PAGES

MISSING

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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, February 20th, 1912.

The President, Mr. J. Bannon, occupied the chair.

Chairman,—

The first order of business is the reading of minutes of previous meeting. As you have all had a copy it will be in order for someone to move that they be adopted as read. Moved by Mr. Herriot, seconded by Mr. McKenzie, 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 regret very much that I was unable to be present at the last meeting, I am also sorry that our Past President, Mr. Baldwin, is not here to-night.

Mr. Herriot,—

Mr. Baldwin asked me to say that through unavoidable circumstances he is unable to be present to-night.

Chairman,—

I was unable to be present at the last meeting on account of receiving a notice at five o'clock that afternoon to attend an enquiry regarding an accident, and I called up Mr. Worth and got him to arrange for Mr. Jefferies to make the presentation of the Past President's charm to Mr. Baldwin, which I understand he did much better than I could have done it myself.

The Secretary informs me that the dues for the present year are not coming in very well, and also that the list of new members is a very small one. While it may be a little early, I think it might, perhaps, be as well to remind you of the fact that your dues for the year 1912 are now payable, and as they are so low, considering the amount of good we get out of the Club, it is to be earnestly hoped that the members will respond as early as possible.

The next order of business is the announcement of new members. I will ask the Secretary to read the list.

NEW MEMBERS.

W. Maybank, Dominion Foundry Supply Co., Toronto.
W. Nicholls, Canadian Supply Co., Toronto.
W. Crowley, Superintendent City of Toronto Motor Garage, Toronto.
P. Holbrow, Machinist, Gurney Foundry Co., Toronto.
A. Stroud, Machinist, Gurney Foundry Co., Toronto.
C. Blackwell, Pattern Fitter, Gurney Foundry Co., Toronto.

Secretary,—

I may say that this is the smallest list of new members we have had in a long time.

MEMBERS PRESENT.

J. E. Rawstron	R. B. Shepherd	A. W. Ritchie
J. Douglas	C. Blackwell	J. Wright
A. Woodley	H. G. Woodley	W. H. Bowie
W. Maybank	W. C. Tait	T. B. Cole
A. Stroud	W. Fish	W. Dennett
J. O. B. Latour	F. J. Ross	T. McKenzie
J. Barker	J. M. Clements	F. Harrison
W. H. N. Davis	W. Harvey	J. Anderson
E. A. Morrison	J. F. Campbell	M. R. Jones
C. G. Herring	E. A. Wilkinson	H. G. Fletcher
J. Herriot	G. P. Beswick	J. W. Helps
W. Crossley	J. Adam	J. A. Dickinson
H. H. Wilson	A. J. Lewkowicz	J. C. Donald
T. H. Barnes	C. Scott	W. R. Gardner
W. C. Sealey	H. V. Armitage	T. J. Ward
C. A. Jefferis	John Anderson	J. Marshall
A. W. Carmichael	G. S. Brown	E. Logan
J. B. Dunlop	G. F. Milne	J. Finlay
W. Carr	G. D. Bly	G. Cook
F. Wickson	L. S. Hyde	C. L. Worth.

Chairman,—

It is the intention of the Club to hold a "Smoker" next month, and I will ask the Executive Committee to kindly remain after the meeting in connection with this matter. The members will all be notified by card in the usual manner, of the date and other particulars.

I will pass over the next orders of business to No. 9, "Reading of papers or reports and discussion thereof."

We have with us to-night our old friend, Mr. Wickens, who will read us a paper on "Soft Coal and a Smokeless City." I do not know of anyone who is better able to handle this subject than Mr. Wickens. While I had an opportunity of reading this paper over, as I have been laid up for a week or ten days, I did not finish reading it through, and, therefore, I shall not be in a position to take much part in the discussion. However, I have every reason to believe that you will enjoy this paper very much, and I will call on Mr. Wickens.

Mr. Wickens,—

When the Secretary asked me to read a paper, I enquired what subject I should choose, and he told me to go ahead and choose my own. Whether the subject I have chosen is an interesting one or not is for you to decide.

I was talking to a gentleman the other day, and told him that I was going to read a paper before this Club, on "Soft Coal and a Smokeless City." He said that he thought the subject was one that would be of great interest to everybody, and added that he thought that engineers should get together, thrash the matter out and settle it once and for all as to the best methods to be adopted to get the desired results. I told him that the matter had been under discussion for the past 18 or 20 years, and there was still something to be said on both sides of the case.

SOFT COAL AND A SMOKELESS CITY.

BY A. M. WICKENS, EXECUTIVE SPECIAL, CANADIAN CASUALTY AND BOILER INSURANCE CO., TORONTO.

The present day tendencies are such that in all cities or even towns of some importance and considerable size there is more or less agitation for the abatement of the smoke nuisance. In some of the larger eastern American cities the use of bituminous or soft coal is prohibited and hard coal only is used for both power and heating boilers. These cities are near enough to the hard coal district to be able to buy hard coal at a price that is low enough to compare favorably with the prices for the soft coals and as hard coal is smokeless, very stringent laws concerning smoke can be easily fulfilled.

In Canada we are not so happily situated. We are obliged to use soft coal for power and also for many heating plants. In the principal cities of Canada and more particularly those of Ontario, the situation is bearing upon the manufacturer very heavily. A municipality will pass a very stringent smoke by-law and expect the manufacturer to carry out its provisions. The city does not agree that any style or system of boiler setting, nor that any smoke preventing device will be satisfactory; they only say that six minutes per hour is all the time the plant may legally discharge black smoke. This leaves the solution of the problem entirely in the hands of the coal user. The first question the manufacturer naturally asks is, why are we subjected to such regulation and he states that he has trouble enough now that competition is so keen to make business pay a dividend upon the capital invested.

