No. 200]

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Chairman—Mr. K. J. COOK.

"LUBRICATION AND LUBRICANTS IN RAILWAY PRACTICE"

BY

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The chief work undertaken in the Great Western Railway Company's Oil and Grease Works at Swindon is the blending and issue of lubricants for engines, also carriage and wagon axles. The yearly issues in the case of engine oil amount to 590,000 gallons, cylinder oil 225,000 gallons, carriage and wagon axle oil 230,000 gallons and wagon axle grease 380 tons. The principal object of blending is to obtain oils to specifications, thus ensuring uniformity of supplies, and the operation consists of mixing two or more oils whereby an intermediate oil is obtained having the required characteristics.

Mineral oils for general lubricating purposes are often referred to as clear or opaque, indicating a distilled or blended oil respectively. Blended opaque lubricating oils are prepared from heavy dark residual oils and tow viscosity spindle oils, whereby an intermediate oil of required viscosity is obtained, the price of which would be lower than an equivalent distilled oil. An example of such a blend follows:—

TABLE NO. I.

	Oil No. 1	Oil No. 2	Blend 50% No. 1 50% No. 2
Viscosity at 70° F. (Secs. Redwood No. 1) ...	170 secs.	—	1448 secs.
Viscosity at 140° F.	50.4 ,,	1169 secs.	148.4 ,,
Viscosity ratio 70° : 140° F. ...	3.37 : 1	—	9.75 : 1
Flash point (close test)	372° F.	526° F.	384° F.
Specific gravity at 60° F. ...	.898	.944	.9215
Type	Clear	Opaque	Opaque

These blended opaque lubricating oils compare very favourably with the distilled oils in regard to their lubricating value, provided the component oils have been carefully chosen, and the only apparent disadvantage is their dark colour and tendency therefore, to stain certain articles with which they may come into contact, and further, the condition after use of such oils cannot be so readily observed as with clear oils, as traces of water or suspended matter would be obvious in the latter.

Oils from contractors are received at the Oil Works in barrels and drums and after inspection are discharged into storage tanks.

During blending, oil is pumped from these tanks as required to a common blending tank where the oil is heated and mechanically mixed. After inspection, the oil is pumped to elevated tanks from which it is allowed to gravitate to barrels or drums as required.

This oil is despatched to engineering depôts in accordance with orders received from the Stores Department, and a system is in use at maintenance depôts whereby stock replenishment is made on the basis of predetermined fixed quantities, so that when stock falls to this figure, further supplies are ordered.

DEVELOPMENTS IN THE LUBRICATION OF RAILWAY ROLLING STOCK.

Grease lubricants figured very largely in the early days of railway history, but the introduction of mineral lubricating oils and the development of machine design caused a decline in the use of greases as the following record indicates. Grease issues for 1902 are taken as a basis.

		Grease.	Oil.	Ratio.
Issues	1902 ...	1,743,126 lbs.	465,241 galls.	1.00 : 2.4
,,	1924 ...	1,438,143 lbs.	1,087,928 galls.	.82 : 5.54
,,	1934 ...	845,431 lbs.	1,149,286 galls.	.48 : 5.86

The chief lubricants in use prior to 1888 were tallow, rape oil and soda base greases, and to a lesser extent animal oils. Rape oil was used for engine motion parts, tallow for cylinder lubrication and a standard soda base grease for axleboxes on engines, carriages and wagons.

The introduction of mineral or petroleum lubricants occurred about the year 1889 and then only for carriage axle lubrication in admixture with rape oil; a typical blend then used was 50% each of refined rape oil and mineral oil. Pure rape oil alone had been tried for this purpose but it was found to glaze the axle pad at the point of contact with the journal, so that the supply of oil was retarded, and this trouble persisted to a lesser extent in respect of these blends.

During this period many problems presented themselves and much experimental work was undertaken by the Company's engineers in regard to the application of lubricants under service conditions and the design of bearings. Gradually a change in practice occurred, and following the successful introduction of mineral oil in carriage axle lubricants, its use was extended to engine motion and then to engine axleboxes, while at the same time a blend of heavy mineral oil with rape oil was introduced for cylinder lubrication.

The use of soda base greases was restricted to wagon axleboxes, but as time went on these were gradually superseded by oil until to-day, very few wagons fitted with grease axleboxes exist under the Company's ownership, the present issues of grease being largely restricted to privately owned wagons.

The following record will serve to show the chief developments during the last 46 years:—

TABLE II.

SUMMARY OF DEVELOPMENTS IN LUBRICANTS APPLIED TO ROLLING STOCK.

