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. . THE CENTRAL . .
Railway and Engineering . . . . Club . . . .
OF CANADA

OFFICIAL PROCEEDINGS

Vol. 2.
No. 6.

TORONTO, CAN., September 15, 1908.

$1.00 per year
15c. per copy

Published every month, except June, July and August by the Central Railway and Engineering Club of Canada.
C. L. WORTH, Sec.-Treas., Room 409 Union Station, Toronto.

PROCEEDINGS OF THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA MEETING.

ROSSIN HOUSE, TORONTO, September 15th, 1908.

The Vice-President, Mr. Burrows, occupied the chair.

Chairman,—

I am very sorry we are starting this meeting late to-night. I do not think it is a good principle to start these meetings a quarter of an hour late and I wish members would bear this in mind and get here on time, so that we can get started punctually and have plenty of time to discuss the papers.

I regret that the President cannot be here to-night. He has had to go to Schenectady and wrote me asking if I would take his place.

I would ask the members if in filling out their cards they will kindly put on their addresses, The Secretary tells me that he has had some of the monthly books returned, through members changing their addresses and failing to notify him.

The first order of business is the reading of the minutes of the previous meeting. I would ask that these be taken as read, as the printed proceedings have been distributed to the members.

Moved by Mr. Baldwin, seconded by Mr. Fletcher, that the minutes of the previous meeting be taken as read.

Chairman,—

The next order of business is the announcement of new members.

NEW MEMBERS.

Mr. E. A. Wilkinson, General Manager, Lukenheimer Co., Cincinatti.

Mr. D. Richardson, Foreman, Canada Foundry.

Mr. W. Cureton, Superintendent Moulding Shop, Canada Foundry.

Mr. W. S. Cowan, Foreman Driller, Canada Foundry.

Mr. Geo. Ellis, Machine Shop Foreman, Canada Foundry.

Mr. A. B. Walker, Manager Machine & Tool Department, Canadian Fairbanks Co., Toronto.

Mr. H. Hitchen, Engine Inspector, G.T.R., Stratford.

Mr. Jno. Lusk, Engineer G.T.R., Sarnia Tunnel.

Mr. C. F. Neild, Coal Merchant, Stratford.

Mr. Jno. E. Goldring, Cashier, Canada Foundry Co.

Mr. J. Mauldey, General Foreman, Dominion Bridge Co., Toronto.

Mr. J. C. Grant, Manager B. F. Sturtevant Co.

Mr. T. E. Hicks, Assistant Foreman Bridge Department, Canada Foundry.

Mr. Samuel Woods, Steamfitter, Bennett & Wright.

Chairman,—

That is a new membership of fourteen, which I think is a very good start for the year. If we can keep this pace up we will do very well.

MEMBERS PRESENT.

G. Baldwin.	W. J. Bird.	Jas. Herriot.
M. Walker.	E. Logan.	J. W. Griffin.
T. A. Sperry.	H. G. Fletcher.	J. F. Campbell.
J. W. McLintock.	G. Black.	N. MacNicol.
H. E. Rowell.	J. M. Clements.	J. Duguid.
S. D. Woods.	H. P. Ellis.	F. S. Ferguson.
G. Shand.	F. R. Wickson.	J. Irwin.
A. G. McLellan.	W. E. Archer.	G. Bernard.
Acton Burrows.	S. W. Price.	G. D. Bly.
A. W. Shallcross.	D. Ross.	J. Barker.
W. Poulter.	J. Dodds.	W. Evans.
W. Farrel.	A. J. Lewkowiez.	J. Bannon.
A. M. Wickens.	R. Muirhead.	G. Mitchell.
J. Richardson.	J. C. Garden.	E. B. Allen.
H. O. Eddrup.	F. Burrows.	T. G. Lewis.
C. L. Worth.		

Chairman,—

There is just one thing I would like to say and that is that the subscriptions have not been coming in as well as last year, and there are a number of subscriptions outstanding and it would help the Club a great deal if the members would pay up between now and the next meeting.

There is no other business to bring before the meeting but I would like to read you a letter received from the Minister of Education, the Hon. Dr. R. A. Pyne, acknowledging receipt of copy of Resolution urging the Government of the Province of Ontario to establish technical or industrial schools, in connection with the paper given by Mr. Clarkson W. James, which was adopted by the Club. The letter is as follows:

"I am in receipt of your letter enclosing copy of Resolution unanimously adopted by your Club in connection with the paper contributed by Mr. Clarkson W. James. I am much pleased to know you appreciate the matters brought before you."

The Minister of Education has gone to England and this is one of the subjects he is looking into very closely over there and I hope something may result from that.

I have very much pleasure in introducing Mr. G. D. Bly, Mechanical and Electrical Engineer, of the Monarch Supply Co., Toronto, who has kindly consented to give a paper on "Elementary Electricity."

ELEMENTARY ELECTRICITY.

BY MR. G. D. BLY, MECHANICAL AND ELECTRICAL ENGINEER, MONARCH SUPPLY CO.

Mr. Chairman and gentlemen:—I feel that we cannot give justice to such a great subject as this, in the short time we have at our disposal. When asked by our Secretary to give this paper, I hardly knew where to begin, as the subject is so broad.

I do not propose to keep you very long with the paper itself, but I sincerely trust what I have to say will prove of interest and value and that you will discuss the subject fully and freely, because, after all, the discussion is the real essence of any such meeting as this. You need have no difficulty in discussing the question to almost any length, because electricity is the most universal phenomena with which we have to deal.

The exact nature of the electricity which makes itself evident in so many ways has never been determined. Many surmises or theories have been advanced, but none have yet been able to stand the test of close examination. But by experimental evidence (which has been gathered for decades) we have been able to determine some of the laws which govern the action of electricity, though we do not know its constitution, very much as we have learned the laws of gravitation though we do not know what gravity really is.