The authorities say the smoke is destroying the appearance of all our fine tall buildings. The housekeepers say the smoke and fine coal dust gets into the house making it difficult to keep houses clean. Well, it appears they are both right and something should be done to help remove the trouble. The City of Toronto consumes yearly 375,000 tons of soft coal because they can make a horse-power as cheap with it as by any other means and further because nearly all of them are equipped to use steam for power and all must use steam for heating during seven months in the year, and some of them use it in process of manufacture all the time, so it appears if any other system is used as a prime mover we must still use coal for heating, drying and many other manufacturing processes. Consequently the first thing to consider is, can we burn soft coal practically or nearly smokeless. It is demonstrated that it can be done. The next inquiry is, will the necessary furnace arrangements be of such character that the fixed charges and maintainance will increase the cost of power to a prohibitive amount. To this we may also say "NO."

Such furnaces as the Murphy, the Rooney, the Jones underfeed stoker and several makes of chain grates are all practically smokeless. These furnaces require some power to run them and consequently the operating maintainence cost is increased above any straight grate or even a shaking grate. Still, as these several furnaces are more economical in the use of coal and give greater evaporation per lb. of coal, there is a saving in fuel as well as the elimination of the smoke nuisance.

If a hand-fired furnace is used it has the disadvantage of receiving too much air over the top of the fuel every time the fires are replenished. This, together with the fact that the supply of fresh coal added in usual quantities greatly reduces the temperature of the fire and this occurs just at the time the volatile portions of the soft coal are being liberated and at a time when the fire should be incandescent, if perfect combustion is to be maintained, the result is that dense volumes of black smoke are escaping from the stack. It has been said that the black smoke from our chimneys represents tons of wasted fuel and this is only in a measure correct. It is possible, however, to have a fairly good result in the furnace with a discharge of considerable smoke. In this case the time during which the dense smoke is discharged is very short only being from one-half to one and one-half minutes after each charge of coal is put into the furnace.

There are many so-called smoke consumers patented and offered to the steam users. The most popular of which are arrangements for blowing a jet of live steam into the furnace with a view to holding back the volatile gasses until they will become ignited and burned. This was first used in 1838 and has been re-invented many times since. Many of them have automatic means to turn on the steam when the fire door is opened and to close it off at a fixed time or as soon as the smoke stops discharging from the stack. Many of these do succeed in reducing the length of time such discharge continues. They are at best only a make shift and do not reduce the coal bills to any extent. In fact, it usually takes rather more coal as extra steam has to be supplied the jets used for the purpose. In quite a number of tests run with and without the jet smoke consumers upon the same boilers, we found that the jets used from $3\frac{1}{2}$ per cent. to 7 per cent. of all the steam generated. We also found that steam was on full from 20 to 30 per cent. of the time and that at the remainder of the time the fires were practically as though there was no consumer on so that if any saving in fuel was made it could only be during the time the jets were on and to make a saving for the whole time the jets would have to save from 30 to 40 per cent. while in operation. These several tests proved clearly to us that steam jets are not economical and that they only partly remove the smoke nuisance. Consequently it appears that any steam jet device cannot really make any saving in fuel and it is also doubtful if they can be made to succeed as smoke preventors.

There are several smokeless furnaces on the market such as the Rooney stoker, the Murphy stoker, the Jones and the Taylor under-feed stokers and the different kinds or make of chain grates. Each of these have their particular friends and all of them give good results as to the fuel used when operated under normal conditions, but any of them will smoke badly if carelessly set and badly managed. One of the greatest advantages with automatic power-driven stokers is that the furnace doors do not require to be opened every few minutes. Just which of these stokers should be used can only be determined by careful and intelligent enquiry and examination. Where the load fluctuates such as in a small street railway plant the stoker that will pick up quickly should be used; in situations where at times an over load is sure to occur, then a stoker should be so arranged that the amount of coal burned per hour can be greatly increased without wasting the fuel or reducing the furnace efficiency to any great extent. Every boiler and furnace is sure to have a fixed amount of coal that can be burned to give its best results and when this amount is either greatly increased or diminished the efficiency of the boiler is reduced, hence it is imperative that the whole situation be carefully studied and worked out if good results are to be secured. There is no hard and fast rule by which it is possible to determine which stoker or appliance should be used. There are many accessories such as damper regulators, feed water regulators, pump governors, recording gauges, flue gas analysis and CO^2 recorders that should be considered and used whenever the coal consumption warrants it. In very small plants it does not pay to spend too much money upon accessories.

A factory or office building has to be heated for from six to seven months in the year and if this is done by the use of exhaust steam from the engine, it has been demonstrated that it is cheaper to heat a building with exhaust steam than by direct steam at high pressure using a pressure reducing valve, the steam engine proving to be the best means of reducing the pressure for the heating coils. In this case about 10 per cent. of the heat unites in the steam and is converted into power. The balance of the heat delivered to the cyclinder may be all utilized for heating purposes.

In figuring the electrical costs for power or light, the cost of coal for heating the building should always be added to the cost for current, apparently about 1.2 lbs per cubic foot of space per year, or if you calculate the cost for steam power the amount of coal that would be used for heating (if there was no engine or no exhaust steam used) should be credited to the cost of steam per horse power per year.

