it on again.

The Berlin & Waterloo Street Railway have obtained permission to change their present system of running their cars to that of the trolley, and the plant will be shortly in course of erection.

Mr. H. A. Everett, vice-president of the Montreal Street Railway Co., will probably take the presidency of a consolidated railway company in Cleveland, Ohio, with a capital stock of $8,000,000.

A large number of Hamiltonians are protesting against the speed the trolleys run on James St. North. It is said the vibration was so great that the plaster fell off the ceilings in houses along the street.

It may sound like American humor, but still it is a fact that there is a pensioner of the United States Government who has been receiving nineteen dollars a month for deafness, and at the same time drew a salary of $1,800 a year for attending a telephone.

It is proposed to build an electric railway from Galt through Preston, Freeport and Berlin to Waterloo. The Waterloo County Electric Railway Co. has been formed to carry out the work, with a capital of $450,000, divided into 4,500 shares of $100.

The Montreal Street Railway Company have ordered 25 new cars from Belleville, Ont., to be delivered on May 24. The company have 115 new electric cars now running, and they expect to have 400 electric cars running in the streets of Montreal within two years.

Hon. G. W. Ross, Minister of Education, has asked the North Toronto Council to supply Upper Canada college with electric light from their works. The council decided at a recent meeting to ascertain how much light is required and the probable cost of changing the engine and boiler.

James P. Dawes and John Torrance, of Montreal, and others ask for incorporation as the Automatic Telephone and Electric company of Canada, with head office at Montreal, and power to manufacture, operate and deal in telephone instruments and electrical appliances throughout Canada.

Long distance telephoning has called into existence a class of operators who are valuable by reason of the clearness and sharpness with which they can pronounce words while speaking rapidly. It has also developed the fact that the French language is better adapted to the purposes of the telephone than the English.

Mr. McBride, of North Toronto, has served notice of action upon the county solicitor to restrain the Metropolitan Railway from running on Yonge street, and all other railways running elsewhere empowered by a York county franchise. The point raised is that only local municipalities have the right to grant such franchise.

An interim injunction, until the trial of action, has been granted against the Town of Port Arthur on motion of the Town of Fort William, preventing them from proceeding to construct a street railway upon any of the streets in the latter town, unless the same be done to the satisfaction of William Murdock, the town engineer.

PERFORATED BELTS.—An engineer has been inquiring of us as to the value of belts perforated with holes. The argument of the dealer is, that the air is let out through these holes from under the belts, and being thus excluded, atmospheric pressure must be excluded and the pressure of the atmosphere upon the pulley will help to secure a firmer grip without further tightening. This is on the supposition that air is carried under the belt in the rush of the belt on the pulley. This engineer does not want to pay for perforated belts if they do not do what is claimed for them, and yet he wants all the adhesion he can get with the least tightening. We do not believe that atmospheric pressure has anything to do with the driving of belts, and has no part in causing them to adhere to a pulley, whether perforated or not. It has been found that at high speed belts do not adhere so well to pulleys as at a slower speed, and this has been claimed to be due to the air getting between the belt and the pulley at the high speed and preventing less adhesion from atmospheric pressure. It can be quite clearly demonstrated that the centrifugal force of the more rapidly moving belt counteracts to some degree the adhesion of the belt and causes it not to adhere so firmly. This is the cause of this peculiarity, not the taking of air under the belt.—*Boston Journal of Commerce.*

Mr. A. T. Smith, manager of the Bell Telephone Company's Exchange, at Kingston, recently read a paper on "Lightning Rods, their Usefulness and How to Construct Them." In answer to the question, what is a good lightning rod? Mr. Smith said: Copper being the best conductor of electricity it follows that a protector constructed of that metal is superior to any known device. The ideal lightning rod is composed of stranded copper wire, making a cable of about ½ to ¾ inches in diameter. This cable is fastened securely to the ridge and side walls of the building by staples driven through the wood work. It is a mistake to insulate a lightning rod from the building; on the contrary, all masses of metal, such as valleys, eave troughs, metallic cornices, &c., should be connected with it. The rod should project above the roof or highest part of the building, or in other words the height of the rod should bear a certain proportion to the size of the building. The lower end of the rod should be carried down into the earth until it meets permanently damp or wet ground, where it should be attached to a fairly large metal plate, or if gas or water pipes are available the rod should be connected with them and firmly soldered. With such a rod little fear may be had of lightning destroying your property, but copper is expensive and a very good substitute may be found in iron, especially if galvanized.

