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THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA

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REPORT OF FEBRUARY MEETING

AND

PAPER ON "LUBRICATION"

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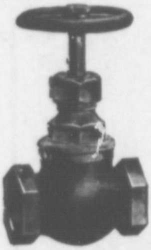

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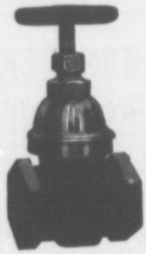

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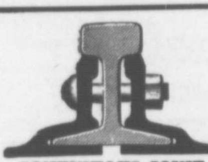

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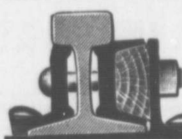

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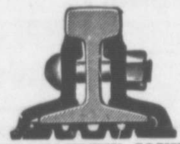

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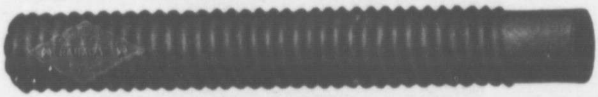

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.... Club ....
OF CANADA

OFFICIAL PROCEEDINGS

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MEETING OF THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA

COMMITTEE ROOM, HOTEL CARLS-RITE,

TORONTO, Tuesday, February 23rd, 1915

The President, Mr. Jas. Wright, occupied the chair.

Chairman,—

It is somewhat later than the regular hour for opening our meeting, and the heavy storm has evidently somewhat curtailed our attendance.

The first order of business is the reading of the minutes of the previous meeting. As you have all had a copy of these minutes, it will be in order for some to move they be adopted as read.

Moved by Mr. J. S. Grassick, seconded by Mr. F. R. Wickson, that the minutes of the previous meeting be adopted.

Chairman,—

The next order of business is the remarks of the President.

I have nothing to say to you this evening, except to announce that at the next meeting, March 23rd, Mr. C. G. Sherman, of the Canadian General Fire Extinguisher Co., will read us a paper on "Automatic Sprinklers."

MEMBERS PRESENT

J. S. Grassick	F. R. Wickson	W. C. Sealy
Geo. Baldwin	N. A. Davis	G. S. Browne
T. B. Cole	J. Douglas	Jas. Barker
T. J. Walsh	Geo. H. Boyd	Jas. Douglas
C. de Grouchy	E. Logan	C. McNair
Jas. Wright	Geo. M. Smith	E. A. Wilkinson
J. B. Robb	J. Dodds	W. Evans.

Chairman,—

I will now call on Mr. McNair to read his paper.

LOCOMOTIVE LUBRICATION

By C. McNair, Representative, Galena Signal Oil Co.

The principle of lubrication is as old as man; and as he had to use but little ingenuity in discovering this principle and its purpose, it being exemplified in the articulation of his own frame, it is fair to assume that he acquired this knowledge at a very early period. Max Verworm, an eminent writer on physiology, writes that early man discovered many simple phenomena by self observation.

It is well known that the ancients possessed at least some simple types of machines, for the reason that they raised many great stones to a considerable height in completed works, after having transported them great distances from the quarries whence they were taken. And it cannot be doubted that engineers in building some of the great pyramids 4,000 years B.C., required the rubbing surfaces of the machines and implements in use to be lubricated, so as to be used more effectively. Neither can it be doubted that even at that early date the efficiency of various lubricants was discussed. Although some knowledge of this, one of the most important essentials to mechanical progress, has been possessed by man for many years, the subject has not been given the attention by the engineer and man of science that its importance would justify. However, science and mechanics are greatly indebted to some earnest and very able students of the subject for considerable practical information and working data, some of which has taken the form of world wide formulae.

The efficiency of a machine is measured by the quantity of work obtained, by dividing the amount of useful work performed by the gross work of the machine; and experience has taught that friction is the principle cause of loss of energy and waste of work in machinery. Also that waste energy is reduced to a minimum by a proper choice of rubbing surfaces and by the best lubrication.

