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

OFFICIAL PROCEEDINGS

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C. L. WORTH, Sec.-Treas., Room 409 Union Station, Toronto

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

ROSSIN HOUSE, TORONTO, April 20th, 1909.

The President, Mr. Jefferis, occupied the chair.

Chairman,—

Gentlemen, the meeting will come to order, please. The first order of business is the reading of minutes of previous meeting. The minutes of the last meeting having been printed and forwarded to all of the members, it is therefore in order to move their adoption.

Moved by Mr. Baldwin and seconded by Mr. Ellis, that the minutes of the previous meeting be adopted as read. Carried.

Chairman,—

The next order of business is remarks of the President. I do not think that I have very much to say to-night, except that I would like to see more members paying their dues. Another thing I would like to say, is that every member should try and bring in another member before the next meeting night. We will now give you an opportunity of paying your dues, so that you can get ready.

Chairman,-

The Secretary will now announce the new members.

NEW MEMBERS.

Mr. T. McLean, Machinist, Grand Trunk Railway Shops, Stratford.

Mr. C. H. DeGruchy, Representative, Finley Smith & Co., Montreal.

Mr. A. J. Carruthers, Engineer, Grand Trunk Railway, Sarnia Tunnel.

Mr. J. R. Ross, Engineer, Grand Trunk Railway, Stratford.

Mr. R. Stockhill, Machinist, Consumers Gas, Toronto.

Mr. F. T. Malone, Representative, Wm. Jessop & Sons, Limited, Toronto.

Mr. W. J. Commins, Manager, Roofing Department H. W. Johns-Manville Co., Toronto.

Mr. J. H. Shaver, Salesman, H. W. Johns-Manville Co., Toronto.

Mr. W. A. Chapman, Manager, Rail Joint Co. of Canada, Montreal.

Mr. W. V. Shaw, Secretary-Treasurer, Robert Mitchell Co., Limited, Montreal.

Mr. E. R. Battley, Machinist, Grand Trunk Railway, Stratford.

Mr. G. Vener, Foreman, Air Brake Department, Grand Trunk Railway..

Mr. C. Young, Foreman, Connecting Rod Department, Grand Trunk Railway, Stratford.

Mr. H. Westbrook, Foreman Patternmaker, Grand Trunk Railway, Stratford.

M. G. Morrison, Foreman, Pump Department, Canada Foundry Co., Toronto.

MEMBERS PRESENT.

H. E. Rowell	G. E. Seegmiller	W. J. Bird
A. E. Till	G. Morrison	W. Bird
C. A. Jefferis	G. Baldwin	W. E. David
J. Duguid	H. P. Ellis	W. H. Bowie
G. D. Bly	O. A. Cole	R. H. Brown
J. C. Blanchflower	E. Southby	J. Mouldey
R. Pearson	J. F. Campbell	J. D. Mair
C. Shand	G. Kyle	W. Roulston
T. McBrien	H. Cross	J. O. B. Latour
J. Dewsbury	A. M. Wickens	C. Geldart
C. G. Herring	W. E. Archer	J. R. Armer
J. H. Stortz	J. V. Jackson	J. W. Griffin
A. W. Shallcross	N. D. Watmough	W. Poulter
T. J. Ward	F. R. Davis	D. Campbell
J. McWater	J. W. Hazlett	A. G. McLellan.
P. McCabe	E. Blackstone	G. Black
E. B. Allen	H. O. Eddrupp	J. Herriot
J. W. McLintock	E. Logan	L. S. Hyde
J. Kyle	C. L. Worth	

Chairman,—

We will pass over the next two orders of business as they are nil, and come to "Papers and discussion thereof."

We have with us to-night Mr. Walsh, Engineer of the Toronto Water Works, who is one of our members and has very kindly consented to give us a paper on "High Duty Pumping Engines for Water Works Purposes." There is always a feeling of satisfaction in every man's mind when he is listening to or reading a paper by someone who has spent the greater portion of his life along a certain line. Whereas with a man selling an article, we know that selling is his business and perhaps the next week he may be in another business, but when we get a man who has been up against practical troubles, having machinery to take care of, there is always great satisfaction in calling upon a person of that character, and I take great pleasure in calling upon Mr. Walsh to-night to give us his paper.

HIGH DUTY COMMERCIAL PUMPING ENGINES FOR WATER WORKS PURPOSES.

BY MR. T. J. WALSH, ENGINEER, TORONTO WATER WORKS.

Within the last few years there has been a large amount of money spent in extensions and improvements in the water works systems of the city of Toronto. The laying of large conduits, the boring of the tunnel across the bay and the laying of large distributing mains throughout the city. It became necessary to purchase new pumping engines to increase the pumping capacity.

The past experience of the water department in the wide open call for proposals for pumping engines, without specifications, leaving the design and immediate details to builders has, in the experience of Toronto, at least, been anything but satisfactory.

As one interested in the pumping department, it became my duty to investigate and report as to the best and most suitable type of pumping engine for our purpose, taking into consideration durability and general efficiency. In doing so I visited some of the largest pumping plants in the United States where almost every type of pumps was in use. In my investigation I had to guard against any experiment as we have had considerable experience in that line and require no more for some time at least. The steam turbines were in the experimental stage with a claim of universal superiority over reciprocating pumping engines, now the mechanical efficiency of a reciprocating pump, that is the pump proper, is about 98½ per cent. The hydraulic efficiency of the turbine pump is in the neighborhood of 70 per cent., a great many are only guaranteeing 65 per cent. It is perfectly evident that the amount of power to be added to overcome this deficiency of flow, is very much greater in the turbine pump.