Service	Type of Lubricant				
	Tallow	Soda Base Grease	Rape Oil	Compounded Oil—Rape and Mineral	Pure Mineral Oil
Engine Axleboxes ...		Prior to 1888.	1889—1893.	1894—1934.	
Engine Motion ...			Prior to 1893.	1894—1934.	
Engine Cylinders ...	Prior to 1893.			1894—1934.	
Carriage Axleboxes ...		Prior to 1888.		1889—1908.	1909—1934.
Wagon Axleboxes ...		Prior to 1896.		1897—1908.	1909—1934.

It must be understood of course, that these dates are not critical but represent changes of policy, as the actual conversion was usually spread over a period of years. Rolling stock was not withdrawn from traffic to effect changes of axlebox design, but the conversion was effected as and when such rolling stock was due for overhaul and entered the repair shops.

CLASSIFICATION OF LUBRICANTS AND GENERAL CONSIDERATIONS.

Lubricants may be broadly divided into four groups:—

(a) The fatty or fixed oils and fats.
(b) Mineral or petroleum lubricating oils.
(c) Compounded lubricating oils.
(d) Greases.

Group (a) may be further subdivided into groups according to their source, e.g. vegetable, animal and marine fats and oils.

Further, the vegetable oils and fats may be particularly classified as non-drying, semi-drying and drying, and typical oils of each class are rape oil, cottonseed oil and linseed oil respectively.

Of the permissible fatty lubricants those which have found favour in practice are rape, castor, olive, palm, tallow, lard and neatsfoot oils, and of the fats, tallow is the most used. Many other oils and fats occur in group (a) but are not suitable as lubricants because they are included in the semi-drying or drying classification.

Certain reservations must be made even in this matter, however, as it is known that all fatty oils and fats are capable of absorbing atmospheric oxygen to a certain degree, involving a change in constitution. The Author has made observations on the behaviour of rape oil when exposed to air, and the following table shows the changes in characteristics which occurred.

TABLE III.

ACTION OF AIR UPON RAPE OIL.

	Viscosity at 70° F.	Free Fatty acids (as oleic)	Saponification Value (Mg.KOH per grm. of oil)	S.G. at 60° F.
Original refined rape oil	490 secs.	2.42%	174	.915
After 4 months' exposure to air ...	—	4.8%	186	.939
After further 4 months' exposure	7840 secs.	8.43%	192	.958

The final condition of the oil was such that it was quite unsuitable as a lubricant.

Rape oil is mentioned as a typical oil of the so-called non-drying class, so that the foregoing data suggests that such lubricants are rather limited in application. It may also be inferred that under conditions of service where high temperatures are involved, coupled perhaps with high pressures, such changes in constitution would be accentuated and experience does confirm this. Where a high percentage of rape oil has been used in a cylinder lubricant, cases of corrosion and pitting of the surfaces have occurred, especially under superheated steam conditions.

In modern practice mineral oils have almost entirely superseded the fatty oils and the factors which have determined this change are :—

(1) Mineral oils are generally more stable under service conditions.

(2) Available supplies of fatty oils would be inadequate to meet the expansion of the machine era.

(3) Mineral oils are much cheaper than fatty oils and fats.

Further, the range of viscosity of fatty oils is rather limited, whereas the mineral lubricating oils may be obtained within a wide range of viscosity to suit the particular type of machine they may be required to lubricate.

The property of intrinsic "oiliness," however, does not appear to be shared equally by fatty and mineral oils, as it is well-known that the former are superior in that elusive property and under certain severe service conditions prove more efficient lubricants.

A practical instance is provided in the fact that when hot axleboxes were developed on carriage or wagon axles, rape oil was often substituted for the pure mineral oil contained therein, resulting in improved running conditions and normal temperatures.

A compromise between groups (a) and (b) may be made with the idea of retaining a measure of the properties of fatty oils and it has been found that the lubricating value of mineral oil is improved by the addition of small percentages of such oils as rape or olive and these blends are mentioned in group (c) as the so-called compounded oils.

The standard oil used on G.W.R. locomotives contains 5% of rape oil and the balance of mineral oil is adjusted by blending to give a viscosity of 105 seconds Redwood during the winter period and 120 seconds during the summer period.

The cylinder lubricant is also a compounded oil containing 5% of rape oil and has a viscosity of 710 seconds at 140° F.—much higher than general machine oils, and this oil is also distinguished by a high flash point—usually not less than 500° F. The service conditions of this oil are such that temperatures of 500° F. are common with superheated steam, so that low volatility combined with maximum viscosity are essentials for this type of oil.