Since lubrication has for its object both the reduction of friction and the prevention of excessive development of heat, the value of the lubricant depends on its efficiency in reducing friction, its durability under wear, its freedom from liability to "gum," its freedom from acid and grit and its permanence of composition and its physical condition when subjected to changes of temperature. It is of great importance to remember that the higher the temperature the less is the lubricating power of any lubricant; and consequently if we have an efficient lubricant under normal conditions, it should not be assumed that a hot bearing may be cooled by increasing the quantity of lubricants on it, but the cause of the bearing heating should be removed, and time and money saved.

It is needless for the writer to attempt any discussion or comparison of the various lubricants and their characteristics, which some chemists consider of so great importance in the selection of the lubricants. Suffice it to say, that it has long since been an acknowledged fact that vegetable oil and animal fats are inferior to properly refined petroleum oil for machinery lubrication. Nearly all vegetable and animal oils are compounds of glycerine with fatty acids, and in this respect essentially differ from the mineral oils. When kept for a long period decomposition takes place, acid is set free, and the oil becomes rancid. This rancid oil will attack and injure machinery.

Regarding viscosity, gravity and the flash, and burning temperature, assumed by some to be of so much value in determining the quality of lubricating oil, a prominent writer in his book on "lubricants, oils and greases," says: "The tests that usually influence the choice or purchase of lubricating oils are the specific gravity and viscosity; but in reality these tests count for little, for the reason that but a small idea of the lubricating quality of an oil can be gained from either of the tests separately, and not very much even when taken conjointly, except in extreme cases; as, for instance, we know that a very thin light oil is useless for steam cylinder and heavy journal lubrication, and that a thick heavy oil is equally useless for light, high speed spindles."

Another writer says of "specific gravity," "it may be pointed out that this characteristic affords little or no information as regards the lubricating powers of an oil. The specific gravity is, however, an aid in selecting an oil for a particular class of machinery. The viscosity does not furnish an absolute means of determing the lubricating value of an oil either, although it enables one to draw certain conclusions. Thus, if the viscosity is too low, the film of oil which keeps the bearings of rapidly moving machinery apart is not sufficiently developed to keep the metal surfaces asunder, and therefore the friction between them is not sufficiently diminished. Again, if the viscosity of an oil is too high, the resistance of the film is so great that heating occurs and the bearings become warm, or even hot, the heat so generated being proportional to the internal friction of the oil, or, in other words, to its viscosity. That oil will prove the best which under given conditions of speed, pressure and temperature has the lowest permissible viscosity."

Many consumers of large quantities of lubricating oil, particularly large railway systems, are provided with laboratory facilities, both chemical and physical, and it not infrequently happens that those in charge of these laboratories feel that the department is not entirely fulfilling its purpose if it does not exercise a certain supervision over the purchase of lubricating oils; making very rigid requirements for the flash, burning, viscosity and gravity tests, assuming when the oils meet these requirements that they have fine lubricating qualities, when, as a matter of fact, oils having much better lubricating qualities may be barred by the very requirements intended to serve as a means for getting the best, the requirements thus defeating the very purpose they were intended to serve. Prof. Thurston in his book on "Friction and Lost Work in Machinery" states in this connection, "The consumer will usually find it economical to use that lubricant which he has found to be the best, with little regard to price, and often finds real economy in using the better material, gaining enough to pay excess in the total cost very many times over."

When it is considered that the locomotive, and all it has accomplished in the interests of man would not have been possible but for the principle of lubrication, the importance of the knowledge of this subject becomes at once apparent. Lubrication has been, and is, just as essential in making the locomotive possible as that great source of power, heat energy, or the water which affords a medium for its conversion into an active force. Without lubrication the locomotive would be impossible, and even with it a considerable portion of the power developed by the locomotive is exerted to overcome the resistance in its moving parts due to friction.