Now, a pumpage of 10,000,000 gallons against 100 pounds pressure will require little over six tons of coal a day with a reciprocating engine on a steam consumption of 10½ pounds of steam per indicated h.p. per hour, which is a little above the best exhibit so far. The steam consumption of a turbine steam engine, so far, with superheated steam, is about 12½ pounds of steam per indicated h.p. per hour, and upon this basis applied to the gross case we find 6 1-5 tons of coal used by reciprocating engines, and a little over 10 tons for the turbine engine. With coal at $3.00 per ton, the difference would pay 5 per cent. on $80,000.00. However, there is no doubt a large field for turbine pumps in small units, and its many advantages will doubtless, in a great many cases give it the preference over the reciprocating pump.

However, for our purpose of continuous work and high efficiency, I had no hesitation in recommending the vertical triple expansion self contained pumping engine with a guarantee of 160,000,000 foot pounds per 1,000 pounds of commercially dry steam as the most suitable for our purpose.

The growth of steam pumping engines for public water supply has been slow, but nevertheless an interesting subject for the past fifty years. That is to say, beginning with the famous old Cornish engine which was so ruthlessly bundled out of the conditions of deep mine pumping under which it was developed into the much more arduous task of forcing water through long lines of pipes; we find the improvement was slow at first, and difficult though certain, then, as we look back from the view point of the triple expansion machine produced to-day at less cost than its clumsy and wasteful predecessors, until finally in later years the onward rush has carried the improvement more rapidly upward until the latest type stand at the top of a steep incline with the possibilities of superheated steam and quadruple expansion looming still a little higher.

In buying and installing a modern pumping engine, there seems to be a certain procedure which has come to be adopted during the gradual development of the business. It has seemed at times as though the mere statement of the requirements to be met was all sufficient for the attractions of competition, and the buyer could be furnished with all the necessary information and details relating to what he was to get for his money, by the competitors themselves. This seems beautifully simple, but there are certain attributes of human nature which completely defeat most of such efforts; each bidder wants the work, and as the object and aim of competitors is to get the most and best for the money, the result is that the party with the lowest bid tries to convince the buyer that his machine is upon equal footing with the others, and he has the lowest figures; while a higher or even the highest bidder tries to convince the buyer that he has very much the best proposition although at a higher figure or highest figure.

The buyer's best course may be upon the middle ground somewhere between the highest and lowest, but he does not know if unfamiliar with the details of the subject, and when he sees the figures varying a hundred per cent. from the highest to lowest for what he supposes ought to mean the same thing, he is entirely at sea and begins looking about him for some sort of help out of his dilemma.

The wide open call for proposals for a pumping engine will result in this state of affairs, sometimes, because certain vital details are not specified in the call for bids, and different bidders will offer machinery to be run at all sorts of speeds, the main object seeming to be to make the lowest price; and, although the lowest price accompanied by proper conditions, adequate dimensions, etc., ought to be the one chosen, it behoves the buyer to be certain that he is safe in his selection.

And the logic of this is that it will be better to have competent specifications prepared in advance than to endeavor to select a proper proposal from the grab bag collection resulting in what might be called the open door.

The matter of specifications would seem at first glance to be very simple, and perhaps it is, to those builders who understand, and have the courage to offer what they really know ought to be furnished; but the ever present grind known by the name of competition coupled with the strongly grounded idea that a contract should go to the lowest bidder, will assert itself and interfere with the fairly rational treatment of the subject. Besides this, there is a tendency amounting to a determination at times to stipulate that the builder of pumping engines must provide all sub-foundations, and foundations proper, do excavating, cut into and replace masonry, floors, walls and whatever may be changed in the course of the installation of the machinery thereby inflicting upon the maker of machinery a lot of work entirely and completely outside of his legitimate business and occupation. But I hold and am encouraged in my belief by experience, that the best course for the buyer to pursue with reference to his own interest is to exempt the engine builder from all work and responsibility outside of the machinery itself, leaving him only that which he is prepared to handle, and leave his mind free from the haunting shadow of matters foreign to his business, and which he cannot meet without a certain element of uncertainty as to cost, and the reflection of which must most surely come back to the buyer in the shape of increased price by reason of percentages added by the machinery maker to cover possible contingencies of which he cannot accurately inform himself beforehand.

In this age and day, when shop practice and management has been brought to a state of perfection which brings the price of a high class economical pumping engine down to a point justifying the use of a very high economy, a much better engine can be installed than most people would buy a few years ago. An engine in which is combined simplicity, high efficiency, and great durability and compactness—in fact a high type of engine is now used in the comparatively smaller capacities which not long ago were left to the field of low economy and low interest account.

There was a time when a pronounced contest was waged between high cost and high economy on one hand, and low cost and low economy on the other, but now the extremes are brought nearer together and finally blended into a still higher economy than ever before at a moderate cost in proportion to the results obtained. It may be that profits are less; but production is certainly less expensive; several factors no doubt combining to help the buyer.

In drawing up specifications for pumping engines general data should be stated for information of intending bidders, arranged in a convenient form so that those at a distance need not go amiss in preparing a proposal, or be put under the actual necessity of sending some one to investigate. Cases of course differ, whether the machinery is to go into an old building or a new one is to be built for its accommodation, so it may not be practicable to lay down a hard and fast rule, but the general data from an actual case may give some idea of the requirements.