In a plant where the load is changeable such as a large office building, the ideal plan would be to buy electrical current for the summer months and use the engines in the plant during the colder weather using the exhaust steam for heating. In many cases this would cheapen in others it would not do so well. This largely depends upon the number of hours per day power is needed. It is claimed by many engineers that it is cheaper to use exhaust steam for heating than it is to use steam direct from a high pressure boiler through a reducing valve. In many large buildings that must be kept up to temperature all the time night and day the engines are run during nights and Sundays with rather a light load and the exhaust steam used for heating because tests have shown this is the most efficient of the two. Some engineers claim that the pulsations received from the engine exhaust materially assist the distribution of the heat throughout the system.

Steam at 100 lbs. gauge pressure contains 337.8°F. of sensible heat, while steam at 2½ lbs. gauge pressure contains 225.49°F. a difference of 112.31. In one case this difference is used up in useful mechanical work and in the other it is used up in non-productive internal work, forcing its particles through a very narrow opening in the reducing valve. The productive mechanical work is reduced by cylinder condensation and by the friction or power required to operate the engine itself without reference to the load it drives.

The designing engineers on this continent have much to learn about the use of steam in engine cylinders. This more especially applies to smaller plants. Take the most economical American engine of say 100 H.P. and the steam consumption will be from 26 to 30 lbs. per horse power per hour, while in Germany and France they succeed in doing this upon from 12 to 16 lbs. while if the engine is compound and condensing, a water consumption of from 7 to 9 lbs. has been obtained. This is mainly because superheated steam is used and cylinder losses are reduced to a minimum. The locomobil and the stumpf engines are built and sold under the above guarantees. We have many instances of smaller steam plants running continuously and showing good economy—to quote one or two of many, a plant having 1—12 in. × 12 in. × 300 R.P.M. Engine and 1—72 in. × 16 ft. horizontal tubular boiler, 1 feed water heater and two duplex boiler feed steam pumps—the factory contains 342580 cubic ft. of space to be heated, the load upon the engine averaged 80 H.P. for 10 hours per day, coal cost

$3.20 per ton, cost per horse power per year, $25.45. This includes wages, oil, water, packing compound and repairs including heating of the building.

A 250 H.P. non-condensing plant, 1 Corliss engine 18 × 42in. × 90 R.P.M., 2 boilers 72 in. × 18 ft., 2 duplex steam pumps for boiler feed, exhaust steam used for heating 1,020,500 cubic feet space, average load on the engine 204 H.P. cost per horse power per year including same as above $18.77. These figures do not include depreciation, interest, taxes or insurance. We also have a record of many steam plants that are isolated and self contained that are being operated at a cost per kilowatt that is low enough to compete with electric power from any other source.

THE GAS ENGINE.

There are many Producer Gas Engines upon the market. Some of them are succeeding well, others not so well. They are perfectly smokeless but not always perfectly successful and reliable. The manufacturers claim excellent fuel results from them and will guarantee a horse power for 1 lb. of small anthracite coal per hour. One would expect that with a result of that kind this form of prime mover would become very popular, still we find very few of them in operation in Canada. In England and in Europe there are many fairly successful Producer Gas Plants in operation and it seems strange to one in this country that there are so few of them installed. There must be some good reason why this is so. Some engineers claim it is because they are more liable to shut down on account of the great number of parts such as poppets, cams, levers, springers, etc. Others say it is because the engine will not operate under large variations of load without greatly increasing the fuel consumption. Whatever may be the reasons, the fact remains that in Canada we have very few successful Gas Producer Plants in operation.

HYDRO ELECTRIC.

In eastern and nothern Ontario we have almost an unlimited supply of water so arranged by nature that it is available for power in many places, and some of them are so situated that the development is not very expensive and recent improvements in electrical generators and transformers have made it possible to transmit electrical energy for a radius of many miles about the generating plant to be used for lighting, power and manufacturing purposes. It is clean to handle and is smokeless. Then, if the price is right and the production great enough we should have light and power for very low cost. In the vicinity of Toronto we are within reach of the great Niagara Falls electric development and are offered current from the Government

Hydro Electric Commission and we are supposed to get this current at cost as the government is not looking for a profit upon the enterprise, just charging enough to pay for the current, the interest upon the cost of the transmission lines and the actual expense of conducting the business so that the users of this current should get it at a very close figure to the actual cost. This means that towns or cities nearest to the source of power can be quoted a lower figure than those farther away on account of the extra cost of transmission lines. It also means that if the far distant towns do not use all the current the transmission lines will safely carry to them the price must go up so the whole problem is a matter of price and as all the equipment under the Hydro Electric Commission is of the newest and up-to-date character, comparison should be made with steam equipment of a like character. It is not fair to the consumer to quote a modern up-to-date electrical plant against an obsolete steam plant, for correct comparison both plants should be up-to-date., There are many places and factories where electric power is entirely suitable and the cost will be less than a steam plant. There are also many others where the steam plant will prove to be the cheapest and best. This applies more particularly where steam is required in process of manufacture. We have many steam plants where the electrical out put is low in cost. For example, one plant where the out put is 267,000KWH for the year the cost per KW. was .181c. Another where the out put was 33,630 KWH per month .04c. Also one when the current amounted to 17,450 KWH per month and the cost .0197 per KWH and one when the current was 48,760 KWH at a cost of .0188. Another one where general conditions were not so good the cost was 1.06 KWH. There are plants in this city making Electric current below 1c. per KWH; in all these cases exhaust steam is used for every purpose possible in the plant.