The etymology and use of the word "electricity" have developed in parallel with the experimental growth of the science which bears its name. Springing from the Latin name for amber, electricus or electrun, the adjective electrical comes immediately from the word "electric" which was used in a book published in 1600 by Dr. Gilbert (the great scientist of Queen Elizabeth's reign), to designate the attraction for light bodies like chaff and bits of paper which amber and similar substances exhibit when briskly rubbed. The original discovery of this electrical property (or property of the amber) is often attributed to a Greek philosopher (one of the seven wise men of Greece) who lived about 600 years before the Christian era, and the meagre reports of whose philosophy are thought by some to contain the earliest records of its observation that have come down to us. It is probable, however, that a knowledge of this peculiar property of amber, and possiblity of other bodies, was one of the well guarded secrets of the priesthood of that day. From the word "electric" also comes the word electricity. Since the day Dr. Gilbert first applied "electric" to a particular phenomenon, our knowledge of all the sciences has widened, and with the widening has come an equal advance in the knowledge which was represented to the ancients by that one peculiar property of amber and similar bodies. The term "electricity" is, therefore, not now applied to any one small branch of a great science, but covers a vast field of facts which are supposed to be based on the same underlying causes.

THE NATURE OF ELECTRICITY.

The action of electricity led many experimenters who lived long after Gilbert to the belief that it was a fluid which was not perceptible to their senses. Benjamin Franklin assumed it to be a fluid, and bodies which exhibited electrical manifestations were thought by him to contain either more or less of the normal amount of the fluid. A Frenchman named Dufay and an Englishman named Symmer considered electricity to be composed of two fluids which were contained in neutral bodies in equal amounts. When by any means this electricity was disturbed in a body, electrical manifestations occurred.

These theories, and a large number similar to them that were promulgated, are now discarded in the light of later scientific knowledge. But the conception of the fluid theory is very useful in giving a clear understanding of some of the *phenomena* of electricity. It is now generally admitted that the *phenomenon* to which we give the name "electricity" results from a state of strain or other manifestation in the ether. The ether is a kind of fluid medium that is supposed by scientists to be present everywhere. It must even be supposed to pass through or be contained in solid bodies, as though they were ether sieves, as well as in empty space. Heat and light are supposed to be carried by it from one body to another, as from the sun to the earth, by means of vibrations or waves, much as the energy exerted by a pebble thrown into a pond is carried to the shores by the waves of the water. In like manner electricity is supposed to be waves in the ether or a strain imposed on it. The question of what the ether may really be need not be considered in dealing with the fundamental laws of electricity.

When one comes to lay down on paper a few thoughts concerning the production of electric energy and the many wonderful feats it performs, we may well pause to reflect, and, say, can it be possible that we are living in such an age. Our ships are guided by its wonderful influence, we may flash messages around the world in the twinkling of an eye, it drives our carriages, hauls our freight, gives us transportation, furnishes light, heats our homes, cooks our food, furnishes a medium by which we may look through ourselves and see as others see us, and enables us to converse with friends hundreds of miles away as though they were beside us.

Lucrez (born 95 B.C.) mentions the fact that loadstone had the power of attracting and repelling iron. The magnetic needle was discovered by the Chinese as early as the year

121 A.D. and used by them on land journeys. It is difficult to give the exact date at which the first observations of electrical phenomena were made. Thales, one of the seven sages of Greece, in the year 640 B.C., is supposed to have been the first to discover that amber had the power of attracting small bodies.

The science of electricity remained in this condition for nearly two thousand years, when Queen Elizabeth's physician, William Gilbert, made a series of fresh discoveries of electrical phenomena, which won him the title, "Founder of the Science." About 1686 Picard observed the luminosity of greatly rarified gases. Experimenting with an imperfectly exhausted barometer tube, he agitated the mercury in the tube, thus producing electricity, which caused the mercury vapor and the remaining air to glow.

It has been said that an apple falling to the ground caused the discovery of the law of gravitation; the motion of a frog's leg led to the discovery of galvanism; chance led Oersted to observe the influence an electric current has on the magnetic needle.

The passage of an electric discharge through any circuit, no matter what may be the character either of the circuit or the discharge, is invariably attended by the production of magnetism. So far from being difficult to produce magnetism from electricity, it is impossible for an electric discharge to occur without being accompanied by magnetic effects.

It might, therefore, naturally be supposed, since magnetism can readily be produced by electricity, that one of the earliest discoveries in electricity would have been that magnetism is necessarily the accompaniment of an electric discharge. In point of fact, however, the world remained in ignorance of this important fact until it was discovered in 1819 by Hans Christian Oersted, Professor of Physics in the University of Copenhagen.

What renders all the more curious the failure to discover at an earlier date the relations existing between magnetism and electricity, was the fact that it had been suspected long before 1819 that some relation existed between these two great natural forces. Franklin by his famous kite experiment in the City of Philadelphia, when he drew electricity from the clouds, had demonstrated, as early as 1752, the identity between lightning and electric discharges. It had been noticed that lightning flashes frequently change the polarity of the magnetic needles employed in the mariner's compass. It therefore seems almost certain that an electric discharge possesses in some way the power of producing magnetic effects. Nevertheless the world remained in ignorance of just how these effects were produced until 1819, when the problem was successfully solved by Oersted.