GENERAL DATA.

Static water pressure at level of engine room floor.
Static water pressure from floor to level of water in well.
Allowance added for friction in force main.
Allowance added for friction in suction pipe.
Total working load upon plungers.
Steam pressure at throttle.
Available clear height above engine room floor.
Engine room floor to basement floor, vertical.
Available distance across engine room.
Wall to wall of engine room, inside, across.
Available on floor, lengthwise of engine room.
Available in basement, lengthwise of engine room.

Then it seems to be desirable to state, at least approximately, the required lengths, or stopping place on the contractor's part, of the suction and delivery main and steam pipe and in this and other items remove to the utmost extent any and all uncertainties, so that the builder of pumping engines may be able to figure on some exact basis; in fact, a clean and comprehensive statement of the work which the buyer wants done will help greatly in the matter, and save a great deal more money than it will cost to make such a statement. A general outline of the work to be done, modified, of course by conditions in different cases, would call for the making of the design, furnishing general and detail drawings or blue prints for approval, and erecting in the pumping stations upon foundations to be furnished by the purchaser in accordance with the detail blue prints and templates, and anchor bolts, furnished by the engine builder. A pumping engine of the desired class or type, together with appurtenances, connections, piping and fixtures within the engine room, complete ready for continuous service.

Some of the first things needed to be known by the builders are the conditions of service under which the engine is to operate. This can be conveniently made known by stating the number of gallons required to be pumped per 24 hours, giving the total water load upon plungers, including friction of suction and delivery mains, static head, point and manner of delivery of water.

The methods of determining the capacity of the main pumps vary according to the ideas of the builders and buyers; sometimes a weir only, sometimes a weir in conjunction with the plunger displacement. I reached the conclusion that with proper pump construction, the plunger displacement is adequate and conclusive, care being taken that the pump valves are reasonably and practically tight under pressure, and of a design including their seats, which will place their capability of holding water beyond doubt, in short, with a properly made pump, measuring the water at the very point of delivery with all discrepancies of leaking pipes eliminated, there could scarcely be so good a measure of the quantity of water pumped, in fact such a pump will no doubt come within one per cent. of the calculated capacity of the plungers in the real delivery of water.

Such pumps can be made, and even if it should cost a little more money to have them, any such excess over the price of a badly designed pump will be trifling compared with the constant, always present loss day after day of coal burned under the boilers and a considerable discrepancy in the amount of water going up the hill. A fairly good general statement of what would be desirable in a pumping engine for most cases, and provided there were no special reasons otherwise, would be about as follows: To have the steam pistons rigidly and directly connected to the water plungers so that no power would be transmitted through working parts and points beyond that due to the equalization of the steam distribution. The steam cylinders and the pump cylinders connected and supported so that the engine would be self-contained; and have all anchor bolts extended downward far enough into foundations to obtain the benefit of the weight of the masonry.

There is no good reason for not stating the stroke of the pistons and plungers, and their speed as well, either or both in feet of travel and revolutions per minute, giving the allowance of excess desired in plunger capacity. The buyer might just as well place all competitors upon an equal footing, leaving very little to argument or uncertainty, and he will find that much the easiest and more economical way of dealing with the matter. Subterfuges relating to percentages of plunger diameter to length of stroke are sometimes indulged in for the purpose of stipulating dimensions, but by far the better way is to come right out with the desired proportions of the water end of the machine conforming, of course, to good practice, but leaving the steam factor largely to the builder on account of the duty guarantee generally required.

I have observed cases wherein it would have been much better to appoint an expert before buying the engine than to wait until after completion for the regulation test of the machinery; and for the reason that, even where the designing is left to the builder, certain stipulations covering principles of construction and proportion, if properly carried out, will ensure the results asked for by the buyer, and all the expert would need to decide would be whether or not these stipulations had actually been met. A test much more readily and decisively accomplished than some of the ends aimed at during the duty tests after construction.

For example, we know that a pumping engine at a given speed, with certain diameter of plungers and length of stroke, will, when properly made, displace just so much water, the construction and workmanship being the guide as to capability. We also know from records and experiences that certain proportions and construction of steam cylinders and appurtenances will perform safely certain economical efficiencies; the entrainment of water in the steam, or the leakage of a force main between the engine and the reservoir will not have any bearing upon these facts as points of design and construction in the engine.

If the buyer is suffering from bad boilers and force mains, the engine builder can not help him out by modifying his machinery. Give the engine builder dry saturated or superheated steam for his engine or the equivalent allowances therefore, and then take the water away from his pump under the stipulated load, and that is as far as he can fairly be held responsible for results.

The condenser for the engine comes in of course for some attention, and whether of the jet or surface type depends upon the situation, from where the condenser water is to come from and other considerations applicable to each case by itself. I am of the opinion that surface type, using the water from the supply or suction mains passing through the condenser, is the best, requiring no extra amount of water for condensing purposes, and will ensure, when all leaks are stopped, the very best vacuum.

As a broad principle, the water for a jet condenser should be taken from the main pumps well by an independent pipe or pipes for the use of the condenser exclusively; and if this cannot be practicably done then the nearest possible approach should be made to such an independent arrangement, with properly proportioned injection pipes. The vacuum in the condenser will always be sufficient to draw the water from any point possible to be used by the main pumps of the engine. The air pump with the speed as moderate as pumping engine, better be driven from the main engine unless there exists some special reason to the contrary; in fact, general economy points to the driving of all auxiliary pumps from the main engine as a broad principle.