Four-fifths of the engines now being used in the world have been constructed during the last 25 years.

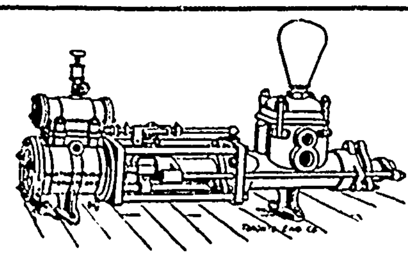
If ever a shop hand is called upon to splice a woven belt, he must be prepared to do a pretty good job with the needle and thread, says the *Journal of Commerce*, and have all the time he may ask for at his disposal, as each separate warp thread must be bound together, rope-spliced fashion, and no two thread ends must come side by side, as it would destroy the even thickness of the splice; and where two or more ply belts are to be united, each ply can be handled in single-ply style, breaking joints as in splicing ropes with the same number of strands, then work in a flexible cement of some kind to bind the fibers and keep them from working upon each other.

OIL VERSUS AIR AS AN INSULATING MEDIUM.

As the result of a series of experiments, Mr. J. B. Williams, in a communication to the American Institute of Electrical Engineers finds: - 1. That air, even when it has a humidity of 80 per cent., is infinitely superior to oil for insulating conductors carrying high tension currents. 2. That pure paraffin is far superior to oil, both for insulating conductors and preventing the escape of the current across the surface of glass. 3. That air having a humidity of 80 per cent., is superior to paraffin as an insulating medium. 4. That oil will not prevent leakage of the current across the surface of glass. 5. That whenever oil covers the surface of hard rubber, even when the latter is paraffined, it destroys the high surface insulation of the paraffined hard rubber, that is, the low surface insulation of the oil has been substituted for the higher surface insulation of the hard rubber, when used bare and clean, or when covered with paraffin. The writer also shows that there is but little difference in the specific resistence of different kinds of vegetable fibre when the fibre is clean and absolutely dry. The resistance of such fibre is high as long as it remains in this condition. But it is almost impossible to keep it so. It may be a matter of surprise to many to learn that cotton which has been dried, and which, therefore, possesses good insulating properties, loses these properties in less that 10 minutes if exposed to a damp atmosphere. Paraffined wood is very apt to be of little use in a short time, for no matter what kind of soft porous material is paraffined by allowing it to absorb the melted wax, the wax rarely hardens in a solid form, but usually contains numerous small spaces, and these spaces absorb *moisture by capillary attraction. It is for this very reason* that a dielectric which is formed of fibre saturated with paraffin soon loses its high insulation when exposed to the air. The microscope will demonstrate the presence of these minute air spaces.

RAILWAY TELEPHONY.

Mr. C. A. Hammond, superintendent of the Boston, Revere Beach & Lynn Railroad, in a recent paper published in the *Railroad Gazette*, calls attention to the growing tendency among railways to the use of the telephone in place of the telegraph in the transmission of train orders; and he urges its wider adop- for the purpose. Within the past year or two, the entire telephone service of his road has been changed to copper metallic circuit, using long distance transmitters with sufficient battery power to allow a dozen or more instruments to be placed on a single circuit: individual calls being distinguished by long and short rings as in Morse code. Care has been taken to neutralize induction, and the line is found to be perfectly quiet day and night. The writer is of the opinion that there is no reason why the telephone, if proper precautions are taken, is not preferable to the telegraph for this class of work. The rule has been for the sender of a message to write it down as he talks and have the receiver write down what he hears, repeating the message as a check. As an instance of working of the system, Mr. Hammond states that he has on file 2,500 train orders in which there is not a single error.



SPARKS.

The Bellechasse Telephone Co. has been incorporated.

Tenders are being asked for lighting Leamington, Ont., by electricity.

An incandescent electric light plant is being installed at Mitchell, Ont.

The ratepayers of the township of Etobicoke have granted the Toronto and Mimico electric railway a bonus of $10,000.

A deputation from Orillia visited Toronto Junction recently for the purpose of inspecting the electric light plant, having in view the purchase of plant.

The High Level Bridge Co., have been given the privilege of supplying electric power throughout Grantham township, and also the right to build an electric railway.

Mr. G. Forbes, of England, consulting engineer for the Cataract Construction Co., has stated that wires conveying power should be placed underground if possible.

The Toronto Incandescent Light Co., will apply for a special Act from the Ontario Legislature empowering them to construct and operate a street railway in Toronto and other municipalities in the County of York.

