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

OFFICIAL PROCEEDINGS

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

ROSSIN HOUSE, TORONTO, Sept.17th, 1907.

The President, Mr. Kennedy, occupied the chair.

Chairman,—

Gentlemen: Our last regular meeting was held on May 21st. Since that time no doubt a number of you present will recollect that we had a Smoker on June 24th, and I hope that you have all recovered from the good time we had that night.

We are a little disappointed to-night that we have not a greater number of members present at our opening meeting; no doubt this is due to the continued fine weather we are having. However, I hope before the meeting closes there will be more members put in their appearance.

Since our last meeting, no doubt there have been a good many here who have had opportunities, during their vacation, of travelling around and seeing what the other people are doing, and it is hoped that the members who have had these opportunities will make use of same by imparting their knowledge to others, and give their names to our secretary for reading of papers at our future meetings. The secretary has a number of names of those who have promised to give papers at our Club meetings, but I am sorry to say that most of them are a little reluctant in giving a date on which they will present a paper.

You are all aware of the amount of work involved in connection with the secretary's duties in looking after the affairs of a Club of this kind, and I am sure you will appreciate the fact that it is a trouble to him when he finds that he has to look around for those who will come forward and volunteer to give us interesting papers to which we may come and listen to.

However, what I want to say in conclusion, is that we would like the members who are desirous of giving us papers to give in their names to the secretary, and say on what date or what meeting they are prepared to bring forward the paper.

Chairman,—

The first order of business is the reading of Minutes of previous meeting:

I understand that all have been forwarded a copy of the Minutes of previous meeting, and I would suggest that some member make a motion that it be adopted as read.

Moved by Mr. J. J. Fletcher, seconded by Mr. A. G. McLellan, that the Minutes be adopted as read. Carried.

Chairman,—

The next order of business is the remarks of President:

I do not know, gentlemen, that I have anything to say to-night that will be of interest to you other than what I have already said.

Our Club, I am satisfied, is flourishing, and we are adding to our membership, but not as rapidly as we would wish, and the appeal by the Secretary sometime ago, that each member bring in another member has not been responded to as it might have been. For the short time we have been holding meetings, we have had a very good attendance, and I am glad to say that the members are now commencing to come in to-night. I might here say that our meetings are supposed to open at 8 o'clock, but we have got into the fashion of getting around at 8.30. I think we all should make an effort to get here at the proper time, as the persons who go to the trouble of making out these papers, must feel it an imposition upon them to have to be kept so late at night when the meeting opens late.

Chairman,—

The next order of business is the announcement of new members: I will call upon the Secretary to read same.

NEW MEMBERS.

Mr. P. H. McCabe, Toronto Street Railway Company, Toronto.

Chas. Murphy, Superintendent, C.P.R., London.

T. Palos, Charge Hand, G.T.R., Palmerston.

W. W. Yeager, Charge Hand, G.T.R., Hamilton.

G. A. Greene, Toronto.

Geo. E. Seegmiller, Fireman, Sarnia Tunnel.

W. B. Cookston, Representative Imperial Varnish Co., Toronto.

A. W. Adams, Sales Manager, Allen & Morrison Brake Shoe Mfg. Co., Chicago.

Secretary,—

There have been only eight new members brought in since last meeting, which I think is rather low. I feel that everyone should and could bring in a new member by the next meeting.

LIST OF MEMBERS PRESENT.

Robt. Pearson.	Harry D. Langlois.	J. A. Mitchell.
J. M. Clements.	O. A. Cole.	H. G. Fletcher.
J. E. Houghton.	Geo. Cooper.	J. Hay.
E. Logan.	Marshall Wright.	S. W. Price.
J. W. Griffin.	J. McWater.	G. Shand.
F. A. Purdy.	J. F. Campbell.	J. J. Fletcher.
J. H. Stortz.	F. A. Purdy.	Geo. Black.
M. W. Barker.	J. W. McLintock.	L. J. Street.
A. G. McLellan.	F. J. Clement.	W. Kennedy.
C. L. Worth.	S. Groves.	T. J. Ward.
W. Evans.	J. C. Garden.	Jno. Dodds.
R. Patterson.	N. MacNicol.	C. A. Jefferis.
I. Jefferis.	F. W. Burrows.	I. O. Frost.
W. Gells.	J. Mooney.	J. R. Armer.
J. Duguid.	W. H. Farrell.	R. G. Gilbride.

Chairman,—

"Next order of business,—Report of Standing Committee." Nil.

"Unfinished business." Nil.

"New Business." Nil.

"Reports of special committees." Nil.

"Unfinished discussion of papers read at previous meetings."