The question of an exhaust feed water heater between the low pressure and the condenser depends for the most part upon surrounding conditions, but it will generally pay to use such an appliance.

The steam cylinders and all piping connected with the engine together with the receivers and all other parts where radiation of heat will represent loss, should be covered to prevent radiation, and where practicable or desirable, to do so, lagged with some suitable material.

The various parts of the machinery should be of plain and substantial design with appropriate shapes and forms adapted to the special purposes. The principal aim being for ample strength, great reliability, good mechanical effects, etc.

Where the design is made by the builder, there is not very much to say when the work is in competent hands, but there is no harm for the buyer or his representative to know that the bed plates and framing should be designed so as to prevent loss of alignment, or undue strains, or changes of load distribution, from variations of temperature or other causes, castings so designed as to avoid objectionable changes of section with reference particularly to shrinkage strains; reinforcement of the body of the castings next to the flanges, proper fillets, round corners, re-entering angles and all such details which may just as well be had at the same price as something less desirable. The desirable machinery coming as much or more from a thorough knowledge of designs and construction, than from the advance in price asked by the builder.

The steam cylinders to be thoroughly steam-jacketed, and all steam distribution valves so designed and located that the steam and exhaust ports are correctly proportioned to cylinder volume, and piston speed affording easy inductions and release of steam with the least friction consistent with minimum clearance.

There are examples of close clearance down as low as the following percentages:—

High pressure cylinders.......	1.4 per cent.
Intermediate cylinders........	.6 per cent.
Low pressure cylinders........	.5 per cent.

The above clearances are about the lowest known and are found in some of the well known three cylinder vertical triple expansion pumping engines.

The construction and arrangement of steam jackets so as to prevent or avoid undue strains and tendencies toward leakage, is very important, and it is pretty safe to say that there are few adjuncts of the steam engine requiring so much attention and careful thought both by the builder and the operator, in proportion to the benefits derived, as the steam jacket. It is really a necessary nuisance.

The receivers with heating coils, situated in the track of the steam in transit from cylinder to cylinder should be of liberal dimensions so as to distort the steam distribution as little as practicable; and, in fact, the distribution of the reheating steam throughout the jackets and receiver coils should be brought to and carried at a point which will give the most economical temperature to the working steam at the different points and pressures, keeping the working steam as dry as possible and avoiding so far as practicable the sending of superheated steam to the condenser.

The main pumps constituting the water end of the machine, are made in various ways and to suit the general design, what is known as the straight flow pump to my mind is the latest and best arrangement—the water passing direct to suction chambers, steel valve decks set vertically between suction and pump chambers and discharge chambers, valve cages bolted securely to valve decks. This arrangement is very simple and gets rid of a large amount of friction, but it is a good rule to follow plain forms and arrangements with pump. The normal action of a pump taking and discharging water is an extremely simple one, as natural as an animal breathing, and, indeed, almost the same sort of a performance, so that it is important to have ample water way of easy and natural shapes, obstructing the flow as little as possible, and conforming to the known characteristics of water in motion as far as may be, thus aiding to raise the mechanical efficiency of the pumping engine as a machine doing work, to the highest attainable point.

Examples may be seen in which the mechanical efficiency is as high as 96%, that is the work accounted for and shown as useful amounts to 96% of the total indicated steam power developed.

The pump valves are, of course, highly important details and in general practice have been brought down at the present day, to plain rubber discs, rather hard and of moderate size, supported by brass gratings of circular form, with radial ribs to support the center of the seat. The valve springs are made of the very best spring wire, valve plates for springs have been done away with as they have been the cause of more harm than good. The area of pump valve openings are a subject which has led to many arguments and disputes during the development of pumping machinery. The reference often being made to percentage of plunger area in denoting the aggregate "valve area" of the pumps. But the valve area by itself, that is, the number of square inches of opening through the valve seats, will not answer the question in relation to the plunger area. The valve area is a factor of the quantity and really independent of the incidental area of plunger; and as a matter of fact the flow of water through the valve seats must not go above a certain velocity, if proper operation of the pump is to be retained. Therefore, the relations between the quantity of water and the area of the valve seats with a limit of velocity held in view, really controls the aggregate of the openings, and any one who will take the trouble to figure it out will find that it matters not whether we consider a small plunger at a high rate of travel, or a large plunger at a slow rate of movement, which means that so long as the quantity per minute and the valve area remain constant, the changing of the plunger will matter but little. If we go to talk about valve area in terms of percentage of plunger area, the speed of the plunger must be considered. This has led to a pretty good rule to govern in such cases, which is to divide the feet travelled by the plunger per minute by 2, and let the result represent the percentage of the plunger area for the valve seat openings.

FOR EXAMPLE:

Plunger speed per minute in feet.	*Percentage of plunger area in the valve seats.*
100 feet	50 per cent.
150 feet	75 per cent.
200 feet	100 per cent.
250 feet	125 per cent.
300 feet	150 per cent.

This will keep the quantity of water the valve seat opening area and velocity of the water through the seat practically in constant relation, which will keep the movement of the water under constant conditions and ensures the proper operation of the pump.

The large pumps will have some advantage over small ones under this rule, or in fact, under any rule of constant nature, for the reason that the valve seats will enlarge a little in large pumps, and then the area of the openings will be greater in proportion to the friction surfaces.