The ideal plant to my mind is a self-contained one generating their own power and arranged for electrical drives for all machines. The engines and boilers of the very best with just enough accessories to conserve as much of the heat as possible, with engine and dynamo units so arranged that they would be running at or near their most economical load a great portion of the time. All power transmission by wire so arranged to the motors that all shafting and counter shafts are eliminated. The exhaust steam to be used for all heating, drying and manufacturing purposes. The heating system to be arranged for partial vacuum and all water of condensation returned to the boilers. This would be the cheapest, most reliable and best form of power plant to build and operate even in the vicinity of Hydro Electric plants, and if properly equipped would be smokeless.

Mr. Wickens,—

I hope the members will take up the discussion, and, perhaps, they may bring out some points which will be of great interest to all of us.

Chairman,—

No doubt there will be a good deal of discussion on this paper, and if anybody wants to ask Mr. Wickens any questions I have no doubt he will be only too glad to answer them.

Mr. Bly,—

I think the paper is very interesting, and the writer deserves a great deal of credit for the time and trouble he has taken to prepare such an excellent paper. He has gone into the various questions very thoroughly, and I am quite sure that the points he has brought out will be interesting to all from the great railways down to the man who has an 8 or 10 h.p. plant.

The first point he touched upon was the smoke. The smoke problem concerns about as many people in this city today as in any place in Canada. The city is attempting to have the manufacturer eliminate smoke. To my mind, the city has started out to do something that it should do itself, that is, it should clean up its own back yard first.

Another point mentioned by the writer was the heating by exhaust steam. I have taken this question up very thoroughly, and have proved to my own satisfaction, at least, if not to the satisfaction of others, that I can heat as cheaply with exhaust steam, and take my electric load as I can by putting live steam through a reducing valve. This being the case I obtain my electric load for nothing, but somebody has said that you cannot get something for nothing, that is true, but the writer has said that the difference between the temperature of steam at 100 lbs. and 2½ lbs. is somewhere about 125 degrees. This was used up, either in obtaining useful work from the engines to the generators and getting something from it, or by passing it through a reducing valve from which no benefit can be derived.

If we get steam at 2½ lbs. pressure, we get a certain number of heat units, and if we put it through a reducing valve we get the same number of heat units. If you can get away from this fact, I am here to be shown. We can by equipping our plant with a vacuum return system collect all the latent heat in the steam.

There is another thing that perhaps the writer could explain, and that is, which is the furnace that will give the best results? He spoke of a number of furnaces in his paper, and it would be interesting to know which of them will give the best results with varying loads, with the least possible waste of coal, what I mean is, where you have to crowd your furnaces part of the time, and bank them at others, and still get the same efficiency out of the coal.

The writer has said that there is a great deal of fuel wasted in the amount of smoke coming through the stack. It seems to me that it would take a man a long time to gather up a ton of coal from the smoke issuing from the stacks. I am told that there is less than one-half of 1 per cent. given off in smoke.

While it is possible to burn bituminous coal with a clear stack and get very poor economy, it is quite possible to burn it with a clear stack and get good economy. If you burn one pound of carbon with insufficient air, you get a combination of gas given off CO and get 4,500 B.T.U. and have a clear stack, while if you add another atom of air, you get a combination of gas CO^2 given off and 14,500 B.T.U.

Chairman,—

I am somewhat surprised at the low cost of generating current, the figures for which Mr. Wickens states he got from New York. I know that in New York City the engineers have been face to face with this problem for the last two or three years, owing to the competition of the big central plants like the Edison Plant in New York. I know of cases where engineers have been practically up against it, and simply had to develop power to meet the Edison prices or lose their jobs. It is necessary for engineers to wake up and find out what is doing in their plant. I know of one particular case where they employ four engineers in a large building on Broadway. The plant owners were undecided as to whether they would shut down their plant and turn it over to the Edison people. This engineer got his staff of four or five firemen and the other engineers together and offered them a bonus if they would turn out certain work, and pay particular attention to the plant for a month, as he felt quite sure that if they did this, they could beat the Edison system. They got to work and did so.

Every engineer must wake up to the fact that, when competition is so keen, he must know exactly what his plant is costing him to generate current, the amount of water he evaporates per pound of coal, and all other particulars in connection with his plant.

Personally I do not think that the Hydro-Electric System is going to seriously affect the steam plants, but I do think that there are certain conditions under which the Hydro-Electric can give a man cheaper power than he can develop it. I went into this matter very thoroughly and know what I am talking about. I make an evaporative test every eight hours. I know how many pounds of coal I am burning, how much water I am evaporating, in fact, I know just what my plant will do, but the Hydro-Electric can supply me current cheaper than I can generate it, and there are many other plants in the city to-day to which the Hydro-Electric, or the Toronto Electric Light can supply current cheaper than they can generate it.

Engineers must wake up and study their plants if they are to make them efficient. They should try and educate themselves, and thus be better men, and show the manufacturers what they can do. Engineers in the past have not been alive to the situation, but now that they have such competition they must see that they make themselves more efficient.

While engineers have been educating themselves, they have neglected the one essential thing, to my mind, and that is to educate the manufacturer to appreciate their services more than they have been doing.

I have been suffering from a cold, in consequence of which I am rather hoarse, and do not feel able to say any more

Mr. Wilson,—

There are many things which enter into the cost of producing cheap power other than the cost of fuel, machinery, etc. Consideration has to be given to the floor space, rent that is charged up, and the interest on the money that is invested, also, the amount that is written off each year, usually 10 per cent. of first cost.

All these things make it very hard for a man with a small plant, say, 150 to 200 h.p. to compete with the rate given by central stations.