Like many other great discoveries, that which demonstrated the relation existing between electricity and magnetism, although apparently difficult to make, yet, when once made, proved to be so simple that it seemed astonishing it had not been made long before. As is often the case, what seemed to be extremely simple after it is once done, was accomplished only after long and persistent efforts. What could be simpler, when Columbus once showed the way to the new world of America from Europe, by simply turning the vessel's prow towards the West across the Atlantic? Yet, it was not until the year 1492 that this venturesome voyage which resulted in the grand discovery of a new world was made. When once made any navigator could visit the new world by merely following in the path pointed out by the great navigator.

And so it was in the voyage or investigation that it was necessary to make in order to show how magnetism can be produced by electric discharges. Like the sailing of Columbus toward the West, this voyage also resulted in the discovery of a new world, the world of electro-magnetism, or magnetism produced by the means of electricity.

Like other scientific men who lived before him, Oersted firmly believed that some simple relation actually existed between magnetism and electricity. All others failed except Oersted who succeeded because, unlike his predecessors, he experimented with an electric discharge and not simply with an electric source that is only capable of producing an electric discharge when its poles or terminals are closed or placed in a complete circuit.

Take for example, the experiments that were made with a voltaic battery in 1805, by Hatchett and Desormes. Convinced that an electric battery was capable of producing magnetism, these investigators carefully insulated and so suspended a battery as to render it capable of free motion, expecting to see it assume a position like a magnetic needle, and point approximately to the earth's geographical poles. Unfortunately for the success of their experiment, they failed to close the circuit of the battery, and, no electricity flowing, of course no magnetic effects were produced.

All Oersted did was to close the circuit of a voltaic battery. It may seem that this was not much, and yet it constituted the entire difference between failure and success.

To get exact ideas in any department of physics we have one firm foundation to build upon, namely, that a certain amount of energy or power of doing work, always remains the same, however it may change its form. We have many sources of electricity, the rubbed plate glass machine, the induction machine, the magneto-electric machine and the dynamo electric machine. To all of these some form of energy is given, and they convert this energy, badly or well, into electric energy.

The first two of those I have mentioned, mechanical energy, is given by hand and to the last two, from a steam engine, and this mechanical energy is converted, partly into heat, which may be regarded as a loss, and partly into electric energy, which we require, but the electric energy is less in amount than the mechanical energy given to the machine. In the voltaic cell zinc is burned, that is, what may be called chemical energy is used up and electric energy is given out. Joul's experiments tell us that any generator gives out exactly as much energy as is given to it, but much appears in the form of heat, so it is the object of an inventor to construct a generator of electrical energy which will give out as much as possible of the energy supplied to it in the form of electrical energy. A clear distinction must be made between electricity and electrical energy. A miller does not merely speak of the quantity of water in his mill dam;—he has also to consider the height through which it can fall. A weight of one thousand pounds falling through a distance of one foot, represents the same energy, that is, it can give out the same amount of work in falling, as one pound falling through one thousand feet. A mere statement, then, of the quantity of electricity given out by a machine is not sufficient; it is also necessary to state what is the height or difference of potential through which it is falling The quantity of electricity in a thunder cloud is comparatively small, but the difference of potential through which this quantity passes when discharge occurs is exceedingly great. So it is with the two factors of the electrical energy developed by a glass plate machine. The quantity of electricity obtainable from the machine per second is comparatively small, but it is like a small quantity of water at an exceedingly great height; whereas in the other machines mentioned, we have, in the analogy of the miller, a very great quantity of water and a very small difference of level.

Many of the simpler phenomena of electricity may be illustrated by the action of fluids but we must carefully bear in mind that the comparison is merely for convenience, and that electricity is not a fluid. It must also be remembered, in using these comparisons, that we do not touch upon the true nature of electricity, which is not known, but only upon the laws of its action which have been experimentally determined. Also that while water and gas may be directly perceived by our senses, electricity is absolutely unpalatable, that is, it cannot be directly perceived by our senses, and the only way in which we may recognize it is by its various effects.

This water analogy is very useful because within certain limits, the analogy is a true one. The following table gives it more fully:—

WATER.	ELECTRICITY.
(1) A steam pump burns coal and lifts water to a high level.	(1) A generator burns zinc, or uses mechanical power and lifts electricity to a higher level or voltage.
(2) Energy available is, the amount of water lifted multiplied by the difference of level.	(2) Energy available is the amount of electricity multiplied by the difference of potential or volts.
(3) If we let all the water flow away through a channel to a lower level without doing work, its energy is all converted into heat because of frictional resistance of the pipe or channel.	(3) If we let all the electricity flow through a wire from one screw of our generator to the other without doing work, all the electrical energy is converted into heat because of the resistance of the wire.
(4) If we let water work a hoist as well as flow through channels, less water flows than before, less power is wasted by friction.	(4) If we let our electricity work a machine as well as flow through wires, less flows than before, less power is wasted through the resistance of the wires.
(5) However long and narrow may be the channels, water may be brought from any distance, however great, to give out almost all its original energy to a hoist. This requires a great head, and small quantity of water.	(5) However long and thin the wires may be, electricity may be brought from any distance, however great, to give out almost all its original energy to a machine. This requires a high voltage and a small current.

If we could leave out of account the kinetic energy, or energy of motion of water, there is the most exact agreement between the laws of pumps, circuits of pipes, and water pressure engines, and the laws of electric generators, electric circuits and electric motors.

It will be readily understood that for some purpose it is necessary to have our electric energy in the shape of a small quantity of electricity falling through a great difference of potential, and that for other purposes we must have a great quantity of electricity falling through a small difference of potential.

In the telephone, X rays, and long distance transmission, it is necessary to have a high voltage or a great difference of potential, with a small current flowing, because we have very little to carry over the wire, but a great length and a high resistance. In the telephone, the magnetizing effect of the sound wave; in the X ray, the bombardment of a few particles of rarified air in a Crook's tube; and in the transmission of energy the pressure or voltage is used. In the plating battery we have the plating material which is a large quantity and the fluid has a low resistance, therefore we require a large amount of current.