The moving parts of a pumping engine should have strength and stiffness to avoid tremor and vibration while at work. The steam piston should be light and strong with liberal bearing surfaces and self adjusting packing, the later day requirements calling for polished faces both for the pistons and the inner surfaces of the steam cylinder heads to reduce the radiations to the lowest possible limits.

The steam distribution valves themselves should be of an extremely reliable type in a pumping engine for water works service and have proper facilities for refitting and adjustment. The engine in most cases being fitted with a variable cut-off mechanism so arranged that it may be easily and promptly manipulated from safe and convenient points while the engine is at work.

The cut-off in the high pressure cylinder is controlled by an automatic governor, and also adjustable by hand. The intermediate and low pressure cut-offs are adjustable by hand only, and in some cases the low pressure both cut-off and exhaust are fixed and not adjustable excepting by changes of a permanent nature.

THE VALVE MOTION.

Throttle valves and other starting mechanism should be so that the engine could be promptly and conveniently started or stopped and generally operated by one attendant from the main floor of the engine room or galleries usually provided.

There are also points to be looked after carefully, pertaining to journal boxes, their adjustment and lubrication, arrangements for manipulation with the least possible delay. The materials entering into the construction should be of the best quality practicable to obtain, and by proper attention to this portion of the work very good results may be obtained.

All of the material used in the pumping engine should be subject to inspection, analysis, or tests, subject to the approval of the buyer. But no allowance for any such inspection analysis or tests should be made by the parties doing the work, the buyer bearing all such expense when they become necessary. Any time during the construction of the machinery the buyer should have the privilege of calling for test pieces of the various materials entering therein, the contractor preparing and supplying such pieces to the buyer in the number, shape, finish and size required, with the understanding, however, that the contractor may have a representative present when such tests are made.

Many times such sampling and testing may not need to be done or wholly done, on account of favorable or satisfactory conditions surrounding the execution of the contract in which case considerable incidental expense could be saved the buyer who would of course eventually be made to foot the bill, no matter how arranged. If it could be made clearly apparent by other means than the expensive testing that the work and materials were satisfactory for the purposes in view, a good portion of the testing might be dispensed with.

Non-conducting material, or false covers should not be applied to a newly erected pumping engine until the construction has been well tested by working steam pressure and all leakage and defects completely remedied.

Then, after the various joints and parts have been shown to be steam tight under working pressure, the heat surfaces where radiation would represent a loss of useful heat, should of course, be protected by suitable covering, and where practicable or desirable, an outside finish of lagging applied. The type of lagging now much used being heavy sheet steel securely fastened to appropriate framing and flanges, and held in place by bands of polished metal. The old time wood lagging generally of black walnut seems to be passing away, although as a matter of appearance will probably never be excelled even if not quite so durable.

Mr. Wickens,—

I am sure I have enjoyed Mr. Walsh's paper very much indeed. He has gone into the matter very carefully and also intelligently, and has given us something to think about. One thing which strikes me forcibly, and which the paper has proved rather conclusively is, that if you wish to put in a good water works you had better obtain the services of a good designing engineer, and do as he tells you, then you will have success. A number of our small towns in building a water works plant, turn the matter over to a committee consisting of a tailor, blacksmith and a storekeeper, and when you consult with these gentlemen, you generally find that they think they know more about putting in a plant than anybody else. The result is that you have a very peculiar water works. There is no doubt, however, that the time will come when all towns requiring water works, will get the advice of an expert and instal machinery to suit their requirements. It is not long ago that the small towns fitted up water works with duplex compound pumps, and if they got a duty of thirty million foot pounds they thought they were doing well. Latterly contractors and engine builders are building equipment to suit smaller plants which will give much better efficiency. Take plants pumping two million gallons in 24 hours. There are some of these plants running which are operated with a compound engine directly connected to the pumps, and which will give 115 or 166 million foot pounds per 100 pounds steam duty per day. That is the old style. There is no doubt that the present ideas are to use high pressure superheated steam, to jacket the cylinders and to do everything possible to make the use of steam as cheap as possible. Then the next point is to get the pump plungers to reduce the friction as much as possible. This means the adopting of such plants as Mr. Walsh has told us about in his paper. When we have done all this we have to take care of the condensed water that we get from our steam jackets, and we must return that to the boilers. I think, perhaps, the best practice, as far as condensers are concerned, is to use the surface condenser and put it in the path of the water coming to the pump. Then the incoming water acts as a condenser for the steam. I know of one case with a two million gallon pump where this was done and the temperature of the water was very carefully taken at each side of the condenser, and it altered the temperature of the water coming from the pumping well less than one degree. It made a happy arrangement because it cost nothing to get the water for condensing purposes, and in that case it worked out remarkably well.

The idea of comparing a fifteen or twenty million gallon pump that is self contained and built with a triple expansion engine, to a pump of two or three million gallons, is absurd as you cannot expect to get the duties from a smaller engine with two cylinders that we get from a large pump with four cylinders or more.

My particular knowledge is more along the lines of pumps from five million gallons down, and not so much with very large pumps. We have in many instances run tests along the efficiency lines on various pumps. We have even had a trial test of a rotary pump run by a turbine engine. This was only a million gallon pumping outfit, the engine running at 10,000 revolutions. We were pumping against 100 pounds head. The plant worked fairly well, but it had one very serious disadvantage, however—they could not run it slow. While it was running they had to pump its maximum capacity, and as the pump was rather larger than the town required and the supply of water would not permit of it running steadily, it could only run two or three hours or until the stand pipe got full, then they had to shut the pump down. This was a bad arrangement as while the pump was laying idle, they were wasting steam and coal. This plant was in existence in a small town who thought they were getting something away better than any other thing in Canada, and imported this particular pump from England.

