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. THE CENTRAL . .

Railway and Engineering Club

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OF CANADA

OFFICIAL PROCEEDINGS

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

Prince George Hotel, Toronto, April 19, 1910.

The President, Mr. Duguid, occupied the chair.

Chairman,—

The meeting will now come to order. As it is nearly half past eight nearly all those who are coming to-night, I think, are present.

The first order of business is reading the minutes of previous meeting. As you have all had a copy it will be in order for someone to move that the minutes be adopted as read. Moved by Mr. Baldwin, seconded by Mr. Rowell, that the minutes of the previous meeting be adopted as read. Carried.

Chairman,—

The next order of business is the remarks of the president. I have not got anything of special interest to say to you to-night.

The next meeting, you are all aware, is the last meeting before the holidays, all the papers we have had so far have been of great interest to the members. The paper at the next meeting will be of very great interest, it will be on boiler tubes. The paper deals particularly with seamless tubes, but will not be confined to seamless tubing. It will give a description of the different kind of tubes, and also go into the diseases of boiler tubes, etc. I have no doubt that this paper will be of greatest interest to all the members, and it will be given by a man who is very proficient to give you some good pointers regarding boiler tubes, and I hope that every member will make a special effort to be present at this meeting, as I would like to see a record attendance at the next meeting.

I do not wish to keep you any longer and will proceed with the next order of business which is the reading of the list of new members by the secretary.

NEW MEMBERS.

Mr. H. V. Tyrrell, Manager, Canadian Machinery, Toronto.

Mr. E. B. Allen, Sales Manager, Allis-Chalmers-Bullock Co., Limited, Toronto.

Mr. A. A. Gardner, C. & W. Walkers, Engineers, England.

Mr. A. Chenoweth, Machinist, Grand Trunk Railway Co., Stratford, Ont.

Mr. P. Jerreat, Machinist, Adams Harness Co., Toronto.

Mr. G. E. Southam, Manufacturer, Gasoline Engines, Toronto.

Mr. J. McGraw, Machinist, Massey-Harris Co., Toronto.

Mr. J. C. Kyle, Office Manager, Philip Carey Manufacturing Co., Toronto.

MEMBERS PRESENT.

C. L. Drury.
G. Baldwin.
J. M. Downer.
J. Powell.
L. Salter.
A. W. Durnan.
W. R. Gardner.
C. A. Tobin.
P. Jerreat.
E. Blackstone.
J. O. B. Latour.
G. S. Browne.
F. Slade.
E. Southby.
J. Barker.
W. H. Chidley.
W. G. Biggar.
E. B. Allen.
J. Dodd.
C. L. Worth.
J. S. Grassick.
H. E. Rowell.
E. Logan.
F. J. Clement.
J. C. Donald.
G. Shand.
G. Cook.
W. B. Moss.
E. B. Gilmour.
R. Pearson.
J. Adam.
G. C. Keith.
J. D. Coffey.
W. J. Daniel.
F. Hardisty.
W. C. Sealey.
G. Black.
H. Eddrup.
J. Duguid.
J. F. Campbell.
J. M. Clements.
G. D. Bly.
J. A. Bell.
E. J. Friend.
A. A. Gardner.
C. C. Chapelle.
G. P. Beswick.
G. A. Young.
A. Stewart.
G. E. Southam.
C. Radford.
W. Keating.
J. McWater.
T. McKenzie.
J. A. Chenowith.
W. Evans.
R. H. Fish.
L. S. Hyde.

Chairman,—

These members have all been passed on by the executive and their membership cards will be forwarded to them in due course.

Under the head of "New Business" I think it will be well to take up the matter of the annual picnic. We shall be glad to have the ideas of any of the members on this subject.

Mr. Baldwin,—

I would move that a committee be appointed to look into the matter of the annual picnic and to make a report at the next meeting. Seconded by Mr. Rowell. Carried.

Chairman,—

I would like to make a suggestion that the appointment of the committee be left in the hands of Mr. Baldwin, who knows the members who could look after this matter better than I do. Will you do that, Mr. Baldwin?

Mr. Baldwin,—

I will give Mr. Worth a list of names before the meeting closes.

Chairman,—

It has been regularly moved and seconded that a committee be appointed to make all arrangements for the annual picnic, and to make a report at the next meeting. What is your pleasure? Carried.