The unit resistance is the olm, which may be defined as the resistance of a uniform column of mercury 106.3 c.m. long and one square millimetre in section at 0° C.

The unit current is the amphere, which may be defined as a current which deposits silver at the rate of 0.001,118 grams per second.

The unit electromotive force is the volt, which is that E.M.F. that will cause a current of one amphere to flow in a circuit whose resistance is one ohm.

Ohms law may be expressed as follows: $C=\frac{E}{R}$ $E=CxR$ and $R=\frac{E}{C}$.

Energy is the power of doing work. It is present in some form throughout all nature. We cannot increase or diminish the total quantity of energy; we cannot create nor can we destroy it. We can only change its form. Energy may either be potential or kinetic; it is said to be potential when at rest and kinetic when in action. There are three forms of energy; namely, thermal, chemical and mechanical.

The potential energy in coal may, when the coal is burned, be changed into kinetic energy of steam. Zinc and copper when immersed in diluted sulphuric acid and connected outside of the acid may have their potential energy transformed into the kinetic energy of heat, gases and electricity. The potential energy in your arm and may be changed into kinetic energy of motion when you turn the handle of a grindstone. The energy of coal may be changed into that of steam, the energy in steam may be transformed into the energy of motion. This may be transformed again into electrical energy, and this again into heat, light and power.

When we raise one pound through ten feet of space we perform a certain amount of work, which is the same whether we take ten minutes or one hundred minutes. But the rate of doing work or power expended, is very different in the two cases, being ten times as great in the first as in the second. So you see there is an important difference between work and power. When we raise one pound 33,000 feet, in one minute we are working at the rate of one horse power. The one pound multiplied by 33,000 feet equals 33,000 foot pounds, as does 1,100 pounds multiplied by thirty feet. In fact any product of pounds and feet equalling 33,000 when expended in one minute equals one horse power. In a similar manner a current of electricity can perform work and its rate of doing work is measured by multiplying the pressure in volts, by the rate of current flow, in ampheres. The resulting product being expressed by the unit called the watt. Thus a current flowing at the rate of one amphere under a pressure of one volt is doing work at the rate of one watt. The watt is the equivalent of 1-746 of a horse power, because it is the power required to perform 44.25 foot pounds of work in one minute which is 1-746 of 33,000 foot pounds. In other words, 746 watts make one electrical horse power. The volts multiplied by the ampheres equal the watts, and the watts divided by 746 equal the horse power.

Electricity may be generated or developed or excited in more than one way. Its sources may be classified under five general heads, namely: Animal, Thermal, Frictional, Chemical and induced. We will briefly consider each of these sources in their order. Many people make the mistake of thinking that there are different kinds of electricity, whereas electricity is always electricity, whether excited by frictional or chemical means or by induction. The difference lies only in the varying effects produced by electricity generated in different ways due to such special characteristics as pressure and quantity which each may possess. It is often convenient, however, to distinguish as to the source of electricity, as, for example, by speaking of animal electricity or induced electricity.

(1) Animal Electricity.

All animal and plant life produces electricity.

(2) Thermal Electricity.

When two unlike metals are joined at their ends and heat is applied at the joint, a current is generated due to the differences in heat between the parts.

(3) Frictional or Static Electricity.

A charge of electricity produced by friction is peculiar in that it resides exclusively on the surfaces of the body charged. If we rub a smooth glass rod with a silk handkerchief the rod becomes positively charged and the handkerchief negatively charged.

(4) Chemical Electricity.

Under this head may be grouped two very important sources of electricity, namely, primary and secondary batteries. When two plates of two different metals or one metal and one non-metallic body (such as carbon) are placed in a liquid, called an electro-lyte, and the two plates are connected together outside of the liquid, a current of electricity is generated. This combination is known as a primary cell (or galvanic) battery. Such a cell gives a potential of about 1.5 volts. Then we have the storage or secondary battery. Although the effect we obtain is the same as if the cell was a reservoir in which we stored electricity until it was needed, we do not really store it. What happens is that the charging current makes a primary battery of the cell by altering the nature of the elements. What we in reality "store" is chemical energy and not electricity. The potential of a cell of secondary battery is about two volts.

(5) Induced electricity.

If we insert a magnet in a coil of wire, we induce a current of electricity in one direction; then if we suddenly withdraw it we induce a current in the opposite direction. If we revolve a loop or coil of wire between two or more magnets we induce currents as in a generator, or in other words if we increase or decrease the number of lines of force passing through a loop or coil of wire a current of electricity will be induced in the loop or coil, first in one direction and then in the other.

These principles were first discovered in 1831 by Michael Faraday, a noted English scientist, and upon them all mechanical generators or dynamo-electric machines of the present day are constructed.

Batteries cost too much to run to permit their being used for electric lighting or power purposes. It costs much more to burn up zinc in a battery than it does to burn coal in a steam boiler of the same power. There are two general classes of dynamo-electric machines, named after the character of the currents delivered by each. These are (1) Continuous current. (2) Alternating current dynamos, and a few words may be said about each.

If we take a loop or loops of wire and mount them on a shaft placed between the north and south poles of a magnet and revolve it we have the simplest form of a dynamo. Many people who are unfamiliar with dynamos suppose that electricity is generated by friction at the brushes, this is not true in the case of a generator, however, as it requires 100,000,000 lines of force to be cut per second to generate one volt, and is caused by revolving the coils between the poles of the magnets in the generator. In the alternating current dynamo, all we have to do to produce a current is to revolve the magnets or poles between the coils and connect the ends of the coils without brushes.