I am sure the paper Mr. Walsh has read, has brought out many points, and there are a number of gentlemen here who are thoroughly posted in the handling of water, and I am sure that they will be able to say something of interest to us. Before I take my seat I would like to say that I have enjoyed the paper very much.

Mr. Duguid,—

I think there are a number of pump experts here who could give more enlightenment on the pump question than I can. However, I believe one of the greatest troubles with pumps in connection with railroads and corporations is, that they never look very far ahead regarding their requirements. They know what is required of the pump at the time, but that is about all they figure on.

Now regarding the rotary pump, about which Mr. Wickens made a few remarks, I think in a few years from now they will find that the rotary pump is not so far out of place as it appears to be at the present time. It strikes me that if there were more pumps like what Mr. Wickens told us about which could only run some three hours before filling the standpipe, it would be a good thing for many towns. It takes many plants all their time to pump sufficient water in twenty-four hours. Towns very seldom get pumps of sufficient capacity.

Regarding the efficiency of pumps, Mr. Walsh no doubt is a better authority on that question than any of us, but it appears to me that the hydraulic end of the pump is not the end to be looked upon for the efficiency at all. If you can get an efficiency of 98½% from the water end of a pump, then it is a great deal better than you can get in railroad service. I do not think it is possible to get that percentage from any pump although I am open to conviction. I do not think you can get as good efficiency on the start as after a few months' run. I think a pump is giving very good efficiency if you get 75%. May be I am wrong in this, but I think 75% is about the efficiency you will get from a smaller class of pumps. I think the whole efficiency of the smaller pumps is in the engine part. They figure on the efficiency of the water end as though that was the whole consideration.

Now concerning the question of the buyer putting in specifications which Mr. Walsh spoke about. I think the smaller amount of specifications a buyer puts in the better.

A good many people purchasing pumps look upon the builders as most people do upon those fellows buying rags, and think the builders are looking for chances to do them. I think such builders as do work for the City of Toronto, will have their workmanship of the highest order as their reputation is seriously at stake. Now if the buyer starts making specifications, etc., it gives the builder a chance to creep out of any difficulties if they should crop up in the future.

Now regarding foundations, I think if the builder does not know how to build the foundations to suit his particular pump, nobody would. The builder knows exactly the different strains which will occur which an ordinary contractor would not be aware of at all. So that I think if a separate contractor puts in the foundations and they are not of the requirements, the builder of the engine will be very ready to blame any defect of the machinery on the foundation.

I also think regarding turbine pumps, that they are in their experimental stage at the present time. However, I believe it is only a matter of a short time that they will take the place of the reciprocating engine in use now. They are doing it in other classes of pumps and there is no question but that they will be able to handle the pumping engine station requirements satisfactorily. Whether the efficiency will be much lower in actual operation, the question remains yet to be proven. However, the repairs to a reciprocating engine would have to be taken into consideration and where you get 90% efficiency from a reciprocating engine, you have a depreciation of 10% in the engine and cost of repairs 5%, but with the turbine engine that would no doubt counteract its low efficiency. There is also a question of superheating of the jackets. I think in actual tests of the steam jacket, the efficiency runs from 1% to 5% of the efficiency of the engine. But a great many do not look farther than the actual jacket of the engine. Some builders claim there is a saving of 30% and some claim there is no saving at all. Mr. Holey, of the Holey Pump Works, says it has got to be proven to him that there is a saving. Now taking superheated steam into consideration, while you get a greater efficiency, yet the cost is much higher. Of course you only take one to show the big saving, but if you took two, the percentage would be cut down considerable.

I do not know that I can say anything further. I am only interested in smaller pumping plants, and in railroad service, anything is good enough for a pump. It does not matter the size of it as long as it is good enough to do that particular station, but I think all the railroads are getting away from that idea now. They are commencing to consider that there is a certain amount of leakage that is not dripping out of the bottom of the tank. I hope in the near future they will be figuring on the same efficiency for their pumping stations as Mr. Walsh has told us about for the city of Toronto pumping station.

I thank Mr. Walsh for his paper. It has been very interesting, and if the Aldermen will let him handle the pumping station as well as he has handled to-night's paper, they will be doing well.

Mr. Latour,—

I have listened to Mr. Walsh's paper with great attention to-night. I think everybody will agree with me that this paper is the result of long practice and study.

Regarding steam jackets, I may say that I have had some experience along that line. The efficiency of the jackets in many cases is generally known to be from three to five per cent. of the net steam consumption over and above what would be used without a jacket, and the amount of steam generally condensed in the jackets runs from 7 to 10%, ranging according to the ratio of expansion. As Mr. Wickens has stated, the capacity of the pumps in small towns throughout Ontario is about one to two million gallons per day, but taking pumps as we find them in ordinary practice, we generally find, instead of their being run to their full capacity, they are pumping only one-third of that, and their cylinder condensation is very high. Condensation often requires the drip valves to be left constantly open, and if they are left open, there is very little to be gained from the low pressure cylinder. I visited one pumping plant last summer and we had to get a certain number of strokes to obtain the guaranteed delivery. The pump was allowed to run at full speed and the pressure required was 110 pounds. We ran the pump for an hour and took our readings. I do not remember exactly the number of strokes it made, but think it was about 80, and the length of the stroke was shortened about 2 inches. Of course by shortening the stroke, it reduces the quantity of the water delivered. After a time we opened the drip valves and it speeded up 10 revolutions. This pump was of the horizontal type. We finally ran the test, but in running it our speed varied about 10 to 20%, but the delivery of the water was constant and it was delivered through a feed pipe and none of it went direct into the town mains.