A pure mineral oil is used for both carriage and wagon axles and its viscosity is adjusted to 120 seconds.

Pure mineral oils are classified chiefly by viscosity, although other considerations determine their inclusion in groups. The British Standards Institution* classify pure mineral lubricating oils as follows:—

Schedule	A—Machinery and Engine Oils.
,,	B—Internal Combustion Oils.
,,	C—Dark Steam Cylinder Oils.
,,	D—Red Filtered Steam Cylinder Oils.

The classification used by the Company is extended to cover many special oils as it will be realised that a wide range of machinery is maintained. The introduction of road transport has rendered necessary the provision of 60,000 gallons per year of motor lubricants, steam turbines and air compressors demand non-emulsifying types of oils and electrical equipment call for special types.

The following classification includes all such oils:—

Schedule	A—Mineral lubricating	oils	(graded	by	viscosity).
,,	B—Compound ,,	,,	,,	,,	,,
,,	C—Non-emulsifying	,,	,,	,,	,,
,,	D—Cutting oils.				
,,	E—Low congealing point oils.				
,,	H—Burning oils.				
,,	K—Miscellaneous oils.				
,,	L—Greases.				
,,	M—Sundries.				

Schedule C contains those oils which are specially suitable for conditions where contact with water is probable as in steam turbines. It is desirable that the oil should separate readily from such water as emulsification of the oil would lower its lubricating value and tend to choke circulating pump systems.

These oils are characterised by a low specific gravity—usually about .87—.88, and their resistance to emulsification is expressed

*British Standard Classification of Pure Mineral Lubricating Oils—No. 210, 1924.

as a number, the test being conducted according to the Institution of Petroleum Technologists Serial No. L.O. 16*.

Schedule D relates to those oils which are used for the lubricating of cutting tools in the machining of metals.

Two types are included—compounded oil and the so-called soluble cutting oil. The first is a blend of rape oil with mineral lubricating oil of a type similar to that mentioned later as a general machine oil and the blend is used on automatic machines for stay cutting etc., and where a soluble oil emulsion would be inadmissible.

The second type is a prepared oil which will emulsify with water and form a cutting fluid which will lubricate and conduct heat away from the cutting edge.

This oil is prepared by dissolving a liquid soap in light machine oil with the addition of an antiseptic, the result being a clear oil which may afterwards be mixed with water in various concentrations according to the type of machine or duty.

Schedule E relates to those oils which lubricate machinery used in exposed places and K to those oils other than machine which are used for secondary purposes such as the lubrication of points, fish plates and chains etc.

The total issues of lubricating oils amount to approximately 1,250,000 gallons yearly and of this figure 1,000,000 gallons is required for rolling stock.

A locomotive "consumes" on an average $3\frac{1}{2}$ times the lubricating oil of all the vehicles behind it and it is obvious that such consumption is brought about through cylinder oil being expelled via the steam exhaust and engine oil being thrown off the motion, whereas in an axlebox, the oil system is enclosed and leakage is only of a casual nature. The term "consumes" of course is used advisedly as although some of the oil is wasted, a portion gives service, but even so, this oil is not fatigued and if reclaimed would give further service.

The last group of lubricants for consideration are the greases. These may be defined as semi-solid lubricants which melt or flow at higher temperatures, and their use is usually confined to axles, heavy bearings and certain parts not readily accessible.

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*Standard Methods of Testing Petroleum and its Products—2nd Edition 1929. Institution of Petroleum Technologists.

They are usually compounded from mineral and fatty oils or fats with the addition of a thickener, and further they may be classified as waterless, or emulsions containing water, the latter type being usually restricted to soda base greases.

The consistency is adjusted by incorporating a metallic base such as caustic soda, carbonate of soda, lime, etc. and the process involves the forming of a soap by combination of the alkali with the fatty constituent whereby the whole is thickened.

The chief grease manufactured by the Company is a soda base axle grease and is used, as already mentioned, almost exclusively on privately owned wagons running on the Company's system. This grease is formulated from an ordinary soda soap base in conjunction with heavy mineral oil, tallow, palm oil and water, and proportions are adjusted to give a grease of the required consistency.

The following is a typical analysis of railway wagon axle grease:—

Hydrocarbon oil	43.9%
Free fatty oil	7.6%
Fatty anhydrides combined as soap ...	17.8%
Soda (Na_2O) combined as soap	2.0%
Water	28.7%

The comparative merits of oil and grease lubricants have been the subject of much discussion, and conclusions point to the fact that while greases resist displacement from bearings to a greater degree than oils, they offer more resistance to shear. A practical illustration of this is provided in the force required to move a grease boxed wagon and that required to move an oil boxed wagon.