It is proposed to join Arkona, Forest, Strathroy and adjoining places by means of an electric railway. The line will cover a distance of 32½ miles, with stations at convenient intervals. Telegraph and telephone lines will be constructed along the route. If the places interested will grant the required bonus of $75,000, it is said the line will be put into operation inside of four months, although no actual company yet exists.

The Canadian General Electric Co. is making preparations for starting business in London. Plans have been prepared for a power house to be erected on Thames and Bathurst streets. The power house will be 6_ x 130, and will have from 1,000 to 1,200 horse power boilers and engines. The total cost of establishing the plant will be about $100 000, and the area over which it is intended at first to extend the wires will be within a radius of half a mile from the power house.

Electric light at Smith's Falls is very cheap to the consumer. He can burn nine 16-candle power lights all night for $12 per year. This is on account of there being two rival electric light companies in the town.

The Bell Telephone Co. has been given an exclusive right, on paying $1,000 a year, to supply London, Ont., with a telephone service, and the Canadian General Electric Co. has been given a franchise at the same place for incandescent lighting.

While engaged at their avocation at the corner of Yonge and Richmond streets, Toronto, two surveyors were thrown violently to the ground by coming in contact with a gas pipe which had become charged with current from the street railway company's wires.

Mr. Dingman, general manager of the Toronto and Scarboro' Electric Railway, has asked the East Toronto council for a right of way to be granted to his company on the main streets for the electric car service. If this is arranged the line would be in active operation by July 1st next.

The Montreal Street Railway Co. are about to build their new power house, which will be completed, it is expected, by next fall. A large number of new cars have been ordered from Belleville, and it is stated that within two years the company will have four hundred cars running in Montreal.

The Toronto and Richmond Hill Electric Railway Co. have been informed, through Mr. T. Caswell of the city solicitor's office, Toronto, that they cannot run their cars within that city. He has also written, asking the Toronto and Scarboro Electric Railway Company for plans and details of their proposed routes affecting Toronto.

At a recent meeting of the shareholders of the Kingston Light, Heat and Power Co. the following officers and directors were appointed: Mr. R. T. Walkem, president; Mr. R. Kent, vice-president; Mr. B. W. Folger, manager; Messrs. F. A. Breck, J. S. Muckleston, W. Nickle, W. McRossie and F. A. Folger, jr., directors. A dividend of 5 per cent. was declared on the company's capital stock.

An English syndicate with headquarters at Montreal has a bill before Parliament to secure power to buy up and amalgamate all the electric light, as well as gas companies in Canada. The transfer of the controlling interests in the Ottawa Gas Company and the Ottawa Electric (arc) Light Company to the syndicate has already taken place, the transaction involving the exchange of $500,000 in money. The capital stock of the two companies together amounts to about $650,000, and the newcomers have purchased from the holders about $500,000 of stock in order to have a controlling interest. The Ottawa Electric Light Company are possessed of valuable privileges, and own their own water power, besides a magnificent plant, at the Chaudiere. Among those who have figured prominently in this deal we find Senator Clemow, Col. Allan Gilmour, Mr. R. Blackburn and Mr. S. Howell. The Ottawa Gas Co. are to hold their annual meeting this month when probably some further details will come to light.

SPARKS.

At the recent fire at Lakefield, Ont., the Lakefield Electric Light Co. sustained a loss of $3,000 on uninsured property.

Mr. W. S. Andrews has severed his connection with the Canadian General Electric Co., Ltd., at Peterboro, and is about to assume the management of a large electric light concern in Pennsylvania.

Four citizens of the township of Monquager, Amherstburg, have been granted the right of way for an electric street railway to be built at that place

The manager of the Winnipeg Street Railway Co. has been investigating a new system of motive power combining the elements of the cable and electric service, making overhead wires unnecessary.

The Guelph Gas Co. held its annual meeting recently, Mr. Guthrie, the president, presiding. The business of the company is fairly satisfactory and a dividend of 5½ per cent. for the year has been paid. In connection with their electric works the directors are having fixed a new 1,000 light incandescent dynamo. They have also ordered a power transmission equipment.

The Auer Light Company of Montreal is likely to become extinct. The promoters of the company find they cannot keep their agreement with the shareholders as there is no contract with Dr. Auer, of Viennesse, for a fifteen years supply of the secret fluid from which a brilliant light was to be obtained, and as it can only be procured from him, the business is at a standstill. The company was started with a capital of half a million dollars.