A short discussion took place as to the advisability of going to some other place than Jackson's Point, but the matter was left in the hands of the committee.

Chairman,—

The next order of business is the reading of papers and the discussion thereof.

We have with us to-night Mr. H. H. Wilson, Chief Engineer of the W. A. Murray Co., Toronto, who will now read his paper on "The Physical Theory of a Direct Current Dynamo."

THE PHYSICAL THEORY OF A DIRECT CURRENT DYNAMO.

BY MR. H. H. WILSON, CHIEF ENGINEER W. A. MURRAY CO., TORONTO.

Around any wire through which an electric current is flowing there is always a magnetic whirl or circuit of lines of force, called a magnetic field; if the strength of the current in the wire is constant these lines of force will have position and direction only, but under certain conditions will have a very active influence on coiled conductors, which will be taken up later. If the current is flowing away from us when looking along the conductor, the lines of force in the magnetic field will circulate around the conductor in a right-hand direction, that is, in the direction of the movements of the hands of a watch. Each line of force will form a ring, or, a complete circuit around the conductor. If two conductors are placed close, and parallel with each other, and an electric current flowing through each of them in opposite directions, the lines of force will have different directions around each conductor, which will cause them to crowd each other in passing between the wires; this will cause a repulsion between them. If two or more wires are placed close and parallel to each other and an electric current flowing in the same direction in each wire, the lines of force will encircle the total number of wires, and will cause an attraction between them. If an insulated conductor is wound around a bar of iron, and an electric current made to flow through the conductor, the lines of force will surround the whole thing with a direction toward one end of the bar, where they will all enter and pass out again at the other end. The end of the bar at which the lines of force are issuing is called the north pole, and the end at which they enter is called the south pole of the magnet; this kind of a magnet is called an electro-magnet. As these lines of force are caused by a current of electricity flowing in a closed conductor, they will under favorable conditions cause a current to flow in another closed conductor. All these wires should have an insulating cover on them. In what follows some attention should be given to the lines of force in the magnetic field, that is, their direction and if they are increasing or decreasing in number, also the direction of motion in the cases of moving conductors.

There are three ways of inducing an E. M. F. in a coiled conductor. First, by mutual induction in which two separate coiled conductors placed near each other, one of them having a current flowing through it supplied from some electric source; this coil is called the primary or exciting coil. The magnetic circuit produced by the current in the primary, sur-

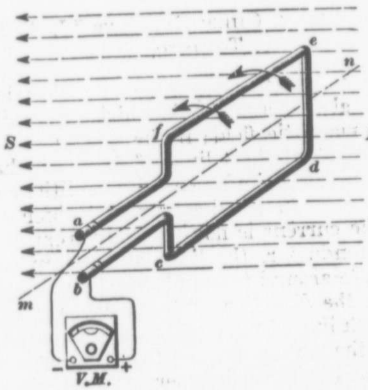

FIG. 1

rounds and threads through the other or secondary coil. If there is any sudden change in the strength of the current flowing in the primary, it will also cause a like change in the number of lines of force in the magnetic field, which passes through both coils. The sudden changes in the number of lines of force passing through the secondary coil induces an E. M. F., which tends to send a current through the coil. If the effect of the action is to diminish the number of lines of force that pass through the coil, the current will circulate around the coil in a right-hand direction, as viewed by a person looking along the magnetic field in the direction of the lines of force, but if the effect is to increase the number of lines of force that pass through the coil the current will circulate around the coil in the opposite direction.

Second, by self-induction, which is due to changes in the number of lines of force caused by the sudden changes in the current flowing in the coil, as for example, the action in the primary coil. If the strength of the current remains constant there would be no change in the number of lines of force passing through the coil, but if the strength of the current suddently increases it will induce an E. M. F., which opposes the applied current in the coil and tends to keep it from increasing.

If the strength of the current that is being supplied is allowed to suddenly decrease, the number of lines of force will also decrease and induce an E. M. F. which acts in the same direction as the original current and tends to keep it from falling. These actions are similar to what would take place if some extra resistance were cut-in in the first case and cut-out in the second case. The current would eventually reach its maximum strength in the coil, but not instantaneous, on account of this induced E. M. F. caused by self-induction due to the sudden fluctuations of the strength of the current supplied to the coil.