The total load was eight tons per wagon and both vehicles were allowed to rest 12 hours before the test.

It was found that an effort of 290 lbs. was required to move the grease boxed wagon and 540 lbs. for the oil boxed wagon, and it was concluded that the oil had been expressed from the interface in the case of the oil lubricated journals, while the grease had resisted expression and thus better initial lubrication was obtained from grease.

After initial movement, however, the oil film is readily established and thereafter less effort is required in maintaining movement of oil boxed wagons owing to the fact previously mentioned —that the oil film offers less resistance to "shear." It is on record during shunting operations shunters would indicate to the engine driver that a wagon fitted with grease axleboxes was being shunted so that the driver could accelerate the wagon to enable it to run to a required point. The frictional resistance of some wagons on test are given in Table IV.

TABLE IV.

STATIC FRICTION OF RAILWAY WAGONS.

Class of Wagon	Type of Lubricant	Load per bearing (lbs.)	Gross Weight =W (lbs.)	Frictional Resistance =F (lbs.)	$\frac{F}{W}$
Open Goods ..	Pure Mineral Oil	1792	11,200	145	.013
,,	Standard Soda Base Grease	1596	10,416	90	.0086
Covered Gds.	Pure Mineral Oil	2156	11,200	195	.013
,,	Standard Soda Base Grease	2268	13,104	110	.0084
Open Goods ..	Pure Mineral Oil	4564	22,288	540	.024
,,	Standard Soda Base Grease	4508	22,064	290	.013

TESTING & EXAMINATION OF LUBRICANTS.

The testing and examination of lubricants is an important factor in the maintaining of issues to required specifications and further in ensuring a standard of supplies from contractors.

Physical and chemical tests enter the field of examination, although chemical tests are more confined to the fatty oils. The latter have well defined characteristics and analysis is able to identify fatty oils and fats by means of special tests, but the more usual purpose of examination is to determine the genuine nature and purity of such oils and fats.

The usual tests applied to rape oil—used exclusively by the Company as a component of compounded lubricating oil are in respect of the free fatty acidity, unsaponifiable matter, specific gravity, and total fatty acids. It is desirable that free fatty acids should be as low as possible, as excessive free fatty acidity would tend to induce slight action on metallic parts and the test is directed to determine whether such acidity exceeds a certain specified limit—usually 2.5%.

The estimation of unsaponifiable matter would indicate the purity of the rape oil, as adulteration with mineral oil would raise this figure above the usual limits, viz. .5% to 1%. A typical analysis of rape oil follows:—

Free fatty acids, expressed as oleic acid ...	1.3%
Unsaponifiable matter	.7%
Total fatty acids	95.3%
Melting point of total fatty acids	18°—24° C.
Congealing point of total fatty acids	18°—10° C.
Maumene's heat test—rise	55° C.
Specific gravity at 60° F.	.916
Colour	Brownish yellow
Clearness	Clear
Free mineral acids	Absent

It must not be overlooked that the fatty oils have characteristic viscosities—castor oil has the highest with 336 seconds Redwood at 140° F., rape oil next with 100 seconds, and it may be noted that usually genuine samples of fatty oils do not differ more than 5% from such figures.

The following table gives the viscosities of some fatty oils, the first two of course belong to the drying and semi-drying groups respectively, and are therefore unsuitable for lubricating purposes.

Table V.

VISCOSITIES OF SELECTED FATTY OILS.

Description	Redwood Viscosity at 140° F.
Linseed Oil	69 seconds
Cottonseed Oil ...	81 ,,
Olive Oil	86.5 ,,
Neatsfoot Oil	90.5 ,,
Rape Oil	100 ,,
Castor Oil	336 ,,

It has already been mentioned that mineral lubricating oils are classified by viscosity and the determination of viscosity is the chief test applied to such oils. The great variety of service conditions in regard to bearing speeds, loads, areas, temperature etc., has made the choice of oils of suitable viscosity important.

Viscosity is usually measured by some form of efflux viscometer and the instrument most favoured in this country is the Redwood viscometer.