The Toronto Electric Light Co. does not seem to me to have any fixed price at all. They will promise anything in order to get your house or business place to become a customer of theirs. They will come in and ask you how much coal you burn, and will then offer to supply you with power for the amount of your coal bill. It is very hard to cut down this coal bill enough to counteract the extra charge of floor rent, interest on the money invested, and, in most cases, the wages of one or two extra men, it is almost impossible to meet competition of this kind.

The question of heating a building with exhaust steam from an engine in place of live steam through a pressure-reducing valve is an interesting one. As far as my experience goes I have found that the exhaust steam from the engine is the best method. I have found that I cannot get live steam at 2½ pounds or three pounds' pressure into some radiators, whereas I can get all the heat I require in these same radiators with exhaust steam at 2 or sometimes below 2 pounds. This may be entirely due to the pulsating motion caused by the engine.

Another thing I have noticed is, that providing the load on your engine is sufficient to give only the exhaust steam you required to heat the building, the coal consumption is about the same and you get the work done in the engine free, or else the heating free. I have thought this matter over very seriously and have arrived at some conclusions, but do not know that I will be able to put them in such a form as to make them intelligible to you. When we put steam through a pressure reducing valve from high pressure to low pressure, I think we should call it heat not steam that we put through. We just let enough heat through that pressure reducing valve to keep up the required temperature, and it seems to me that the same thing takes place with the engine. We let in a certain amount of steam before the cut-off, the temperature of which is very high at that point, but, after the valve cuts off the supply the steam starts to expand, that is, it takes up more volume, as the piston moves along, consequently it takes no more live steam to get the same amount of heat in the system than when the steam comes through the reducing valve.

Chairman,—

I might also say that I personally do not agree with the remarks Mr. Wickens made in regard to the value of live steam versus exhaust for heating.

I have always been taught that it takes heat to run an engine, and if you utilize the heat in the steam after running your engine you are saving yourself that much steam. I have taken this matter up with several first-class engineers, and one of them, a friend of mine in Buffalo, states that you can do much better with exhaust steam. But none of them have come forward with any facts, they tell us that the conditions are so in their particular plant, but they have not produced any facts to bear this out. It is all very well to say that you can heat a building to-day with exhaust steam better than you can with live steam. If a man is running a 500 h.p. plant and is generating 500 h.p. at the bus bar, he requires all that exhaust steam to heat his building. Now, supposing he shuts down his power plant, he has still got to heat his building, then, naturally, he must be getting the 500 h.p. he developed for nothing, because, when his plant is shut down he must heat his building with live steam, therefore there is the loss of 500 h.p. at the reducing valve which is not accounted for.

Mr. Wickens,—

The Chairman claims that nobody had any facts. I have a report here from a New York engineer which I will read.

A test conducted by John Fallon, C.E., of New York, to determine the difference between live steam through a reducing valve and exhaust steam for heating gives the following:

The radiator used contained 12 sections 30 in. high and was 460 feet from the boiler.

Exhaust Average of 65 Readings—
Steam Pressure per Gauge, 1.83 lbs.
Steam Temperature at Radiator. . . . . 204.63° F.
Temperature of Saturated Steam at Pressure. . . . .217.9° F.
Drop in Transmission. . . 13.27° F.
Live Steam Average of 5 Readings—
Steam Pressure as per Gauge. . . . . 2.3° F.
Steam Temperature at Radiator. . . . . .206.
Temperature of steam at Pressure. . . . . .219.4° F.
Drop in Transmission. . . . 13.4° F.

Steam taken from the same boiler at 100-lbs. pressure.
In one case it turned an engine to reduce the pressure.
And in the other the work was all used up forcing past small openings.

Mr. Wilson,—

Referring to the difference between using the pressure-reducing valve and exhaust steam from a steam engine for heating purposes.

In the first place, with the pressure-reducing valve, we only open a small orfice and let out a small quantity of steam continually. With the steam engine we let a small amount of live steam into the cylinder and then we shut it off entirely until the next stroke. The steam, after expanding in the cylinder, is reduced in pressure, but increased in volume from two to four times, so you see that the exhaust steam has been reduced within the cylinder, while with the pressure-reducing valve it is reduced right at the valve, consequently you get some value of the steam by passing it through the engine and doing work, whereas, in the other case, no benefit is derived from the steam before it is reduced.

Mr. Lewkowicz,—

I should like to know what is the difference in the volume of steam passing through the radiators in the two cases mentioned in a given time, that is, the cubic feet of live steam, and the cubic feet of exhaust steam? We can readily understand that where there is an unlimited supply of exhaust steam passing through the radiators that the volume might be greater, yet give off less of its heat than a lesser amount of live steam, as the steam in passing through the engine would lose a certain amount of heat, but having an unlimited supply of exhaust steam the volume can be increased to make up for the lower temperature. In the case of the live steam the tendency would be to economize and just keep enough steam going through the radiators to give the required radiated heat. Have you any data in reference to this matter of relative volume passing through the radiators in a given space of time?

Mr. Wickens,—

If I understand the question correctly, you want to know the difference in the volume of steam from a steam engine, and the volume of live steam necessary to obtain the same results.

If you reduce the pressure of the steam you reduce the temperature, and the more you reduce the pressure the less heat units you will have in the steam, consequently, the greater will be the volume required. Steam at 15 lbs. gauge pressure has 213.08 degrees F., 26.26 cubic feet, and weighs 1 lb., while steam at 115 lbs. pressure has 337.8 degrees F. and 3.86 cubic feet, and weighs 1 lb. The question whether the loss of heat units is greater when the steam is passed through a reducing valve, or through an engine cylinder, is a point that seems difficult to understand.