Third, by electro-magnetic induction, which is caused by the sudden changing of the number of lines of force passing through the coil due to some movement of the coil at right angles to the lines of force while in the magnetic field. The direction in which the current will flow in the coil can be determined by placing the thumb, forefinger and middle finger of the right hand so that each will be at right angles to the other two. If the forefinger points in the direction of the lines of force and the thmub points in the direction towards which the conductor is moving, then the middle finger will point in the direction towards which the current in the conductor tends to flow. A piece of copper wire bent into a rectangular form (Fig. 1) and the two ends connected through a voltmeter so that any E. M. F. can be detected, also the polarity, and placed within a magnetic field with its plane at right angles to the lines of force. In this position the coil encloses the greatest number of lines of force, by revolving the coil on a horizontal axis within its own plane, so that the upper side of the coil in starting to move will have a forward motion when looking along the magnetic field in the direction of the lines of force, thus an E. M.F. will be induced in the coil. From the same point of view and by the above mentioned method the current will be found to flow along the top side of the coil from left to right, down the end and along the lower side of the coil from right to left, through the voltmeter to the upper side again. Although the top side of the coil in the start will become the lower side at the completion of one-half revolution, the current will flow in the same direction in the coil while making this half turn, but as the coil starts on the second half turn, by applying the thumb and finger method, the current is found to have reversed within in the coil. If the coil is revolved at a constant speed it will be seen that the greatest E. M. F. will be generated as the coil passes through a position, bringing its plane parallel to the lines of force, because at this instant its sides will be cutting the largest number of lines of force in a given time. As the coil starts from its vertical position (Fig. 1), the E. M. F. starts at zero and reaches its maximum when passing the quarter turn, then the E. M. F. will fall to zero again as the coil comes to the half turn. At this point the voltmeter connections should be reversed in some manner, because the current reverses within the coil but does not reverse in relation to the polarity of the magnetic field. If two metallic rings were fastened one to each of the ends of the coil, in such a manner that they would revolve around and with their centres at the axis of the coil, and two contact pieces making electrical contact one with each ring and connected with some external circuit, the current would alternate in the circuit from one direction to the opposite direction in each revolution, thus giving an alternating current both in the coil and the external circuit, which can be changed to a current having the same direction of flow in the external circuit by fastening two halves of a metallic ring, one to each of the ends of the coil and made to revolve with the coil, each segment being separated or insulated from the other, and two contact pieces put in contact with this ring or commutator at points diametrically opposite each other and connected to an external circuit. The E. M. F. will rise and fall twice in each revolution as before, but the E. M. F. in the external circuit will cause the current to flow in the same direction at each impulse, but the current in the coil will alternate just the same. In the case of the single coil the commutator affords a means of reversing the connections at the ends of the coil with the external circuit. Another coil (Fig. 2) can be inserted in the magnetic field with its plane at right angles to the plane of the first coil, and the metallic ring or commutator cut into four equal segments, each insulated from the other. The ends of the coils should be connected to the commutator, so that the segments connected to the ends of each coil will be diametrically opposite each other, and for convenience the connection should be made half way between the ends of the segment, so that a line drawn through the points of contact of the brushes with the commutator, and the centre of the commutator and the axis of the coils, will be either parallel or at right angles with the lines of force in the magnetic field when one coil is parallel with the lines of force. If the line through the points of brush contacts is to be parallel to the lines of force, then the ends of the coil, the plane of which is passing through a parallel position with the lines of force, should be connected to the segments on which the brushes are making contact; but when the brushes are set in a position at right angles to the lines of force, the ends of the coils would have to be extended and bent a quarter turn back or forward in order to be connected with the segments under the brushes at the proper time as the coils revolve. By having the two coils revolving in the magnetic field there will be four pulsations in the external circuit and all in the same direction; also the E. M. F. of each pulsation does not fall to zero in the external circuit, because as the E. M. F. nears its maximum in a coil the commutator segments to which it is connected comes into contact