Determinations are usually expressed in seconds for the outflow of 50 millilitres at the temperature of the test and such determinations may be made at two or more temperatures according to information required. A reduction in viscosity occurs of course, on heating oils and the following relative viscosity curves

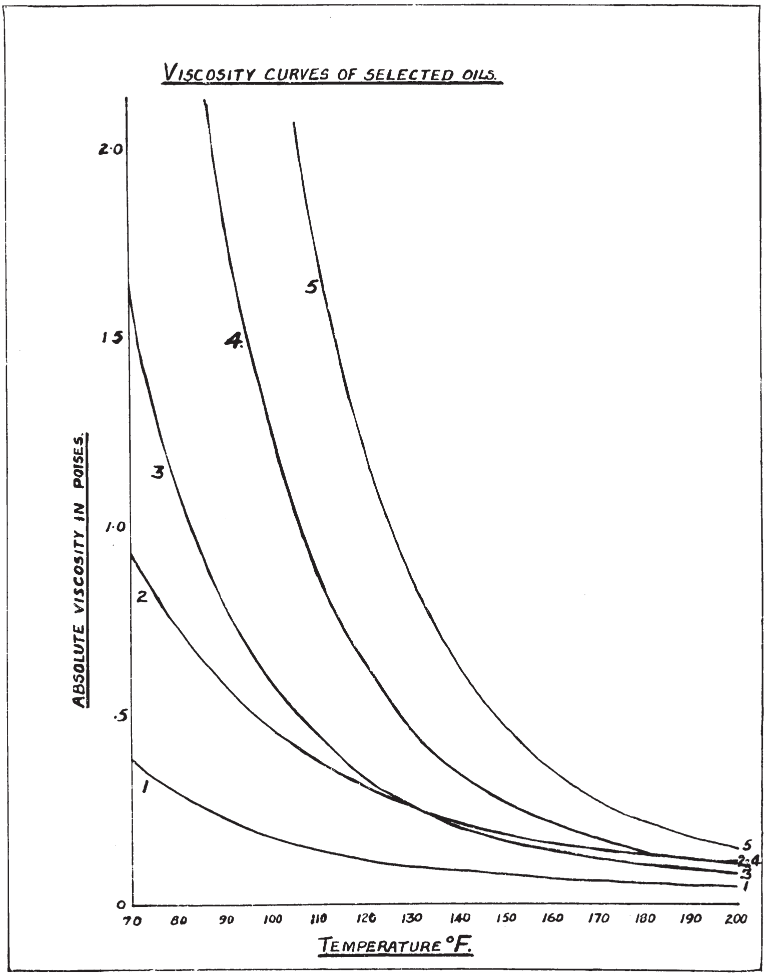

FIG 1.

(Fig. 1), give an idea of the behaviour of a few oils. It will be noted that the viscosity of rape oil (Curve 1) is not reduced to the extent that pure mineral oils 3 and 4 are.

TABLE VI.

ABSOLUTE VISCOSITIES OF SELECTED OILS.

No.	Description of Oil	Absolute Viscosity in Poises (Redwood).						
		70° F.	80° F.	100° F.	120° F.	140° F.	180° F.	200° F.
1.	B Spindle Oil	0.3923	0.2918	0.178	0.1188	0.0866	0.053	0.0425
2.	Crude Rape Oil	0.9287	0.7341	0.466	0.312	0.219	0.1356	0.107
3.	General Machine Oil (CL)	1.606	1.117	0.5839	0.3325	0.2024	0.1027	0.0795
4.	Heavy Clear Mineral Oil	4.764	2.979	1.273	0.6365	0.3476	0.1418	0.1029
5.	Extra Heavy Motor Oil ...	10.770	6.552	2.614	1.214	0.6305	0.2228	0.1498

Other physical tests applied to mineral oils include the flash point, specific gravity, pour point, and reaction, and further the oil may be examined for water or suspended matter. The following is a typical analysis of a pure mineral general machine oil.

Viscosity at 70° F. (seconds Redwood) ...	699
,, 140° F. ,, ,, ...	98
Ratio of viscosity—70 to 140° F.	7.1 : 1
Specific gravity at 60° F.	.918
Flash point (close test)	388° F.
Pour point	Below 25° F.
Reaction	Neutral
Type	Clear—Pale

The obvious, and most practical, method of ensuring suitable lubrication of a machine is to use an oil of equal value to that specified by the makers and to check its behaviour in service and when necessary examine samples of used lubricant at intervals. Troubles are more likely to arise during initial "running in" of a machine or prime mover, so that if satisfaction is obtained during this period the oil should prove quite efficient thereafter. The purity of an oil is, of course, a very important factor and the cleanliness of containers, oil feeders, etc., should be carefully checked up and stocks of oil should be protected to prevent the entry of dust and water.

Much experiment has been directed to the question of suitable lubricants for locomotive work and a large number of different types of oil have been tried out, although a measure of stabilisation has been reached in the last eight years, and it would appear that a change in bearing design, etc. would be the chief factor in determining a change of type of lubricant.