Coming back to the higher class of engines; those having a capacity of four to five million gallons I have assisted in making tests on, but the efficiency has been down to about 90%.

The high efficiency of the pump is generally accounted for by the plungers being very hard and polished, and allowing a small film of water to flow between the packing and the pump's plunger, which practically makes it free from any contact with metal or packing, as it is practically rubbing on water. I cannot see any other way to account for it. In small pumps the plungers are generally solid and running in a brass bushing which is generally worn to a considerable extent, and the water just surges back and forward.

The old style crank and fly wheel pump is still in existence in some of the small towns in Ontario. In one place we found the duty down to forty million foot pounds. Most of that duty was practically lost in forcing the water through the small mains, where, as you know, the friction increases very fast in small mains.

There is not much left for me to say on this subject as

I think every other point has been covered very fully by the speaker.

Mr. Bly,—

I do not know much about pumping engines myself. If it was a boiler feed pump I would be more able to say a little about it, but pumping engines for water works is entirely out of my line. I know if Mr. Walsh keeps up the pressure we have no trouble.

I feel there are others who can discuss the paper better than I can.

Mr. Stortz,—

I do not know that there is anything I can say in particular about this question, I having had but little experience with pumps. There is just one point which has struck me regarding pumps. I could never understand clearly why they diverted from the fly wheel. It always seemed to me that a pump is like an air compressor, which relieves its load on the end of the stroke and takes the free load on the start of the stroke. I know in compressing air that you get better results by delivering the load at the end of the stroke. It has always been a question in my mind why they do not use the fly wheel on small pumps, more especially on the larger class of pumps. Probably some gentleman here is well posted and can throw some light on this subject.

Mr. Walsh,—

The fly wheel at the present time in large pumps is good practice, but on smaller pumps they generally make them without the fly wheel. The fly wheel would not make much difference in a small pump as the main object of the fly wheel is more to take the load over the centre.

In listening to the remarks made, especially those of Mr. Duguid, I do not know whether Mr. Duguid interpreted my remarks right. It was not my intention to give you to understand that we left the builder entirely free from responsibility for the foundations, but we do not wish the builder to build the pumping station because he builds the pump. We ask him to supply the drawings, templets, etc., of the foundations, and he takes the responsibility of seeing that they are carried out according to the drawing. The buyer should not, in my mind, take any responsibility for the foundations. I know of instances in this regard which have cost the company considerable.

With regard to the jacketing, Mr. Duguid is right in saying that there is a loss of about 10% of steam taken for jacket heating. We have done considerable experimenting during the last three months with our six million gallon pump installed at the station, and have run tests and got 164 million foot pounds duty. With this pump we have been experimenting on different occasions with the jacketing and with 35 pounds on the intermediate cylinder and zero on the low pressure cylinder, we got the best results. There is no doubt in my mind but that the jacket is a good thing. It is really a necessary nuisance in a way. There is one great advantage in jacketing a cylinder, that is, in case of fire you can start up your pump at once with safety, whereas you could not do this if it were not jacketed as it would require time to warm up the cylinders.

With regard to reciprocating pumps, it is common practice with the vertical triple expansion pumps of the present day, to get an efficiency of 98%. There is no question about it that with an outside packed plungers and valves in proper shape, that you can do this. We have an arrangement down at the main pumping station which will tell you at a glance just how much the pump is doing.

Mr. Duguid,

I did not wish to question the statement of Mr. Walsh regarding the matter of getting 98% efficiency from a pump, but more wished to express my surprise that you could get such an efficiency from any pump, and that you could maintain that efficiency.

Mr. Armer,—

I would like to ask Mr. Walsh a question about hydraulic efficiency. He spoke of the efficiency of the turbine pumps being as low as 60%. I do not quite understand what hydraulic efficiency means and I think an explanation would throw some light on the comparison made between a reciprocating and turbine pump.

I have noticed most of the large vertical pumping engines single acting, that is the work is done on one side of the plunger only. I have often wondered what objection there would be to having them double acting. I would think the capacity of the pump would be greatly increased in comparison with the extra space taken up and the extra material used.

Mr. Walsh,—

Regarding the efficiency of the turbine pump, there is no question that there is a greater amount of slip in the centrifugal pump.

Regarding the centrifugal pump being double acting, this is not practical to do, as you must take into consideration the weight of the plungers, pistons, crossheads and rods, which would not balance. There is always a certain amount of water allowed to go with your plunger, which acts as a lubricant, but this does not amount to much. It is not well to tighten up your glands too tight as it will slow up your engine.

Mr. Blanchflower,—

There is one question I would like to ask. Why is the area smaller on the discharge side than on the suction side? Has that always been your experience in high pressure pumping systems, Mr. Walsh?