Chairman,—

We are very much indebted to Mr. Bly for the excellent paper he has given us to-night, the preparation of which shows a great deal of research.

It seems to me that electricity should be a very popular theme in Canada, because Canadians have done a great deal to develop it in a number of ways. We know that the telephone was invented in Canada, being started at Brantford. Perhaps you may not know that the first electric railway was started in Toronto, being operated at the Industrial Exhibition grounds. It was not a large one, being only an experiment, but it was the first electric railway to be operated in America. I have a photograph in my office of some of the cars, which are very quaint looking and vastly different from the splendid cars we see on our streets to-day.

We hear a great deal of complaint about the Toronto Railway, especially in the daily papers. I move about a great deal and I do not know of any better system. I think you will all agree with me that the way they handled the Exhibition traffic recently was marvellous. Even the papers, which are generally abusing the Company, had to admit this. I think the way in which they carried the enormous crowds home at night was wonderful.

Canadian capitalists are aiding the development of electricity not only in Canada, but in Rio de Janeiro and Sao Paulo, in Brazil, and Mexico City and Monterey, in Mexico. I think we may say that the supply of electricity which can be generated by water in Canada is practically unlimitable. If we go back even for a few years, who would have thought that we would be sitting here to-night in a room lighted by electricity coming from Niagara Falls or that our street railway would be running with the same power. There is a great field in Canada for electric traction, not only for city lines but also for inter-urban lines. I think one of the great troubles in the development of inter-urban lines in the Province of Ontario is the passing of legislation which places so many restrictions on the granting of franchises that the ardor of capitalists is dampened and they will not invest in such enterprises. The establishment of a thorough system of inter-urban lines throughout the Province is of the greatest importance to farmers. Take for instance the Hamilton, Grimsby and Beamsville Railway, which has greatly benefited the farmers between Hamilton and Beamsville, by providing a better market for their fruit, dairy and other products and by generally improving the condition of rural life. It is most important that inter-urban railways should be established throughout this province in order to improve the farmers' market facilities and make their lives more pleasant. While there should be ample provision made for the control and regulation of the rates of these railways, too many restrictions should not be created, or capitalists will not invest. I think that within the next two or three years we will see an up-to-date high speed electric railway running between Toronto and Niagara Falls. As you doubtless know there is sufficient space provided on the Toronto and Niagara Power Co.'s. right-of-way for such a line.

It is interesting to know that what will be the longest inter-urban line in Canada is now being built in British Columbia, from Vancouver through the Chilliwack district. The British Columbia Electric Railway Co. is building some fifty miles, which will be a very fine piece of construction. This line will go to the United States boundary and be practically a through line.

Electricity is commencing to take the place of steam on the old railways. Some of the most interesting work that has been done is on what is known as the electric zone on the New York Central Railroad. The New York, New Haven and Hartford Railroad, instead of allowing outside electric lines to compete with its system, is building them as feeders. So important is this work considered by the management, that Mr. McHenry, Vice-President of that railroad, who was formerly Chief Engineer of the Canadian Pacific Railway, is devoting practically all his time to electric railway matters.

Electricity is now being used a great deal in railway shops; perhaps one of the largest installations of electricity for shop use is at the Angus Shops of the Canadian Pacific Railway at Montreal. It is also being used at the Grand Trunk Railway Shops at Stratford. I was at Moncton, New Brunswick, the other day and had an opportunity of looking over the plans of the very complete electric equipment which is being installed in the new Intercolonial Railway Shops there.

The Secretary has just reminded me that you enjoyed the convenience of electricity for the Club's picnic this summer. I am sorry I was not there although I was on hand to see you start off. I think that before the evening is over, we should pass a resolution expressing the Club's appreciation of the excellent service that the Toronto and York Radial Railway gave. They certainly carried the members at a very reasonable price and I believe that those who had the opportunity of being present enjoyed themselves immensely.

I do not wish to call upon the members individually and will be glad if any person who has anything to say will just get up.

Mr. MacNicol,—

Mr. Chairman and friends:—I am very much interested in Mr. Bly's paper, and might say that there is not very much that I can say regarding it, either for or against. He has laid down the bare facts.

A short time ago I had the privilege of looking over a number of electric locomotives and was struck with a great many things which concerns a railroad foreman. There are no side and main rods, eccentrics, leaky flues, etc. I asked myself the question, why it was that we have not had this thing long ago, and I am still asking the same question.

It seems to me that the repairs in connection with the steam locomotive compared with the electric locomotive is enormous. To-night I was asking Mr. Bly if he would enlighten us a little on this question. No doubt the reason electric locomotives have not been used before this is due to the consideration of cost of power. I am sure that the cost of repairs must be a great deal less on the electric than on the steam locomotive. I only got the paper a little while ago and I could find nothing in it to quarrel about.

Mr. Bly,—

The only thing I can say concerning what Mr. MacNicol remarked, that it is very much like the other experiments which have been made in the development of electricity. The experimentors have been at a loss to find out how to build the electric locomotive. As Mr. MacNicol has said, the electric locomotive has no side rods, valve rods, eccentrics, etc.; no doubt the electric locomotive has come to stay.

The Westinghouse Co., on the other side at their works, perhaps a year or so ago, found out that in some cases the direct current was advantageous to the electric locomotive, while in other cases the alternating current was advantageous. It was then found that they could run the direct motor in series as an alternating motor. Therefore, the question of different currents for electric locomotives was solved, as they found they could run a certain distance on direct current and then throw the motor in series and run along on alternating. Years ago we did not know anything about this and thought that when we used the alternating current, we could not use the direct current motors.