RECLAMATION OF USED LUBRICATING OIL.

The recovery and purification of used lubricating oil has been a subject of increasing importance of late years and much experiment has been directed to methods of clarifying all types of lubricating oils and rendering them suitable for further use. During use, oils become charged with impurities varying with the situation of the machine and the service conditions, as well as contamination with water.

Internal combustion oils become heavily charged with carbon and fine metal particles from big end bearings etc., and often this contamination is of the order of 6% by weight. Used carriage and wagon axle oil contains iron oxide derived from the braking of wheels, dust from the permanent way, metal particles from the bearing metal, and water.

The most troublesome impurity is usually water, as emulsions are often developed in the presence of finely divided solids and are frequently difficult to break down—especially is this so if the oil is compounded with fatty oil to the extent of 10% and upwards.

Methods of purification of used oils may be classified as follows:—

(1) Settling or sedimentation with or without chemical treatment.

(2) Clarification by centrifugal machine.

(3) Filtration as in the stream line filter.

The method employed in the Oil Works is that of centrifugal clarification with or without chemical treatment, and the chief oil so treated is used carriage and wagon axle oil. In this case the process involves pre-treatment with .2% alkali to break emulsions and remove asphaltic bodies formed during service.

The oil is first strained through rough gauze into storage tanks, heated by steam coils to 200° F. and treated with reagents, and then it is pumped to elevated tanks and a settled portion representing about 30% of the charge and containing the bulk of the impurities is first run hot through a continuous bulk centrifuge which removes the heavier solids. The once treated oil skimmed from this machine is stored and on completion of the operation of the bulk machine, is returned to the feed tank and the whole charge is then run hot through a separate high speed centrifugal machine as illustrated in Fig. 2. This machine, which has been developed by the Super Centrifugal Engineers Ltd., consists of a rotating cylinder, termed a bowl, 30 inches in length and 4 inches diameter driven by belting from a motor. The bowl revolves at 15,000 r.p.m. and the hot oil feed on entering the bowl at the bottom strikes a plate and is deflected to the sides and centrifugal force separates the components of the used oil according to their specific gravities, the solids building up as a deposit on the cylinder walls, while water and oil are resolved into separate columns which build up in the bowl. Water and clarified oil are tapped continuously by two ports at the head of the machine and collecting covers direct the oil and water sprays ejected from the ports into separate streams—the water to waste and the clarified oil to storage.

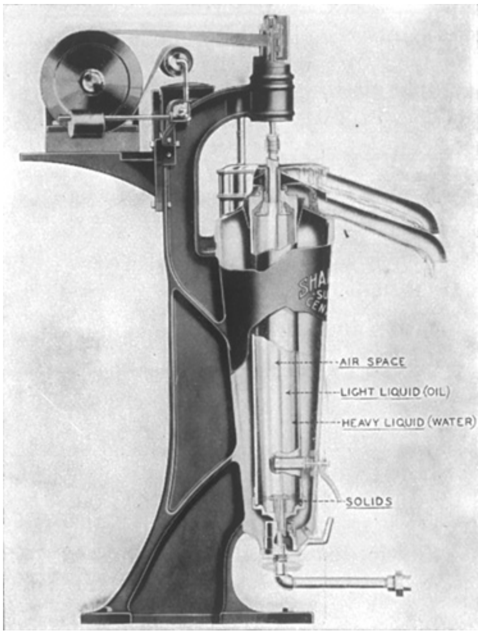

FIG. 2.

Sedimentation in tanks was formerly practised in reclaiming used oil but this system has been completely superseded by centrifugal treatment with a greater resultant yield of clarified oil.

The oils dealt with are as follows :—

Used carriage and wagon axle oil—recovery 35,000 galls. per annum.

Crank case oil—recovery 8,000 galls. per annum.

Miscellaneous oils—10,500 galls. per annum.

The following comparative figures show the characteristics of used carriage and wagon axle oil before and after treatment.

TABLE VII.

CHARACTERISTICS OF USED AND EQUIVALENT CLARIFIED AXLE OIL.

	Redwood Viscosity at		Viscosity Ratio 70 to 140° F.	Flash Point (CT)	S.G. at 60° F.	Suspended matter	Water content
	70° F.	140° F.					
Used oil	secs. 1962	secs. 236	8.31 : 1	—	.951	1.0%	28.27%
After clarification ...	1055	116	9.09 : 1	342° F.	.9245	No trace	Trace

Since the introduction of machine treatment in 1926, the yield of recovered oil has totalled 360,000 gallons, while roughly 146,000 gallons of water were separated and 20 tons of solids extracted.