While the information obtainable on the subject is rather meagre, we know that the lubricants used and the means of applying them to the primitive locomotive were in keeping with the crude design of all the parts; and inasmuch as we find that the modern locomotive with its nicely designed parts and using the very best lubricant applied by modern methods, loses through friction over 10 per cent of the maximum power developed; and as we know this quantity or proportion of waste energy is considerably affected by the quality of the lubricant used, it is reasonable to suppose that the success of the early locomotive was in no small measure delayed by faulty and inefficient lubrication.

The present hydrostatic lubricator with its disc sight glasses and attachments for stopping the feed without disturbing the adjustment of the feed valve, and automatic drain valve for preventing loss of oil when draining lubricator, is a tremendous advance in the interest of safety and economy over the tallow cup of forty years ago. But it is neither fool proof nor perfect; it requires intelligent handling for effective service, and for it to give the most effective service the locomotive must also have intelligent handling. The lubricator should be so located that the engineer may have an unobstructed view, not only of, but through the sight feed glasses; and in all cases it must be located so that the oil pipes have a constant downward course, as an upward turn in the pipe will pocket the oil and result in an intermittent feed to the valve and cylinder, and consequent imperfect lubrication.

A case is known where an inspector was recently called to investigate a complaint of imperfect valve lubrication on a locomotive, and found the lubricator located on the engineer's side of the boiler 8 or 10 inches below the top; the lubricator pipe to the left steam chest was trained up over the boiler and had to slope upwards at least 10 or 12 inches above the point of connection at the lubricator.

The best service from a valve or cylinder oil, requires that it enter the steam chest thoroughly atomized, each drop being divided into thousands of minute drops, or atoms, as it reaches the rubbing surfaces. This is accomplished by a combination process of emulsification, vaporization, and atomization and it follows that a first class cylinder oil must possess the qualities to readily emulsify and atomize, with a sufficient degree of vaporization to spread itself over the surface with the steam, in other words to lubricate the steam. Uniformity of distribution is as important as the uniformity of supply. These are principles that apply to valve and cylinder lubrication, irrespective of type of valve or temperature of steam.

The design of valve and method of introducing the oil are very important factors. It has been practically demonstrated that a flat or slide valve cannot be successfully used with very high temperature of steam, because of the heat warping the valve, presenting an uneven surface to the seat, but with the modern locomotive of to-day we have piston valves with superheated steam which after giving our engineers some alarm on the start, we find are as easy if not easier to lubricate than slide valves with saturated steam.

The evolution of the locomotive has carried with it the progress from the earlier method of delivering the lubricant through the medium of a plug cup, located on top of the steam chest, to the more convenient location in the cab. The automatic displacement cup located on top of the steam chest, has been superseded by the hydrostatic, or mechanically operated lubricators, but it seems that because, in the infancy of the locomotive from the top of the steam chest was the logical place to admit the lubricant, precedent rules that the old custom shall prevail and at present, on a large percentage of the locomotives in this country the oil for valve and cylinder lubrication is delivered direct to the steam chest or valve chamber.

Is there any good reason for a continuance of this practice, other than convenience, custom, or precedent?

The best authorities are agreed that the ideal method of lubricating steam surfaces, is by having the oil introduced in an atomized form, lubricating the steam. Then why not deliver the oil into the steam at a point where this process can take place before it reaches the steam chest or valve chamber, and thus secure lubrication at every point where the steam has contact?

The lubricator pipe should enter the steam cavity, or steam pipe well above the steam chest and not at the top of the steam chest, as did the old fashioned tallow cup for the reason that it has been pretty well established that the most effective valve and cylinder lubrication is accomplished by saturating the steam with the lubricant before it comes into contact with the parts to be lubricated, rather than depending upon the parts being smeared with the lubricant. In view of this it is hard to understand why the practice of entering the pipes at the top of the steam chest is continued unless it be due to the general tendency to pursue old methods.

Admitting the theory of saturating the steam with the lubricant to be true, it is evident that that oil which can be most readily taken up by the steam without having its lubricating qualities impaired, is the most effective lubricant; granting of course, that service has proved it to be an effective lubricant.