Might here say, gentlemen, that I think we should hold a special meeting some night in order to discuss papers read at previous meetings. I am sure it will be of interest to all of us to have a review and discussion of these papers.

The following paper on Injectors was presented by Mr. James T. Burke, Chief Factory Inspector for the Provincial Government:

Mr. President and Gentlemen: It affords me a good deal of pleasure to have the honor of presenting to your honorable body a paper on Injectors. If time had permitted I would like to have gone into this question more exhaustively, but have endeavored to give you a brief outline of the working, history and operation of the injector. An injector, as you are all doubtless well aware, is a device for injecting a supply of feed water into the body of a steam boiler. It was invented in 1858 by Monsieur Giffard and covered by French patent No. 21437, May 8th, 1858, and United States patent No. 27979, April 24th, 1860. It may be interesting to you to know that the invention of the injector was merely the outcome of Monsieur Giffard, endeavoring to perfect a flying machine. Finding it necessary to lighten the equipment as much as possible, he, fortunately, conceived the idea of using this system of supplying water to a small evaporator, in place of a steam pump, which was too heavy for his purpose. The flying machine was a failure, but Monsieur Giffard, through his patent injector, made somewhere in the vicinity of one million dollars. Prior to the invention of the injector, boilers were supplied with water usually by the use of steam pumps which forced the water into the boiler against the pressure of the steam. In Monsieur Giffard's injector, this is effected by the pressure and condensation of steam from the boiler itself. Monsieur Giffard takes a jet of steam from the boiler, causes it to lift the water in an external pipe and blows it directly into the boiler against its own pressure. So paradoxical and inoperative did this seem at first, that it was met with incredulity and not until repeated demonstrations established the fact, was it accepted as an operative device. The supply of water and steam are conducted to a combining tube and have to be adjusted according to the conditions of the pressure in the boiler and according to the temperature of the feed water. It is found that when the feed water is at a temperature above 120 degrees Farenheit, the injector will not work, the condensation of the steam being necessary for satisfactory results. To explain the principle on which the apparatus works, has been somewhat of a puzzle to engineers, for it certainly appears contrary to the laws of science that the steam should force the water into the boiler against its own pressure. To understand this thoroughly one requires a fair knowledge of the laws governing the velocity of steam and water when flowing from the same vessel under pressure and discharged into a medium of a different pressure. I will endeavor to explain how the velocity of a jet of steam or of water issuing from a boiler is ascertained, and consequently why when issuing from the same boiler or when issuing from separate boilers, but having the same initial pressure, there is so large a difference between the velocity of the jets. First, the question is asked, how can any person tell how fast the jet of steam will flow through an opening in a boiler?. How do they measure it? Well, our first help in answering those questions will come from a careful consideration of the law of falling bodies. Suppose one stood on the top of a high steeple and were to let drop a stone from the hand, and that stone were to strike the earth in four seconds, how high would the steeple be? This latter question to the beginner in the subject of mechanical subjects is about as difficult to answer as the former is, but you will see what we can do with the latter question first. From experiments, which have been made with falling bodies, it is known that the acceleration of gravity is 32.2 feet per second practically. This means that if a stone be dropped from a height greater than 32.2 feet, the first second it occupies in falling its velocity will increase from zero at the beginning to 32.2 feet at the end of the second. If it continues to fall for two seconds, its velocity at the end of the 2nd second will be twice 32.2 or 64.4 feet, for it is gaining in velocity at the uniform rate of 32.2 feet per second. At the end of three seconds occupied in falling its velocity will be 96.6 feet. At the end of four seconds 128.8 feet; assuming, of course, that the air does not offer any resistance, which it practically does not, to a falling stone. Now we know that if the stone dropped from the top of the steeple, and it required four seconds to strike the ground, its velocity at the instant of striking the ground is four times 32.2, or 128.8 feet per second. It is the knowledge of this fact that is going to help us to determine how high the top of the steeple is from the ground. The first second the stone was falling it started with zero velocity and attained a velocity of 32.2 feet at the end of that second. As the gain in velocity is regular, or, as the book tells us, the velocity is uniformly accelerated throughout the time occupied in falling, it follows that the distance through which the stone falls will be equal to the average velocity throughout the fall multiplied by the time occupied in falling. As before stated, the body started with zero velocity, and at the end of the first second, it had acquired a velocity of 32,2 feet per second; so that dividing 32.2 by 2 gives the average velocity during the second, and multiplying by 1, the number of seconds occupied in falling gives the distance through which the body falls. The first second which would be in this case $\frac{32.2}{2} \times 1$ equals 16.1 feet. At the end of the 2nd second occupied in falling, the body will have acquired a velocity of 32.2x2 equals 64.4 feet per second so that $\frac{64.4}{2} \times 2$ equals 64.4 feet distance through which the body will fall in two seconds. At the end of the third second the falling body will have acquired a velocity of 32.2x3 which equals 96.6 feet and will have fallen through a distance of $\frac{96.6}{2} \times 3$, which equals 144.9. At the end of the fourth second the falling body will have acquired a velocity equal to 32.2x4 which equals 128.8 feet, and will have fallen through a distance of $\frac{128.8}{2} \times 4$, which would equal 257.9 feet. Therefore, the top of the steeple must be 257.6 feet from the ground. The rate at which a falling body acquires velocity varies somewhat between the equator and the poles, being slower at the equator and faster at the poles than at any other point on the earth's surface, but for the purpose of practical calculation no account need be taken of this. Let us suppose, now, that instead of a stone, it was a a drop of water we let fall from the top of the steeple and that we let it fall through a perfect vacuum, it would strike the earth in exactly four seconds, and at the instant of striking would have acquired a velocity of 128.8 feet per second, the same as the stone had when it struck the earth. If we had a column of water 257.6 feet high contained in a pipe, and were to open a hole in the bottom, the water would issue from the opening at a velocity equal to that acquired by a drop of water falling from the top; because although the water at the bottom would not have so far to fall, the moment an opening was made there, the pressure upon it, due to the weight of the column of water above it, would cause it to issue at the same velocity it would have acquired due to gravity alone, had it started from the top and fallen through the whole length of the column, which would be the same as the falling stone, 128.8 feet per second.