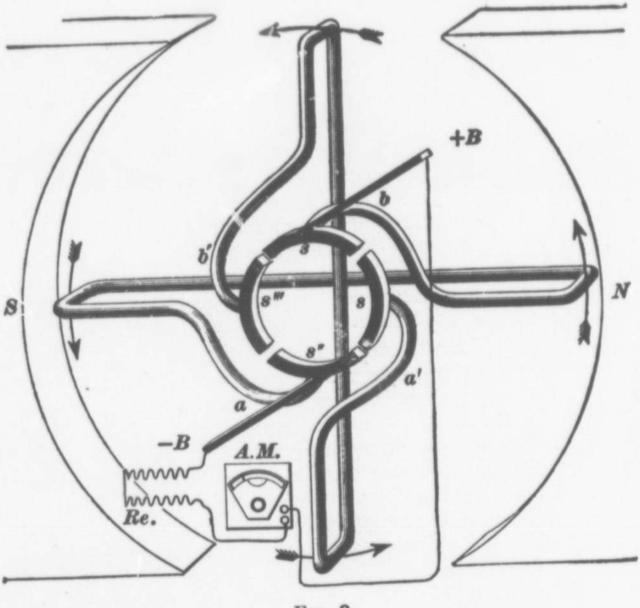

FIG. 2

with the brushes. As the E. M. F. starts to fall in this coil, the E. M. F. in the second coil is rising; and as the segments of the commutator to which the first coil is connected are about to pass from under the brushes, the commutator segments of the second coil are about to come in contact with the brushes, which will raise the E. M. F. in the external circuit up to maximum again. If the coils are placed and connected to the segments and the brushes in the positions as described above, it will be found that the E. M. F. in both coils are about equal, and the current will have no injurious effect on the brushes or commutator segments at the points of making and breaking of contacts with each other. If any even number of coils, say as many as can be placed in the circle, and each insulated from the other and their ends connected to commutator segments as described, and rotated at a constant required speed, the pulsations would be so rapid in the external circuit that the E. M. F. would be almost always at the maximum and the current would have a steady flow in the external circuit. It will be seen that each coil has its own commutator segments and that through them it comes in direct contact with the external circuit for an instant twice in each revolution, coiled conductors arranged and connected as above is known as open coil drum winding. A cylindrical iron drum can be used on which to wind or place the coils, the drum, or core, as it is called, is supported on a shaft extending from the core at both ends. On one end is also placed the commutator. The whole thing revolves with the shaft, which is held in position by two bearings, one at each end. The presence of the iron core has a tendency to greatly increase the number of lines of force in the magnetic field, which makes it possible to get a greater E. M. F. with the same speed. The coils should be insulated from the core. The commutator segments or bars should also be insulated from the shaft, in order that the current will flow in the external circuit when closed.

The core can also be made in ring form, very much like the rim of a fly-wheel, a cross section of which would be rectangular in shape. The ring would be supported by a spider fastened to the shaft. These cores should not be made of a solid piece of iron, because when rotated in the magnetic field it acts as a closed conductor, their sides cutting the lines of force at right angles, thus inducing an E. M. F. that cause what are called local or eddy currents to flow in the core itself. These eddy currents will cause the core to heat up uselessly, and also to consume a considerable amount of energy. To overcome this difficulty the core is built up with a large number of round, thin iron plates, or discs, each being insulated from the other by some non-conducting material, such as insulating japan, varnish, or very thin paper. The whole thing should be bolted together in such a manner that their flat surfaces are parallel to the direction of the lines of force, also to the direction of rotation. The building of the core in this manner does not diminish the magnetic permeability of the iron, but almost prevents eddy currents from flowing in the core. Another good point about the core is that it will attract nearly all stray lines of force from the surrounding air, because the lines of force will complete their circuit more readily through the core than through the air or some other non-magnetic substance.