What reduces the pressure of steam is when it does some kind of work. It does not matter whether it is forcing its way through a reducing valve, pushing a piston, or heating a surface. In doing any work of this kind the temperature of the steam is also reduced; however, if a thermometer is placed on one side of a reducing valve, and another one placed on the other side it will be seen that the loss in heat units is less than should be, showing that in this case there is a small amount of superheat added to the steam in its passage through the reducing valve. This is one reason why some engineers claim that heating a building through a reducing valve is the cheapest plan.

Mr. Lewkowicz,—

I do not think Mr. Wickens quite understood the question, I was not referring to the change in temperature, but to the volume in cubic feet of steam required to give the same amount of radiated heat in each case in a given space of time.

Mr Wickens,—

In considering these conditions we did not consider the latent heat at all. The latent heat would be alike under both pressures and in each case.

Mr. Wilson,—

I believe that you can get steam enough from an engine to do your heating for nothing, that is, of course, if you have enough work for your engine to produce only the necessary amount of exhaust steam. There is to be considered the condensation in the cylinder, a few leaks in the steam main from the boiler to the engine, all of which, of course, will be a loss. On the other hand, you will have to burn the same amount of coal to heat the building with live steam, that you would to get the exhaust steam from the engine less what is lost through the condensation of the cylinders and the other losses I mentioned.

Mr. Latour,—

I read Mr. Wickens paper through and I think that Mr. Wickens has gone very fully into this matter.

Regarding the question of exhaust steam and live steam for heating, I think the point had better be explained by explaining that the engine, that is a simple engine, only uses 10 per cent. of the heat units to develop a certain quantity of work which may account for the fact that you can heat as cheaply from exhaust steam as you can from live steam through a reducing valve.

In reference to furnaces, a couple of years ago I was examining a power plant, one of the principal features which was the height of the furnace, which was 12 feet. That seemed to be a long way from the grate to the boiler, but they were getting very high results. At another plant where they had a battery of seven boilers we found that when they ran one boiler constantly they made no smoke, but when the stacks from the seven boilers were turned into one stack they developed smoke. I have noticed right here in Toronto small plants where the loads were constant, that they could run without making any smoke, but a similar plant under similar conditions, but with a varying load, that they would have considerable difficulty with smoke. If at one time a plant is run without making smoke and at another time there is smoke it is evident that the conditions have been changed. There is no smoke with a certain proportion of air, certain proportion of coal and certain proportion of draft. If these conditions were maintained there would be no smoke, but if the load is increased and the various proportions of air, coal and draft are not changed accordingly, there will be smoke. To run a plant satisfactorily it is necessary to have suitable measuring instruments to determine the pressure of the air, its velocity, etc., in order to meet the varying conditions and adjust the supply of air, etc., to meet the necessary changes.

One Sunday about a year ago I visited a central heating plant in Detroit, and spent the whole day there. It was a stormy and windy day and they had to put on all the fire they could to keep the required pressure. Some of you may know where this plant is situated. It is right in the heart of the retail district and if they blow any dust on these stores they immediately get into trouble. I noticed that they were very particular about the air pressure, regulating it carefully in proportion to the amount of coal they were using. This was not done at one place in particular, but at each furnace, one furnace going wrong would make smoke, even though all the others were right.

Coming down to the cost of power per K.W.H., I will give you a few figures of costs I obtained in different tests. One plant using about 500,000 K.W. Their cost was 4c., another plant using about 1,000,000 K.W. produced theirs for 2.96c. The Chicago Edison plant, I believe, is about 0.35c. There are many plants producing a K.W.H. for 0.8c. down to 0.5c.

Unless Hydro-Electric power can be delivered without all the conditions that are attached to it, the steam plants producing power at these low prices are cheaper than the Hydro-Electric.

Mr. Helps,—

I had not the least idea that I was going to be called on when I came to this meeting to-night. I have listened to the valuable paper read by Mr. Wickens and the discussion with a great deal of interest.

The question of smoke in a city like this is one of vital importance. One hears a good many kicks about the smoke by-law, but I think it is the duty of every engineer in a city like this to try and make Toronto a smokeless city. Smoke not only disfigures the buildings in our city, but it is a source of danger to the general health of the people, and I think it is a public duty to see that every engineer lives up to the by-law in regard to smoke.

Mr. Wickens rightly attaches much importance to the type of stokers employed. If we are going to prevent smoke, I am certainly of the opinion, after seeing many experiments tried, that the most satisfactory stoker was the one which gives a steady, constant stream of coal in very small quantities, and that coupled with chain grates on which the coal is evenly distributed. In that way you get as near as possible to total incandescence, which condition, I think, it is impossible to obtain in any other way.

Some figures were mentioned as to the relative cost of power. I think it would be impossible for anyone of us to go very much into the relative cost of power in one night. The main question to-night is the question of smoke. The question of the cost of K.W. hours per year is such a large subject that it would be quite impossible to begin to discuss it while any other subject is under discussion, there are so many points to be discussed in connection with it, anyone of which might alter the whole face of it.

The question of heating by exhaust steam is certainly a complex one, but I cannot say that I agree with some of the speakers. My whole experience goes in the direction laid down by yourself, Mr. Chairman, that is, that it is a mistake to suppose you can use exhaust steam for heating without an increase in the cost of fuel. Under proper conditions in either case it will be found that the cost of fuel will be the same.

It should be remembered that by sending your exhaust through your radiators you are putting a resistance in its path, the condition obtained being exactly the reverse of a vacuum condenser which relieves the back pressure and increases the efficiency of your engine.