With these facts concerning the falling body and the water issuing from the opening at the bottom of the water column, let us see what we can do to determine the velocity of water when issuing from an opening in a steam boiler under pressure. If the boiler carries, say 180 pounds steam pressure (absolute), it means that there is a force of 180 pounds on every square inch of the surface of the boiler, and also that all the water in it is under this pressure. To be a little more exact, we might say that there is a little more than this pressure on the water in the bottom of the boiler, because the weight of the water itself is something, but for our illustration this weight may be neglected. As there are 144 square inches of surface in the side of one cube of one foot, it follows that the total pressure on a square foot of surface of the boiler carrying 180 pounds of steam will be equal to 144x180 or 25,920 pounds. Assuming that a cubic foot of water at a temperature of 373 degrees, corresponding to a pressure of 180 pounds absolute, weighs 54.34 pounds, a column of water high enough to produce this pressure (25,920 pounds) on a square foot of the surface on the bottom supporting it will be equal to 25,920 divided by 54.34, or in round numbers 477 feet. To find the velocity with which the water will issue from an opening in the boiler all we now have to do is to find what velocity a body will acquire in falling through a distance of 477 feet vertically toward the earth. To do this, we must vary somewhat from the rule used to find the height through which a body will fall in a given time due to gravity, which is, multiply the acceleration of gravity by the square of the time occupied in falling and divide this result by two. As our distance is 477 feet, twice this will be 954 feet, and this divided by 32.2, the acceleration of gravity, gives 29.6; the square root of 29.6 is 5.44, which is the time in seconds a body falling freely through the air will require to fall through a height of 477 feet. To find the velocity acquired by the body at the instant it passed the last foot, as already explained, we multiply 32.2 by 5.44 and we find it to be 175 feet per second. Therefore, if we open a valve in a boiler carrying 180 pounds pressure below the water line anywhere, the water will rush out at the rate of 175 feet per second. Probably, in a practical experiment to determine this, the velocity would not be so high, as some account would need to be taken of the resistance of the atmosphere at the opening, and if the water had to flow through a valve, and also a shorter length of pipe, of the frictional resistance encountered. But our method of determining the velocity of flow of the water from the boiler will always give results which will be found very close to what a practical experiment will show. A cubic foot of steam weighs considerably less than a cubic foot of water, both being contained in the same boiler, and in a boiler under a pressure of 180 pounds absolute per square inch a cubic foot of steam will have a temperature of 373 degrees Fahrenheit and will weigh .3983 of a pound or nearly four-tenths of a pound. We learn from the foregoing that a cubic foot of water in a boiler under 180 pounds pressure weighs about 136 times as much as a cubic foot of steam in the same boiler under the same pressure. This may be found by dividing 54.34 by .3983. We saw that it required a column of water 477 feet high when at a temperature of 373 degrees to produce a pressure of 180 pounds per square inch on its base; it would require a column of steam $=\frac{180\times144}{.7389}=$ 35.076.6 feet to produce a pressure on its base of 180 pounds per square inch. But we cannot ascertain the velocity of the steam issuing from the boiler according to the same method by which we ascertained the velocity of the water because the steam acts so much differently; the moment it escapes from the opening it expands in a direction almost at right angles to the direction of the jet. This expansion is due to the internal pressure of the jet being greater than that of the atmosphere, and this, together with the work the jet does in pushing the air out of the way, lessens its velocity very considerably. In the case of the water flowing from the boiler, however, the resistance from the atmospheric pressure does not make much difference with its velocity, but we know that in the case of steam it does. Therefore it is better to consider the velocity of steam when allowed to flow from a boiler through a properly shaped nozzle. The shape of the nozzle is such that the steam in escaping expands to atmospheric pressure before it leaves the mouth of the nozzle, and, therefore, there is no expansion at right angles to the direction of the jet the moment it leaves the nozzle. To determine the velocity of steam discharging through nozzles, numerous experiments have been made and from these experiments formulas have been derived by the use