Recovered carriage and wagon axle oil is reblended in the standard oil issued for this purpose and a considerable saving is therefore effected, while miscellaneous oils treated are blended with other lubricants according to quality.

DISCUSSION.

Mr. K. J. Cook (Chairman) said that the Author had presented a very interesting paper dealing with many aspects of the subject, and an additional value would be obtained from an examination of the various samples.

One very interesting point was that of the percentage of oil used for lubrication; in other words how much was used, how much really lubricates, and how much was wasted. He believed the Author stated that at least 80% was wasted, so that there might be a field for conserving oil. On the other hand, the oil cost is roughly 1/46th of the cost of locomotive repairs, so that the objective of preventing wear must be kept rigidly in view.

It was interesting to hear exactly what proportion of oil relative to locomotive consumption was used in other vehicles; the Author quoted about 1/30th. It was apparent that the figure used on rolling stock other than locomotives, is very small. It was also stated that there was no recovery of oil from locomotives and that it was only recovered from carriages and wagons. It might be mentioned that from 3,000 to 4,000 gallons of lubricating oil are recovered per annum by boshing methods from the Locomotive Works. It was understood that the oil contact with the alkali in the bosh was not disadvantageous, but rather assisted subsequent filtering.

Another very interesting point was the gradual transference from grease to oil in wagon axleboxes, which has been influenced by the increase of speed in freight trains, and with the introduction of the vacuum fitted goods working with an average speed of 45 m.p.h., the Great Western Railway found it necessary to equip all wagons operating these services with oil boxes, and that has gradually extended.

On the other hand, in some countries there was tending to be an extension of grease lubrication, possibly not in the same form in which it had previously been used in Great Britain. There was present at the meeting an old member of the Swindon Engineering Society who would no doubt be able to give some details of recent grease lubrication in India.

Mr J. E. Bottomley said he appreciated his invitation to the meeting to renew old acquaintanceship of twenty years' standing. He was pleased to see the Society going as strongly as ever. When members pass on from Swindon to other parts of the world, they greatly appreciate the meetings they have had in Swindon.

Referring to the tendency to revert to grease lubrication abroad, Mr. Bottomley said that in India such lubricants were definitely favoured for axleboxes, slide valves and all cylindrical bearings, and had also been tried on sliding surfaces. The main reason why grease was successful in India was because it formed a dust shield, although on plane surfaces, such as slide bars, this condition was not possible, as of course the surfaces were exposed. In axleboxes a system was in use in which a block of grease was kept in contact with the underside of the journal, the pressure of contact being regulated with springs. A perforated metal plate is interposed between the grease block and the journal proper and this plate was specially designed to bed correctly on the journal and under these conditions hot boxes have been almost entirely eliminated.

Mr. Bottomley went on to say that experiences of grease lubrication on the G.I.P. Railway had been recorded in a paper given before the Institute of Locomotive Engineers by Mr. Renwick.

Introduction of pooling was being undertaken in India with the idea of obtaining greater mileages, their objective being 12,000/15,000 miles per month. In order to realise this, an engine must require a minimum of attention. An engine may be run from its depot to a point, perhaps, 100 miles away, when the crew was changed, and the engine proceeded to another point. Only when it had run 1,000 miles was the engine returned to its home sheds for attention.

Mr. Renwick in his experiments had found that a charge from the grease gun per lubricator would carry the engine throughout the trip.

The question of type of grease was important of course, and he believed that experiments had been undertaken to determine suitable types, and probably the Author would be able to indicate the differences existing between types. He believed that the block grease used in the axlebox had a melting point of about 400° F.

Continuing, Mr. Bottomley mentioned that some trouble had been experienced in India with regard to the formation of carbon deposits in cylinders and suggested that a contributory cause was the higher superheated steam temperatures obtained (around 700° F.) At the same time, he realised that viscosity and flash point were not the only critical values in a cylinder lubricant, although a contract specification commonly mentioned these.

With regard to the question of private owners' wagons running on the G.W.R. retaining grease lubrication, he thought that these owners really do find it is the cheaper lubricant, thus confirming the findings of the Indian Railways.

Mr. E. H. Gooderson said he would like to reply to the reason why private owners retain grease and it was because they did not have to buy the coal to run the trains, as experience showed that the hauling of vehicles fitted with grease boxes caused an increased coal consumption.

He went on to say that the paper had been a very interesting one and had raised points that would need consideration. He thought that all engineers realised that there was more oil wasted than used, but the statement that cylinder oil was expelled through the steam exhaust on a locomotive seemed to suggest a far greater loss than was generally admitted.