Chairman,—

Mr. MacNicol, don't you think that one of the reasons why more railways have not been electrified is owing to the question of cost? The railways are equipped for steam and it would be a serious thing for a large system to go to work and instal an electric system, as it would mean an enormous expense. It would mean practically the changing of all the rolling stock. The New York Central Railroad is adopting electricity in the New York terminals and within the electric zone. It is also proposed to electrify some other sections, and then by degrees these different links may be coupled up by electrifying all the lines where power is available.

Mr. MacNicol,—

No doubt it is quite an expense to electrify a railroad. However, for the last few years some of the railroads have been changing their motive power to a heavier class. I think they might have changed their power to electric as easily. Taking into consideration the cost of repairs on steam locomotives, which is considerable, it would seem that this would be sufficient inducement to go to the expense of electrifying the system and putting it into operation as soon as possible.

Chairman,—

When you take into consideration the bad water, which often has to be contended with, especially out in the Northwest, you would think the electric locomotive would be advantageous.

Mr. Bly,—

Of course long distance transmission has only come into prominence recently. It is only about eight or ten years ago that they started to develop Niagara Falls. It took about twelve million dollars investment to put in the machinery and a transmission line to Buffalo, and they thought they had something tremendous. Now they are transmitting electricity long distances such as sixty, eighty and a hundred miles. At Victoria Falls, in South Africa, they expect to transmit power one hundred and fifty miles distance at about 150,000 volts. It was thought ten or twelve years ago that it would take an eight or ten inch diameter wire to supply such a current, but now we find that a wire the size of your thumb will take 25,000 to 50,000 h.p. One ampere coming over a 60,000 volt line, which comes into the city of Toronto from Niagara, will give us seventy to eighty h.p. You will see that the current is the only heating property we have and when we cut down the current, we can reduce the size of the wire, like Professor Tesley in New York where they thought he was getting dangerous and they made him get out. He went to Colorado and started experimenting and produced currents or rather flashes or sparks twenty feet long like claps of thunder. In doing that he took a current of eight hundred amperes at ten million volts and produced sparks as I have said before, about twenty feet long. Later developments will produce, perhaps, not in our day, but our children may see, carriages being propelled without wires on the same principle as wireless telegraphy. Professor Tesley, in his experiments, has proven that currents of 100,000 frequency and over, and 100,000 volts can be handled without danger. You can charge a man who can walk with 100,000 frequency current and 100,000 volts and he can light a sixteen candle power lamp without wires. You can see from this that this is fast coming along the line of transmission of power without wires.

Chairman,—

Is there any gentleman here from Sarnia? It would be interesting if we could get at the cost of electric locomotives. Perhaps Mr. Duguid can tell us something about them.

Mr. Duguid,—

I have been at Sarnia Tunnel but do not know anything about the cost of the electric locomotives.

It is a little early yet to make any remarks regarding our shop experiments with electricity at Stratford. I have been always struck regarding electric current and rather struck with Mr. MacNicol's remarks. I do not think they have electricity advanced far enough to warrant any change in equipment on railroad service. There is an uncertainty regarding the cost and I do not know of any generator plant yet that can give the exact cost of electricity. The Hydro Commission cannot even give us the cost of electricity delivered from the Falls.

I do not know much about electricity. They are installing a power plant at Stratford of 1,600 h.p. and no doubt by the first of the year it will be in operation.

Chairman,—

What kind of power are they installing?

Mr. Duguid,—

Electric power, and the lighting is Cooper Hewit.

Mr. T. A. Sperry,—

So far, the figures I have seen on the cost of lighting have not been very concise, but they show in general that electric power per unit at the point of usage runs higher than steam by a considerable percentage.

Economy in electric usage is in its elimination of waste. With electricity you use only what power you need and then shut it off when not wanted, but with steam there is a continual loss through radiation and the blowing off through pipes and a continual loss of steam within the engine itself, but with the electric motor the minute you get through with it, you stop it and the cost ceases, whereas your steam engine must keep running on. It is, as I said before, in the efficiency of its use, its direct application and elimination of shafting that economy of electricity comes in.

I think the gentlemen present will have formed the opinion by the discussion thus far, that the great drawback with electricity for locomotives, is in the uncertainty of the whole problem. They are experimenting and spending thousands of dollars every year trying to ascertain the best form of application and how to get it, and the electrification of railroads we have so far installed is simply experimental. It is possible we may change the whole present design and scheme entirely before we adopt electricity permanently for the locomotive. There are some places where electric motive power is essential. There is some discussion now regarding the changing of the whole system of electrification of the New York Terminals, one of the places where it is essential. I understand they are contemplating throwing out the whole scheme and putting it on a different basis. It is found to be impracticable to run both electric and steam motors over the same lines. The steam locomotive interferes with the overhead trolley wires, and then the speed of the electric locomotive is slower than the speed of the steam. The steam has a faster drive and a heavier tractive power than the electric locomotive. I will not say, however, that it is absolutely impossible to run both systems over the same line, but it is generally conceded to be impracticable.

Chairman,—

There are some lines running electric and steam locomotives over the same tracks.

Mr. Sperry,—

Yes on urban lines, and where there is no interference.

I would like to say regarding an early remark of our Chairman, that inter-urban lines are spreading very rapidly. In Indianna and Ohio there is a more complete net work of inter-urban traffic than in any other place in the world. Those two states are simply a net work of electric lines. We are going to get these lines around Toronto and I think they will come rapidly.

Chairman,—

I believe when the Sarnia Tunnel was electrified it was intended to do away with the steam locomotive altogether in it.

Mr. Sperry,—

Your electric locomotive has a speed of 25 to 30 miles an hour, while the steam locomotive has a speed of 40 to 50 miles an hour.

Chairman,—

Is not the speed of the electric locomotive equal to the steam locomotive? Do not the reports of the tests on the New York Central show this?