of which a pretty close estimate can be made of the velocity of steam at various parts of the steam nozzle through which it is flowing, and also at the moment it enters the atmosphere after leaving the mouth of the nozzle. At the entrance to the steam nozzle the velocity of the steam is nearly the same as would be found by finding the height of a column of steam of uniform density having the same weight as the steam pressure in the boiler produces on a unit of area of boiler surface. In other words, the velocity of the steam at the entrance to the discharging nozzle may be found by practically the same method employed in finding the velocity of water issuing through an opening from the boiler. But the moment the steam passes the entrance to the nozzle, it expands in the direction of its flow, and increases its velocity, and it is the velocity at the moment the steam leaves the throat of the nozzle that we wish to determine. Let us take the case of steam through a nozzle, and the height of a column of steam of the same density as that of steam of 180 pounds pressure has already been found. You will observe that it is considerably higher than a column of water under the same absolute pressure, and anything dropping from this height would have a much greater velocity when it struck the earth than it would if dropped from the top of a column of water of the required height for the same pressure, namely, 180 pounds. By experiment a formula has been found for calculating the velocity of the steam while passing through the entrance to the steam nozzle and this formula is: Velocity equals 3.5953 times the square root of the height of a column of steam of the same uniform density as that of the steam in the boiler required to produce the given pressure on its base. In our case the absolute pressure is 180 pounds, the height of the column of steam required to produce the same pressure (180 pounds) is 65,076.6 feet, and the square root of this is 255.1, and 255.1x 3.5953 equals 917 feet, the velocity of the discharging jet of steam as it enters the passage to the nozzle. This we learn is a considerable swifter speed than the water had in coming out of the same boiler. But, as I have already remarked, the steam expands on its way to the nozzle, its pressure falls, its volume and velocity increase. Experiments have shown that the ratio of expansion is about 1,624, so that the final velocity of the steam at the moment it passes through the throat of the nozzle would be equal to 917 feet (the velocity of the steam in the entrance to the nozzle) multiplied by 1.624, which equals 1,489 feet. We have now seen that water and steam issuing from the same boiler, under the same initial pressures, have widely different velocities, and have learned something of the way in which the velocities are ascertained. What we now know of the difference in these velocities will help us considerably in obtaining a clear, satisfactory conception of the principles upon which the injector is constructed, and to understand why this appliance for feeding the boiler is able to take up water and to force it into the same boiler from which the steam is taken against the same pressure as the steam has that is operating it. In the injector a jet of steam issuing from the boiler is made to come in contact with a supply of water, cold enough to condense the steam immediately at an opening connected by piping to the water space of the boiler. The high velocity of the steam, as it condenses, is imparted to the particles of water and this water flowing into the orifice or opening passes into the boiler with considerable force and velocity. The injector is a convenient means of feeding a boiler, but is not economical because of the high velocity at which the water is made to enter the boiler. Its advantages are its simplicity and convenience and the fact that the water is heated by it before it enters the boiler. Its disadvantages are that it takes so much steam for the amount of work done and that it is so easily put out of order by some little chip or impurity in the water, or by becoming heated up—as its successful working depends upon the condensation of the steam as it issues from the nozzle in the injector.

Again thanking you for the opportunity of addressing these few remarks to your Club and for your interest and attention, I trust that your Club may continue to prosper in its work of social and educational interests.

Moved by Mr. Garden, seconded by Mr. Black, that a vote of thanks be tendered Mr. Burke, for his interesting and instructive paper. Carried.

Chairman,—

I trust we may have the pleasure of listening to many such lectures in future, and I am sure if we are permitted to listen to such discourses, we will have no trouble in increasing the membership of our Club.

Has any other member anything to bring before the Club?

As no person has anything else to bring up I would move an adjournment, seconded by Mr. Fletcher. Carried.