Going a little farther with the same reasoning it is found by experience that the most effective lubrication is accomlished in the cylinders of engines using saturated steam, when the oil comes in contact with the steam in the form of an emulsion; the oil in this condition being highly impregnated with water. This emulsion probably results from the oil forming a coating in the bottom of the lubricating pipe and the condensed steam picking it up in small particles during its downward passage to the steam chest. When this emulsion or mixture of oil and water comes in contact with the steam it immediately flashes into steam, owing to its large contents of water. The steam in this way becomes saturated or filled with small particles of oil, which congeal and adhere to the surrounding walls and all enclosed surfaces. This separation of the oil into small particles and consequent distribution by the steam, is not so well accomplished when the oil feeds into the steam in a condition unmixed with water, as the vaporizing temperature of the oil is considerably higher than the temperature of steam at 200 or even 225 lbs. pressure. Hence, this additional argument in favour of an oil that is not too heavy at a medium temperature as the thin oil will mix more readily with the condensed steam.

This line of argument does not apply to engines using superheated steam so much, as the heat at high temperature superheated steam is usually sufficient to separate the oil into particles small enough to be carried by the steam without the presence of water.

In connection with the thought just advanced it is proper to bear in mind that with the use of the hydrostatic lubricator, the oil is not forced into the steam chest, but is entirely dependant upon the force of gravity to carry it there. This depends upon gravity for perfect operation and the fact that the gravitative force only acts upon the oil when the steam pressure is uniform throughout the entire length of the lubricator pipes, is probably the greatest imperfection of the hydrostatic lubricator; but its reliability in other respects and its ease of maintenance so preponderates this fault that it is commended as the most acceptable device for the purpose. As practically every handbook published for the benefit of the locomotive engineer, describes in detail the various types of hydrostatic lubricators and the proper method of applying and operating them, it is not necessary to devote space to features that have been fully covered by more able writers.

The engineer of experience has learned that it is necessary when working his engine under certain conditions with full throttle to occasionally ease up on the throttle to permit the steam pressure in the lubricator pipe to equalize, otherwise the pressure becomes greatest at the steam chest end of the pipes, and the material in the pipes ceases to flow downward, thus interfering with proper lubrication. When the engineer is unacquainted with the existence of this condition, he often wrongly assumes that the lubricator is not feeding enough oil when his engine begins to indicate improper lubrication.

With the more general application of high temperature superheaters to locomotives many were concerned to know how the valves and cylinders of the locomotive using high temperature superheated steam were to be lubricated, and whether the oil would stand the high temperature and still retain its lubricating properties. Because of the use of improper material in the cylinders and packing, and the lack of experience in handling the superheat locomotives, much trouble was at first experienced in the operation and maintenance of some of these locomotives, and it was very promptly assumed by some that the fault lay in the lubricant. The manufacturers of the lubricant, after careful investigation, determined that the lubricant was able to meet this new tax upon it without being appreciably affected as to its value, and were very shortly able to convince the doubful of the correctness of their conclusions.

Since the substitution of materials more able to resist wear and tear at high temperature, and a better knowledge resulting from experience in the proper handling of the superheat locomotive, the troubles of maintenance and operation have practically disappeared and it has been found that this type of locomotive can be just as effectively and economically lubricated as the non-superheat locomotive.

The important thing to remember in the operation of the locomotive using superheated steam is that the lubricant does not flash or burn in an atmosphere of steam, even though it be 1000 deg. F, therefore if care be exercised to maintain an atmosphere of steam in the steam chests and cylinders there will be no carbonization of a proper lubricant. Those railway officers having had the longest and most extensive experience in operating the superheat locomotive require these engines to be equipped with some form of auxiliary or drifting throttle to be opened when the main throttle is closed while the engine is drifting.

Experience has taught the unprejudiced that the direct cylinder feed is not only unnecessary but that better results are actually obtained without it. Much of the accumulation in the cylinders and deposit on the cylinder walls of these engines is undoubtedly due to too much oil, and this has been found to be the case mostly with engines equipped with the lubricator pipes connected direct to the cylinders.