I think Mr. Wickens slightly misunderstood the question in reference to volume. To my mind, that is where the mistake of the whole thing lies. We talk about steam containing a certain number of heat units. What is really meant is "heat units per unit of volume." Suppose you take steam at 100 lbs. pressure, it contains a certain number of heat units per cubic foot. If you take that steam and bring it down to 2 lbs. per sq. inch it still contains the same number of heat units, but spread over a larger volume. You have not lost any heat units. The engine takes that steam and converts same into mechanical power, but I do not think that experience will bear out the statement made a little while ago that only 10 per cent. is used in the engine. Why, if this is so, the steam engine must be the most uneconomical thing we have. If for every 100 lbs. of coal consumed we are only using 10 lbs. we must be actually losing 90 per cent. of our heat, but the amount lost or used in the engine is not still available for heating the building.

Where live steam is used, the steam goes through a reducing valve, and we are told that power is used up in forcing it through the reducing valve. What you really do is to allow a certain amount of steam to go through the reducing valve, when it expands into a larger volume. We are told that before passing through the reducing valve it contains a certain number of heat units, but after passing through it contains a smaller number. This is not so; the only thing that has happened is that it is expanded into a larger volume. Whatever may be our ideas derived from experience only, we say, and I am speaking from cases where this has been put to very careful test, that you cannot get something for nothing: that as a matter of fact the cost of fuel used is practically the same whether exhaust or live steam is used.

The writer has said that he did not include the cost of depreciation, insurance, etc., in the figures he gave us on the cost of operation of steam plants. To my mind these figures which have been omitted form a very great proportion of the total cost, and I would certainly like to ask the reader of the paper why he should leave that right out. I have made numerous tests along that line. I made one a few years ago in a large plant. The cost of coal was $3.00 per ton, and it was a pretty good grade of coal. The boilers were Babcock boilers, and we used a Ransome high speed engine, Holmes dynamos. I think anyone acquainted with English plants will agree that we had a good plant to work on. The plant was new and had only been running a year and was carrying a steady 10-hour load, yet the very best price we could get out of that plant under the most favorable conditions was a little under 3c. per K.W. hour, and I may say that I think if any engineer here is able to get his plant to produce power at that figure he has got something to be proud of.

Mr. Wickens,—

In preparing the figures for the cost of operation of two plants, I was figuring on an ordinary steam plant as compared with a plant supplied with Hydro-Electric power. There would be the necessary equipment in each plant suitable for the class of power to be used, and I looked at it this way, that the cost for depreciation, insurance, taxes and so forth would be practically the same in either case.

I did not intend to go very much into the question of cost as it is such a deep subject that we have only time to-night to touch the high spots as we go along, and I think possibly it would be well to get someone to give us a talk along those lines at another time.

To return to the question of the steam. If you take any heat out of steam you have got to put it there first. I remember an old experiment, I suppose many of you have seen it. A man takes a pound of water and puts it in a cylinder having one square foot area, and raises the temperature until it all turned into steam at atmospheric pressure, and that pound of water turned to steam will raise a frictionless piston 26.26 feet high, making 26.26 cubic feet of steam. If he loads that piston 90 lbs. per square inch and starts the same game over again, he would only be able to raise that piston 5½ feet, but he would have to use the same number of heat units.

Mr. Helps stated that an engine giving only 10 per cent. efficiency was pretty poor showing. There are not many engines that will give 10 per cent. efficiency, and it is a known fact that we lose practically 90 per cent. of the heat we turn into the steam engine cylinder.

Mr. Wilson,—

Take water that goes into the boiler say at 60 degrees temperature, the temperature of that water is raised until the pressure is one hundred pounds, and the temperature is 337 degrees, we take 60 degrees away and this leaves us the amount of heat we put into it. The water now is about ready to evaporate in the boiler, which will take up something more than 966 latent heat units. There is the difference between the 60 degrees and 377 and 966 to be added together, which is the heat per unit in the cylinder up to cut-off.

The steam engine only takes part of the sensible heat, that is, it reduces it from 337 degrees down to somewhere about 220 degrees, consequently there is a drop of about 100 degrees within the cylinder before the exhaust starts. This shows that a single cylinder engine, running non-condensing, only does work in the cylinder equal to about 10 per cent. of the heat delivered to it, when the temperatures I have mentioned are maintained.

Mr. Lewkowicz,—

To get back to the question of smoke. It might interest the members to hear of something I learned during my travels in England last year. That was the McKay bridgewall, which is a cast iron bridgewall containing a great many slits and holes in it through which air is admitted from the ashpit and is mixed with the hot gases as they pass over it, which has done a great deal towards solving the question of complete combustion in the furnaces on steamers and has aided considerably in the abatement of smoke nuisance on them when it has been used. It is a very ingenious device and is made in parts so that if any part should burn out it can easily be replaced.

Mr. Wickens,—

The device that Mr. Lewkowicz speaks about would not be at all suitable for land practice. On these vessels where they carry about 200 lbs. pessure and force the fires until they burn from 30 to 50 lbs. of coal per square foot of grate area ber hour, they have so much heat leaving the grates they can afford to turn air in at any part of the furnace over the grates without reducing the temperature of the gases too much, and are thus able to consume them, but in our ordinary land tubular boilers we do not have such an enormous heat as we only burn from 10 to 15 lbs per square foot, consequently we could not let air in in the same way to assist in consuming the gases and smoke.