Mr. Sperry,—

I did not see these reports.

Chairman,—

My understanding was that the electric locomotives were equal in speed to the steam locomotives.

In regard to operating on the same line, as you said, it is probably only in cases of short distances, but on the old

Niagara Central which was electrified and made into the Niagara, St. Catharines and Toronto Railway, they are at this time hauling freight by steam and passengers by electricity. In the Province of Quebec the Quebec Railway Light & Power Co. has an electric light from Quebec City to Cap Tourment. During the summer they carry an enormous pilgrimage traffic to the shrine of Ste. Anne de Beaufre and the whole of this is hauled by steam locomotives. The Canadian Pacific Railway carries the pilgrims to Quebec on its steam trains and there transfers its cars to the Quebec Light & Power Co., which hauls them to Ste. Anne by steam locomotives. The Canadian Pacific Railway is helped out by the electric railways in taking their trains into Quebec.

Mr. MacNicol,—

I think in Germany they are running an electric locomotive one hundred miles an hour.

Mr. Sperry,—

Was this done in trials or is it practical?

Mr. MacNicol,—

I do not know.

Chairman,—

There is no doubt that the electric development in Ohio and Indianna is enormous, and I think I may add that the State of Michigan has a magnificent service.

I shall be glad if some other gentlemen will carry on the discussion.

Mr. MacNicol,—

I think there is a danger of the wires being damaged by the steam locomotive running on the same line as the electric locomotive. I know in Sarnia Tunnel they had to protect the tunnel from cinders and put a special bonnet in the stack of the locomotive.

Mr. Poulter,—

The District Railway in London, England, is using the steam and electric locomotive on the same line. It is underground part of the way.

Mr. Wickson,—

Regarding the question that was asked about Sarnia Tunnel; of course up there the electric and steam locomotive must use the same sidings. The steam locomotive must bring the train in and run with it some distance under the electric wires.

Following up Mr. MacNicol's remarks, from a locomotive foreman's standpoint, although the electric locomotive has no side rods or leaky tubes, yet when anything goes wrong with it, it is a very difficult matter to remedy same and when it burns out, it burns something out complete. Of course there is a great difference in the cost. It would be a matter of tearing out the motor and rewinding it, which is a very expensive job.

Speaking of the speed of the electric locomotive. In elevated and underground service practically each car is a locomotive, controlled by one man on the head car, and on that account an electric locomotive cannot pick up a train of cars anything like as quickly as is done on these roads.

Chairman,—

We would like to hear from Mr. Black.

Mr. Black,—

I am an interested listener.

Mr. Bly,—

There may be one thing which perhaps is a little disadvantageous in the electric locomotive, that is of using the alternating current. When you use an alternating current to start with it takes from three to five times as much current to start as the running current, so you can imagine to start a train it would take a tremendous amount of power. I think this is one of the reasons that the Westinghouse people experimented with the direct and alternating current together.

Mr. Sperry,—

Do the Westinghouse people use the shunt or compound?

Mr. Bly,—

Series, I think.

Mr. Duguid,—

What is the actual difference in cost of one steam horse power and one electric horse power?

Mr. Bly,—

It is hard to say where you would start to reckon that horse power. I do not know very much about the steam locomotive. As to the efficiency of the compound condensing engine, it is about 20 to 23 per cent., and the rest is thrown away. Now if you put that on the electric horse power and generate same, it would give you about 92 per cent. of its efficiency, so that the cost of generating an electric horse power by steam and sending it out to the track to the electric locomotive, there is quite a loss in it. As I do not know the efficiency of a steam locomotive at the rails, perhaps some other member may be able to give us this information.

Mr. Sperry,—

It is an impossible question to answer because of the fact that in some engines the cost per horse power will be just two or three times greater than in another. The same is true in your generators. To get any sort of a statement at all, you will have to eliminate all questionable considerations. I believe that is what the gentleman had in mind when he asked the question. There is a difference of 150 per cent. in the cost per horse power in steam locomotives themselves, even in locomotives of good standard design.

Mr. Duguid,—

The question of cost of electric and steam for locomotives is similar to the electric power company's high charge. If the Hydro Commission will charge $24.00 per horse power along their line, what would it cost if they had to generate it by steam? They cannot tell you how much it will cost to develop electricity by water.

Mr. Bly,—

They claim that the Toronto Electric Light Co., developing by steam, costs $40.00 per horse power. If the Niagara Power Companies can generate it for $10.00 per horse power at their station at the Falls and it costs $8.00 per horse power for transmission. then its cost delivered in Toronto would be $18.00 per horse power. I think these are the figures given by the Hydro Electric Commission.

Mr. Duguid,—

I think if any person has watched the discussions regarding Niagara power, they will be about as wise now as when they commenced.

Chairman,—

I think as Mr. Duguid does, that a person who has followed the discussions on Niagara power for the past two or three years, will be about as mystified now as when he started.

Mr. Fletcher,—

I think if it is not asking too personal a question, Mr. Bly perhaps may give us some figures from his experience.

Mr. Bly,—

When you talk about the cost of electricity you must take into consideration the conditions. In my case we have a great deal of heating to do. We use high speed engines and only get about 15 per cent. of the heat in the steam out into current, which is a small amount. Now in the winter we use the other 85 per cent. for heating. When you use it for heating it is hard to get the cost of an electric horse power. I cannot see why an electric horse power should cost so much. Of course they figure on the peak load. $18.00 to $25.00, I believe, were some of the rates given by the papers for the cost per horse power by the Hydro Commission. For motors of 5 horse power would be $25.00 and over that would be $18.00 to $25.00 per horsepower. A great deal of money is spent in machinery for the development of electricity and the man who uses it for two or three hours a day really gets it at less than its actual cost, whereas the man who is continuously using it, is charged more than he should pay.