If the theory of effective valve and cylinder lubrication by saturating the live steam with the lubricants be true, then it is true that the lubricator pipes leading directly to the cylinders are not necessary, because ample lubrication is secured from the particles of oil contained in the steam, which must come in contact with the cylinder walls after leaving the steam chest. The hydrostatic lubricator must inevitably maintain a more continuous and uniform feed of oil to the cylinders on locomotives using superheated steam than on those using saturated steam; for the reason that the steam in being forced through the contorted passages of the superheater suffers a loss in pressure before reaching the steam chest, consequently the steam pressure in the lubricator pipes, at the steam chest end of the pipe, never exceeds or even equals the pressure of the lubricator end.

It should be borne in mind that the only force behind the steam flowing through the superheater to the steam chest is the boiler pressure, and that notwithstanding the superheating, the steam in overcoming the friction in the superheater pipes must lose in pressure before reaching the steam chest.

The advancement in the lubrication of the external parts of the locomotive has probably not been so great as with valves and cylinders, yet a marked improvement has been effected, both in the interest of efficiency and economy, by the substitution of mineral for vegetable and animal oils for this purpose.

The introduction of mineral oil for locomotive lubrication can best be told by quoting from the 1909 report of the Master Mechanic's Committee on Locomotive Lubrication. On page 269, 1909 proceedings, American Railway Master Mechanic's Association, we find the following:

"The mineral oils or petroleums were placed on the market in the years soon following, and on account of their cheapness and superiority as a lubricant, their use became general. The natural West Virginia oil, with its notable characteristics . . . . immediately found favor and was considered superior to sperm. The production of West Virginia oil was limited, and as the demands rapidly increased the supply was soon exhausted. Mineral oils of varying qualities, good, indifferent and bad, competed for the lubricating business, and as uniformity was desirable the old adage of 'Necessity being the mother of invention' was exemplified by a manufacturing concern in 1869 introducing for railroad service an oil for external lubrication, combining the excellent qualities of nature's best lubricating product with other ingredients, producing an article which met all of the requirements of the day; . . . a gravity permitting of ready flow, and the sustaining power for support of the ever increasing loads upon the bearing surfaces. The lubricant has stood the test of service from the date of its introduction, and is now used on the majority of the railroads of this country, as well as on many of the English and Continental lines of Europe."

The rapid development of the locomotive into units of very heavy power, occasioned by the constantly increasing demand of transportation have gradually produced such radical changes in the manner of operation and maintenance, until lubricating conditions seemed to demand the use of grease on crank pins, and a little later the same lubricant began to find favor when applied to driving journals.

The popular argument in favor of the use of grease on driving journals, is that the bearings require less care and attention than when lubricated with oil. The influence of this argument has been rather far reaching in its effect upon the conditions surrounding the lubrication and maintenance of the most important bearing on the locomotive, with the result that so little care is coming to be used in the proper preparation and maintenance of main journals and bearings that it is to be feared that the day may come when the mechanical department will have to recognize that power conditions with grease lubrication are more of a problem than with oil, and the executive officers of roads will endeavor to find the cause of the increased fuel consumption.

The annual oil bill of a large and important railroad is something of an item and the effective lubrication of the locomotive has a vital relation to successful transportation, but the cost of fuel and locomotive maintenance are subjects which in the present struggle for profitable operation cannot very well be ignored. Fuel consumption for locomotives of this country is estimated to exceed $200,000,000 annually. If the loss of energy of the locomotive under the best conditions be 10 per cent and the conditions are such as to increase this loss 5 per cent, $10,000,000 are added annually to the cost of fuel from which no revenue is being derived.

To get the best possible results from the use of grease in driving boxes, the brasses should be made of good bearing metal, homogeneous and free from all imperfections incident to poor foundry work; they should be bored to proper diameter and given a reasonably good fit, using the same care in all respects as for oil lubricated bearings. The perforated screen of the grease cellar must be made to exactly conform to the diameter and have a full bearing against the journal over its entire surface; otherwise the grease does not feed properly and becomes carbonized resulting in a hot box. The grease cake should be machine pressed to fit the cellar and not allowed to get too thin before it is renewed.