Mr. Walsh,—

Yes. It is a very funny thing, but a great many do not know it. Take for instance a six million gallon pump we have out there. In one case we have 24″ discharge. You can actually close that valve within 1″ of the bottom and the pump will keep on running, which shows the great amount of water which will keep on running through a small opening. A 36″ main reduced to the smallest point, does not reduce the pressure at all by passing the water through it. It is made in the shape of a syphon and the water passes down through the centre. It goes through very fast without reducing the pressure. I have often wondered whether it would not be good practice to cut down a lot of the large mains we are using, although there is no question but what they cut down a great deal of friction. Of course if you went any distance it would increase the friction largely.

Chairman,—

I was just thinking while Mr. Walsh was reading his paper about taking the builders' specifications and keeping a "wide open" specification. Is the average water works engineer competent to make out specifications? Presuming he has run six or even ten different makes of pumps, and that is considerable experience for the average man, is he sufficiently competent to make out a set of specifications? The builder on the other hand designs and sells pumps on their merits, and therefore should produce a good pump.

For instance here is a man who has possibly been a good mechanic and secures a position as engineer. Can he make out proper specifications? I question it very much. Now if he went to the committee—the tailor, blacksmith and storekeeper—and told them he required the assistance of an expert, he is placed in a rather difficult position. He claims to be an engineer, yet cannot make out the specifications. Realizing his position is at stake, perhaps suggests as a possible way out of it, to write the different builders and get their specifications, and that they be submitted to some good reputable consulting engineer. Even the consulting engineer may make a mistake.

Now regarding the remark Mr. Walsh made about the "wide open" specifications. That is all right for the City of Toronto, but to the smaller towns the thing is, what is the best course for them to pursue? It is a debatable question. The engineer's position depends upon it, and what had he better do under the circumstances? In a great many instances he will say, we want a so and so pump, as he has been running that class of pump for a number of years and it has given him good satisfaction, but he does not know whether there is any other pump which will give better efficiency. He only knows about that particular pump. Then, of course, you can go to the consulting engineer, and he is not always infallible. He may be a very good man and conscientious, yet does not know what best to recommend. Now the question is what is the best course for the average man who is buying material. The only thing he can do is to take the best builder's specifications and pick out the best points in them all. Then again the builders do not appreciate having their specifications changed. The engineer does not always have an opportunity of consulting an expert, and I think it places him in a very critical position, and I believe a great deal of the trouble with the machinery bought at the present day is due to this one fact, that they expect the man who is filling the engineer's position, to know everything. Of course if anything is wrong he is responsible. The majority of the men who are at the head of corporations are in other walks of life and do not know what is best to do under the circumstances, and that, I think, is the true cause of a great many blunders and mistakes, which are not always up to the water works engineer or builders.

Mr. Walsh,—

In answer to our Chairman, I do not believe myself, and in fact my paper is not intended to infer that the engineer should draw up the specifications. We can call for the general data of a pump. It is an easy matter to draw up specifications to suit your requirements, after you have chosen your design, to cover general data. Then they submit their details within a certain time and we look over their drawings and after a thorough study we make changes to suit. If not satisfactory we can change certain parts, but of course taking into consideration the type of pump we are having built. As I have said before, it is an easy matter for a man to investigate for himself. Builders will submit you drawings and details. There is quite a difference in the opinions of designers in detail parts. One will ask for a 4" crank pin where another will put in a 6". Some one will have probably a crosshead pin smaller than a crank pin. It is really surprising how men of experience differ.

Mr. Wickens,—

Furnishing a pump for the City of Toronto where they have got a good staff of engineers, is very different from small towns. The difficulty with small towns is they expect the engineers to know too much, and they are not willing to pay the cost for an expert engineer's advice. The Chairman's remarks along that line were exactly right. It has been our province during the past three years to get mixed up with a number of pump troubles in different towns, and we found the trouble was that they did not know enough themselves and did not wish to spend two or three hundred dollars to get advice.

Regarding foundations, I spent twenty-two years between the buyer and the seller. During that time I got foundations hammered into me—just a little bit. It is a mistake to expect the man who builds the engine to build the foundation. It is also a mistake to expect him to have no responsibility in this regard. We found the best way to handle the foundations was to have the builder submit his plans and specifications and have the work done by a local contractor under the supervision of the builder. This places the responsibility on the builder and he is sure to see that the foundations are properly done.

Chairman,—

Before adjourning I would like to recommend a hearty vote of thanks to Mr. Walsh for his very able and interesting paper.

Moved by Mr. Baldwin and seconded by Mr. Duguid. Carried.

Chairman,—

Mr. Walsh, on behalf of the members of the Club, of which we are pleased you are a member, allow me to extend to you our hearty vote of thanks for your coming down here to give us a paper, and as I said in the beginning, we appreciate it more because you are a practical man and know what you are talking about.

Mr. Walsh,—

I assure you, gentlemen, it has given me a great deal of pleasure in reading that paper to you. I trust it has proven of interest. I hope at some future time to be able to give you a paper on some other subject.

As our friend, Mr. Worth, has said, we wish everybody to help in forwarding the interests of the Club, and I took upon myself to do "my little." While the paper may not have been interesting to all, yet I trust it has been to some.

Mr. Baldwin,—

You remember last summer we had a bit of a picnic up at Jackson's Point. I do not think it is too early to talk about our next outing. If I am not out of order, I would like to ask that you appoint a committee to take the matter up and report back at the next meeting.

Chairman,—

In connection with our annual outing, would say that we have a reception committee, and we will bring the matter up at the next Executive meeting and report here at our next regular meeting if that will be satisfactory.

Proposed by Mr. Ellis, seconded by Mr. Duguid, that the meeting be adjourned. Carried.