The Author referred to the introduction of greases on railway rolling stock in India mentioned by Mr. Bottomley, and said he agreed that a primary advantage would be the exclusion of dust, etc. from the part being lubricated under such conditions.

He also agreed with Mr. Gooderson that if private owners of wagons had to pay for the coal consumption of engines hauling grease lubricated wagons, they would view the matter with concern, as it was an established fact that less work was required in maintaining movement of oil lubricated vehicles, but on the other hand, many colliery wagons standing in sidings for a period, would prove more difficult to move if oil lubricated, as pointed out in his paper. Another aspect in favour of greases would be in cases where wagons were used on tips. Oil would probably escape from boxes when the wagon was inclined, although he believed that this difficulty had been largely surmounted by specially designed boxes.

Mr. C. W. G. Lanchester mentioned that a good deal of coal dust must find its way into the bearings of oil lubricated wagons standing in sidings near collieries, tips, etc., and suggested that for that reason, many owners had retained grease, as the latter would act as a shield to the entry of dust, etc.

Mr. E. R. Radway said that he would be interested to know something of the types of mechanical mixers used for blending at the Oil Works. During a period of maintenance work there, he had noticed the installation of an archimedean screw mixer and would like to have the Author's observations on the efficiency of that appliance.

The Author, replying, stated that three types of appliance were in use for mixing, the slow speed dredger type in which baffle plates were carried on an endless chain, the propeller type, and the archimedean screw type, the latter being a screw contained in a closely fitting cylinder open at the bottom, the screw revolving at a definite speed. An oil lift is obtained within the cylinder and cascades over the top while an equivalent volume enters at the bottom of the cylinder, and so a cycle is set up. In addition compressed air is used for certain types and is by far the most positive form of mixing.

Continuing, the Author said that the question of types of lubricating greases had been raised by Mr. Bottomley, and it would be recognised, of course, that the kind of grease to be used, whether hard, medium or soft, depended on the service conditions. The class of greases being considered were of the waterless type and were usually admixtures of lime soap with mineral oil, the consistency of the grease being determined by the percentage of soap base incorporated, and the viscosity of the mineral oil used. Soft greases usually contained about 17.5% base and stiffer grades up to 25%.

Mr. R W. Dawe said that he had been very interested in the paper, and the subject was one that should be of vital interest to engineers in general, as it would help them to appreciate the savings which could be effected by adopting suitable methods of conserving oil. The Author had stated that the glazing of axle pads had been completely overcome by the use of pure mineral oil in place of the fatty or compounded oils which were first tried. This may be true of G.W.R. experience because the oils have been subject to close control by analysis. There were, however, many grades of hydrocarbon oils which often contained considerable amounts of asphaltic bodies, and these bodies were capable in service of combining with metallic particles, etc. to form an insulating layer between the oil pad and the journal and so retard the supply of oil. It was within his experience some 15–16 years ago on an Irish Railway that a certain hydrocarbon oil gave trouble in this respect and on further examination the oil was found to contain asphaltic matter to the order of 3%. In the selection of hydrocarbon oils, therefore, chemists take care to choose those oils which are free from such bodies.

THE AUTHOR said that he quite agreed with the importance of control of supplies by analysis, and in his opinion, satisfaction was only to be ensured by such control. The instance mentioned of mineral oil containing 3% asphalt was a case of an altogether unsuitable oil and the usual test should not reveal more than a trace in hydrocarbon lubricating oils.

MR. J. E. BOTTOMLEY said that the G.I.P. Rly. had tried compounding oils for axle box lubrication, but they invariably failed well within six months. On the other hand there was a traction department who possessed some costly electric locomotives, which did four journeys each day and maintained good oil pressures and successful running with those oils.

MR. J. W. HIGGS said the Author had put forward the suggestion that it might be possible to place splash shields and catch wells in the engine to help collect escaping oil. He thought that inspection would show the impracticability of placing such shields in the confined space available, and would not be worth it in view of the low maintenance cost of oil.

THE AUTHOR in reply said that as the Chairman had pointed out that 3,000/4,000 gallons of engine oil was recovered from the bosh in which engine parts were cleaned, but apart from this he (the Author) could state that the direct recovery was nil. The quantity of used carriage and wagon axle oil received from traffic was only 4% of the total issues, but the reclamation of this oil represented a saving of £1,200 per annum. Exclusive of cylinder oil, the issues for engine lubrication were 2½ times that for other vehicles and a recovery of 5% only would nearly double that saving.

Fig. No. 2 by courtesy of The Super Centrifugal Engineers, Ltd.