Driving journal lubrication is too important a feature in locomotive operation to relegate to the ignorant and irresponsible.

The practice of blowing off locomotive boilers in the pit, directly under the driving journals has a detrimental effect upon the driving journal packing, and is particularly objectionable when the cellars are packed with grease, as the condensed steam has a very deteriorating effect upon the grease.

Running locomotives at high speed, that have been designed to pull heavy loads at low speed, is one of the most common causes of the heating of locomotive journals. A locomotive with driving wheels 54 inch diameter, journals 10 inch diameter, and a 30 inch piston stroke, running 45 miles an hour has a piston speed of 1,400 feet per minute and the speed of the surface of the driving journal is 12 feet per second; the speed of both the piston and driving journals being twice what it should be.

The lubrication of the other parts of the locomotive has undergone no great change, except in the character of the lubricants and the economical use of it.

The adoption of types of valve gear, other than the Stevenson link motion, the rubbing parts of which are more accessible and less liable to heat, has assisted much towards more effective and economical lubrication of these parts. Guide bars are found to be more effectively and economically lubricated by locating a packing cup midway of the length on top of the bottom crosshead shoe, and one adjustable feed oil cup midway of the length on top of the top guide bar.

The improvements in the parts of the locomotive; improved oil houses, equipped with adequate storage tanks and self measuring devices; improved methods of saturating the waste packing and removing the surplus oil in room kept at proper temperature, the reclamation and re-use of grease; the reclamation and renovation of old waste packing by putting it through a hot oil bath; the proper preparation of grease into forms for driving journal lubrication and into candles and discs for crank pin lubrication; and above all the daily attention given the subject by railway officers and subordinates, combined with the greatest of all essentials in the economical use of anything, proper accounting and comparative statements, have all been important factors in bringing about an economy in locomotive lubrication that has not only awakened the wonder of all acquainted with it, but has aroused such an interest in the minds of railroad officers that they have applied the same methods for economy to other departments with the result that it is impossible to estimate the total saving that has resulted directly and indirectly from these methods.

Notwithstanding some opinions to the contrary, the economical lubrication of the locomotive inevitably means efficient lubrication; for the reason that a more than sufficient oil not only encourages a wasteful and careless application, but also fosters a thoughtless and irresponsible attitude towards locomotive operation and maintenance; while a supply which has been intelligently determined as sufficient tends towards careful use of lubricant and careful operation and maintenance. Even at this late day, when we know that after all the modern term; "Scientific management", is only a term for finding the best and making it the standard, and although in almost every department of human endeavor, limitations recognized as standard, are applied, there are those who still hesitate to limit the supply of oil to meet certain conditions, even when the quantity to meet said conditions has been well established.

There is no good reason why a number of men operating the same machine, under the same conditions, should not be able to lubricate the said machine, doing uniform quantities of work, with uniform quantities of lubricant. Any other arrangement simply encourages inefficiency on the part of some of the operators.

The great difference existing between the results obtained on different railroads towards economical and efficient locomotive lubrication is the strongest possible argument that the work of education has not been completed, but really just begun.

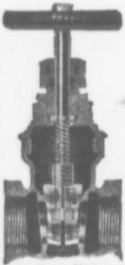
I trust this contribution, if of no other service, will be an incentive to all well wishers of the club to add their "Mite" in whatever manner possible to the success of the club and at some future time the subject of this occasion may be presented in a more interesting and instructive form.

Chairman,—

As the hour is getting late, I think it would be well if we postponed the discussion of this paper until some future meeting.

It will be in order for some one to move that the meeting adjourn.

Moved by Mr. N. A. Davis, seconded by Mr. J. B. Robb, that the meeting adjourn.



JENKIN'S VALVE

For Sale