If a ring core is properly placed in the magnetic field, the lines of force after issuing uniformly from the north magnetic pole will enter it and crowd together and remain in the ring as long as possible before entering the south magnetic pole. The cross section area of the ring is usually made large enough to hold the total numbers of lines of force passing from the north pole to south pole. If the number of lines is larger than the iron in the ring will hold the rest will pass through the air within the ring. By bending an insulated conductor across the outside of the ring core and back through the inside of the ring to the point of starting and secured to the core so that it will rotate with it, in this, as in the previous case, the top of the core will have a forward motion in the direction of the lines of force in the field, it will be seen that the part of the coil lying on the outside of the core is cutting lines of force. If the strength of the field is not more than the iron in the core will hold, that part of the coil passing through the core remains inactive, because it is not cutting lines of force. By connecting the ends of the coil through a voltmeter the current would be found to circulate around the coil in a right-hand direction while passing through the first half revolution. At this point the coil is about to change its direction of motion in relation to the lines of force, and the current will flow in a right-hand direction in the coil again, but it has reversed its direction of flow within the coil itself, because after rotating a half revolution with the core it has also passed through a half revolution on its own axis, as well as the above mentioned change in direction of motion. The outside of the ring core could be covered with coils insulated from the core and each other and their ends connected to commutator bars in the same way as the drum core winding, and the resultant E. M. F. in the external circuit would be similar in action. This is also the open coil winding applied to the ring core. In an open coil winding as described, the E. M. F. in the external circuit could never be greater than that generated in a single coil, but if a conductor makes several turns around through the ring before its ends are connected to the external circuit there would be an E. M. F. generated between the ends of the coil equal to the product of the number of turns, and the E. M. F. in one turn, if they are very close together, or, in other words, each turn of the conductor would generate its own E. M. F. and the turns would be connected in series with the external circuit. This winding would be of an open coil type also, but has the advantage over the single turn system of generating a greater E. M. F. with the same strength of field and the same speed of rotation.

Starting with a long conductor and winding it around through the ring (Fig. 3) one turn after another, so as the whole face of the core is covered and the two ends fastened together, this would make a continuous coiled insulated conductor. The commutator should have as many bars in it as there is complete turns on the core. Each turn is taped with a piece of wire called a lead, at the commutator end of the core, and connected to the bar, whose length is about in line with the plane of that turn to which the lead is connected, then the brush contacts with the commutator will

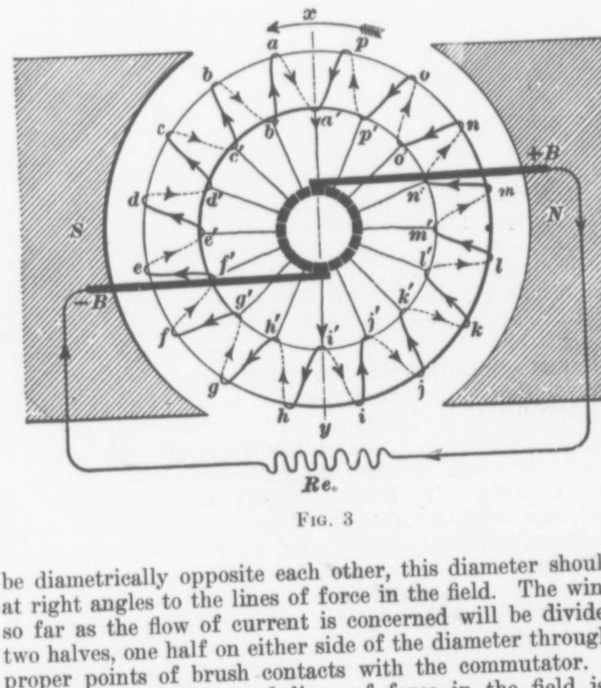

FIG. 3

be diametrically opposite each other, this diameter should be at right angles to the lines of force in the field. The winding so far as the flow of current is concerned will be divided in two halves, one half on either side of the diameter through the proper points of brush contacts with the commutator. The direction of rotation and lines of force in the field is the same as in the other cases. If the core is rotated there will be an E. M. F. generated in all the parts of this winding passing across the outside of the core. The E. M. F. in each outside conductor passing down in front of the south pole tends to act toward the positive brush, and the E. M. F. in all the conductors passing upward in front of the north pole also tends to act toward the positive brush, thus one-half of the winding is connected in parallel with the other to the positive and negative brushes through the leads from the winding to the bars on which the brushes are making contact. The direction of the lines of force in the field between the poles in each case is supposed to be horizontal. If the turns of the winding in the last case, starting at the lower brush, and is wound in a right-hand direction and advancing on the core in the opposite direction to that of its rotation, the upper or top brush will be positive. The E. M. F. generated in either half of the winding will be equal to the sum of the E. M. F. generated in each outside part of the winding; that is, all the turns on either side of the core between the brushes are connected in series. A winding of this kind is called a closed coil ring winding, and will also give a greater E. M. F. with the same speed and strength of field than a single open coil winding. A closed coil winding can also be placed on a drum core or on the outside of a ring core. Each conductor on the core will have a motion almost parallel with the lines of force for a considerable time twice in each revolution and will be practically inactive so far as the generating of an E. M. F. is concerned, but they are very necessary in a closed coil winding as a conductor to complete the circuits to the brushes. The drum with its winding and the commutator is called an armature. The iron frame or yoke through which the armature shaft extends on either side has two laminated projections fastened on the inside and extending very close to the face of the armature. On these projections or pole pieces are placed the field windings. These windings are connected in series and also in series with a resistance box or rheostat, to control the current flowing in them; the ends are then connected one to each of the brushes or terminal of the armature. A dynamo of this kind is called a shunt dynamo. If a piece of insulated wire large enough to carry the output of the dynamo is taken and a few turns made with it around each pole piece in addition to the shunt windings, so that it will help to strengthen the magnetic field and then connected in series with the external circuit, it would be a compound wound dynamo. The current should flow through each winding on each pole piece so that the face of one will be positive and the face of the other will be negative. If this is done the lines of force will flow in the iron yoke from the negative pole piece to the positive pole and across through the armature to the negative pole again, thus completing their circuit. The dynamo considered in this paper is a simple bypolar type, which requires only two sets of brushes.