Mr. Wilson,—

The device mentioned is to assist in consuming the smoke after we have made it. I think we should try some means of preventing the production of smoke in the first place, that is, do not let the smoke get away from the coal. What I have in mind is that all the air should pass through the incandescent coal, the smoke also should pass through it. The coal should be pushed up from underneath, and it will become hot before it reaches the incandescent coal and some of the carbon gases will be liberated, and they will have to pass through the incandescent coal with the air and thus be consumed. Of course we would have to take care that the coal was not crowded too much and thus liberate more carbon than could be consumed with the air supplied.

Mr. Bly,—

Taking up the point that Mr. Wilson spoke about. Chain grates will accomplish this providing that you do not have to crowd them, and that the load is constant, but where you are developing electrical power where the load is up one minute and down the next, which causes a great variation in the required amount of steam, you have got to have a furnace that will adjust itself to conditions of this kind.

I have three furnaces in my plant and you cannot push these furnaces hard enough to make smoke, these boilers figure at 10 square feet of heating surface, 115 h.p., and we are carrying a load of anywhere from 300 to 325 h.p. We also heat buildings of 150,000 square feet radiator surface, and yet we are able to run our furnaces in such a manner as to create no smoke.

Now, coming down to the plan of heating by exhaust steam. We heat from the back of York street to Bay and King, some of the buildings are 120 feet high, and we do it with from two to three pounds pressure of exhaust steam. I do not think that there is a live steam heating system that you can heat with less than five pounds. We have some buildings that we heat with live steam, but we do not get the same results by a long way that we do with exhaust steam, in fact, with the exhaust steam system we can heat buildings four or five times the distance away with 2½ pounds.

Chairman,—

I heated my building during the last cold snap without any difficulty whatever, a vapour on the system, and I had a 5 in. vacuum. It all depends on your piping system, you might have to carry 10 or 15 pounds to do the heating with.

Mr. Bly,—

I notice Mr. Wilson said that the Toronto Electric Light had three or four different prices. These people have been trying to get me to take their power, but when I showed their representative what I was doing, he claimed that I was getting better results than almost any other plant which he had visited, and he further stated that during the winter time he could not touch my price, but he thought that during the summer he could do better. The Hydro-Electric System wanted me to take current at 2,200 volts, and I would have to put in the reducing apparatus myself. Under these circumstances, I do not see how the Hydro-Electric is going to affect us.

Mr. Wilson,—

The remarks I made in reference to the Toronto Electric Light refers to four or five years ago. Six years ago the Toronto Electric Light practically had a monopoly of the power business, to-day there is a competitor in the market, and they are out looking for all the business they can get.

Mr. Jefferis,—

In the first place, I want to congratulate Mr. Wickens on the excellence of his paper. I know that it has required a great deal of thought and time to prepare it. In the second place, I want to congratulate the President on the able manner in which he has handled this rather ticklish meeting. In the third place, I want to say to the operating engineers here, and particularly to the last two gentlemen who have been speaking, "Don't worry." I don't mean to say to you sit down and let things go, but, I do mean this, that the steam engine has been invented a long time, and that it will still be on the job when we are all under the sod. If I were to speak to you from a personal point of view, and in the interests of my company, I would tell you to use coke for fuel, or to buy this or that kind of gas engine as a solution to your difficulties, and I would be right, but I do not want to do that.

A good many years ago, one of the officers, high in the Hydro-Electric management told me that with the Government behind them they could sell electricity very, very cheap. This, of course, would not be a very tough proposition for them. It is a tough proposition, however, to compete with a company that is backed by the Government, especially when the managers of the enterprises with which you are concerned are looking for dividends on the money that is invested. At this time, an old saying of the negro cook in our family when I lived in the Southern States, comes to my mind, she used to say, "Surely, the Lord will provide," and He will provide. I do not think that if there is any president, or general manager, or high representative of any company who has the privilege of being present at this meeting to-night who would not realize something more of the trials and problems that their engineers are battling with in their endeavors to faithfully carry out their duties in the interests of the firm for which they are working.

My advice to you is to do the very best you can, but don't worry about it. If your company or corporation is going to put something in which they think is going to reduce the cost of operation do not worry about it, all you can do is to run your plant at the lowest possible cost, consistent with true efficiency, and if you do that, I think you will all hold your jobs, and I am quite sure that those present, as I said before, will have left long, long before the steam engine is put out of business.

Mr. Lewkowicz,—

I take great pleasure in moving a hearty vote of thanks to Mr. Wickens for the excellent paper which he has prepared and read before us to-night.

Mr. Gardner,—

I second that.

Chairman,—

You have heard the motion, that a very hearty vote of thanks be tendered to Mr. Wickens for the interesting paper which he has given us to-night. What is your pleasure?

Carried unanimously.

Mr. Wickens, I have great pleasure in tendering you the unanimous vote of thanks of this meeting for the splendid paper which you have read, and which has resulted in such an excellent discussion.

Mr. Wickens,—

I can assure you, Mr. Chairman, that I appreciate very much the vote of thanks that you have just tendered to me, and I also wish to state that it has given me a great deal of pleasure to have had an opportunity of reading this paper to-night.

If this paper has helped any one man here to-night to a line of thought that will be useful to him, I am glad I spent the time I did in preparing it.

I did not expect to convert our friend, the Chairman, at one attempt. I have known him for a number of years, and, while we have many things in common, this is a subject on which we do not see eye to eye.

Chairman,—

The next paper will be "Notes on Foundry Practice," by

Mr. E. B. Gilmour. You have all heard Mr. Gilmour before, and know what a very able man he is on that subject.

I do not think there is anything more to bring before the meeting, so that it will be in order for someone to move that we adjourn.

Moved by Mr. Fletcher, seconded by Mr. Lewkowicz, that the meeting be adjourned. Carried.