Mr. Duguid,—

Take a shop that is driven by steam power and change it over to electric power, will it not cost more to distribute that power by electricity than by steam?

Mr. Bly.—

At the Joseph Simpson Co. they were transmitting power by belt from a Wheelock engine. The engine would take about 75 horse power on belting and shafting alone. It would only develop about 110 or 115 horse power for actual work. We changed that over to electric current and put in a high speed compound Goldie & McCullough engine, having a speed of 200 revolutions per minute, 3-phase alternating current, 325 horse power. Later on they put in another 325 horse power engine. They increased their power considerably and put in fifty motors. For the amount of work they increased, their actual consumption did not seem to increase nearly as much in proportion.

Mr. Fletcher,—

I only regret that we have not more prominent men in electric work here to-night. This meeting following the Exhibition, a great many of them are very busy, which I believe is the reason for their not being present, and then there is a convention going on in Philadelphia, which is taking some of our members away. Mr. Jefferis, one of our old members, is at home sick in bed.

Mr. Bly, I am sure, could not have given us a more enjoyable evening. While I have known Mr. Bly a great many years, I am very pleased to see that he is so well versed in his work. I move that a vote of thanks be given Mr. Bly.

Mr. Baldwin,—

I have pleasure in seconding that motion.

I must admit when you ask me to discuss anything appertaining to electricity I am at sea, as I am an old steam railroad man since 1882, consequently wrapped up in steam locomotives, and am at the present time running the locomotive at the Canada Foundry.

I would like to say a few words in reference to some of the remarks of Mr. Bly. He states that in the near future people will be riding around in cars without overhead wires, in reply to that I may say that thirty-seven years ago, when I was a boy I had just such a ride on an electrically driven car, which ran along on rails on Ramsgate sands, and it was a dining car at that, for well do I remember buying cakes and candies from a counter at the rear end of the car.

With reference to Sarnia Tunnel being electrified, I happened to be at Point Edward at the time the Tunnel was being built, holding a position of second in charge of the iron work on the car boats which carried the cars across the river, and I could continually see my finish, as, as soon as the Tunnel was opened, they would lay me off and they did.

We have with us, Mr. Chairman, the Chief Engineer of the Canada Foundry Co., Mr. W. Bird, possibly he would like to say a few words on this subject. He is, I know, a little bashful but if you call on him I am sure he will be able to interest us.

Chairman,—

We shall be glad to hear from Mr. Bird.

Mr. Bird,—

I do not know that I can say very much. I was an interested listener.

I think one of the chief reasons why electric locomotives are not coming to the front more, is largely due, as Mr. Bly said, to the fact that they cannot satisfy themselves how much current they use. Then again there is the question of snow in the winter time. They get into a snow bank and snow gets under wheels and stops contact with the rail and there they stay until some steam locomotive comes along and pulls them out. Then again they cannot get the weight in the electric locomotive to haul a load like the steam locomotive. Their loads are always of a light character and when they come to haul tonnage they cannot do it.

I have nothing to say further.

Chairman,—

You have heard the resolution that a vote of thanks be given Mr. Bly. What is your pleasure in the matter? Carried. Mr. Bly, I have very much pleasure in tendering you the thanks of this meeting for your excellent paper. We have all listened with a great deal of interest.

Mr. Bly,—

I can assure you it is a pleasure for me to do what I can for my fellowmen. We are only men among men. If there is anything I can do to help a man along or give him any information which will benefit him, I am glad to do so. I find I get benefited myself in helping others. It is not the man who hides himself under a bushel in this world that gets along.

Mr. MacNicol,—

There is one thing which I would like to correct, which I think is an error. It is in reference to the remark that the electric locomotive cannot get the weight to pull as much as the steam locomotive. At Sarnia tunnel the electric locomotive pulls 1,000 tons; and steam locomotives only brought up 750 tons. The electric locomotive is constructed so as to make two separate units which can be consolidated and operated as one.

Mr. Bird,—

There is no speed attached to the electric locomotive with a heavy load and if you put it out on the road, it would not be in it with the steam locomotive.

Chairman,—

I am very sorry that we did not have our President with us to-night, as he is a practical man. However, I have done the best possible under the circumstances to take his place.

The next paper will be on the "Ordering and Handling of Supplies," by Mr. A. Tory, Storekeeper, Grand Trunk Railway, London. It is a very important subject and I think it will be a good chance for some of you to air your grievances against the stores department. I do not think there is a branch of the service that is not interested in the handling of stores. You can all help in getting a good turn out. I think for the next meeting we might ask all the storekeepers on the Grand Trunk and Canadian Pacific Railway to come as our guests and to give us the benefit of their experience.

One thing we should do, and that is, try and be punctual so that we can start at eight o'clock. As I remarked once before, there is no institution which should be on time more than a railway, and as we are a railway club, we should also be on time.

Mr. Herriot,—

This is the first meeting since our picnic to Jackson's Point, and I would like to move a resolution for a vote of thanks to be given the Executive Committee for the arranging of such a successful affair. I am sure that everybody, who was present on that occasion, enjoyed themselves. We might also send a letter of thanks to the Toronto and York Radial Railway for their fine service and low rates on that day.

Mr. Sperry,—

I have pleasure in seconding that motion.

Chairman,—

If the mover will allow me, I think we should include the Entertainment Committee. I did not have the pleasure of being at the picnic but I am sure it was an enjoyable affair. I hope it will be repeated.

I have much pleasure in putting the resolution before the Club.

Moved by Mr. Baldwin and seconded by Mr. Fletcher that the meeting adjourn.