Chairman,—

As it is getting pretty late I think it would be well to leave the questions to be asked on this paper until the next meeting night.

Before going any farther I would like to say that we have with us to-night Mr. Powell, secretary of The Canadian Railway Club, Montreal. I know he is due to leave Toronto at 10.15 and I am sure we shall be very pleased to hear from Mr. Powell before he leaves.

Mr. Powell,—

Mr. Chairman and Members of The Central Railway and Engineering Club:

This is only the second time that I have had the privilege of being present at any of your meetings. I think the first time was at its inauguration, and as a representative of The Canadian Railway Club, which is perhaps the mother of this Club, I wish to convey to the members of this Club the feelings of the members of The Canadian Railway Club with regard to your prosperity and success. They have watched you with a great deal of pleasure and are pleased with the good work that you are doing. They are not jealous of your prosperity, but are glad to have you do this wrok.

I came in from the North to-night, and intended to go on to Montreal at 8.30, but I could not get accommodation, and I am now going at 10.15. I took the opportunity while here, of coming in to your meeting.

I thank you very much for calling upon me and I wish you all prosperity.

Chairman,—

We have listened with a great deal of interest to Mr. Wilson's paper to-night. He has taken a lot of trouble to get out these drawings and write the paper, and we are very much indebted to Mr. Wilson for the trouble he has taken.

It is a little late now to start any discussion on the matter, but, although Mr. Wilson has gone into the subject very fully there may be some members who would like to ask Mr. Wilson a few questions, and after all the hard work he has done to-night in reading the paper and explaining the illustrations I think it would be as well if Mr. Wilson would kindly bring back the drawings with him to the next meeting and any questions any members would like to ask him then I am sure he would be pleased to answer them.

I think no doubt that the members will be pleased to tender Mr. Wilson a vote of thanks for the excellent paper which he has read to-night.

Proposed by Mr. Baldwin, seconded by Mr. Blackstone, that a vote of thanks be tendered to Mr. Wilson for his paper. Carried.

Mr. Wilson,—

If the paper has been any good to any of the members, I feel well repaid for the trouble I have taken, and I shall be only two pleased to have a chance to give another paper.

Chairman,—

For the benefit of the members who were not here at the opening of the meeting I would say that it was moved and seconded that a committee be appointed to arrange for our annual excursion, and for them to report at our next meeting. The committee that has been appointed is as follows:

W. R. McCrae.	C. A. Jefferis.	A. J. Lewkowiez.
H. G. Fletcher.	G. Baldwin.	E. Logan.
C. L. Worth.	J. Duguid.	J. F. Campbell.
J. Bannon.	A. W. Carmichael.	

With the assistance of the Reception Committee when called upon.

Mr. Worth will notify the members of this committee the date of the meeting. It will be up to the committee now to get busy and make all arrangements, and judging from other years there will not be anything lacking to make the excursion a success.

Do not forget the next meeting night, as we expect to have a very interesting meeting. If there be no other business it will be in order for someone to move that we adjourn.

Moved by Mr. Logan, seconded by Mr. Blackstone, that the meeting be adjourned. Carried.