Nov. 11, 1941. M. FAIRLIE ET AL 2,262,526

LUBRICATION

Filed July 15, 1938 4 Sheets-Sheet 1

Fig. 1,

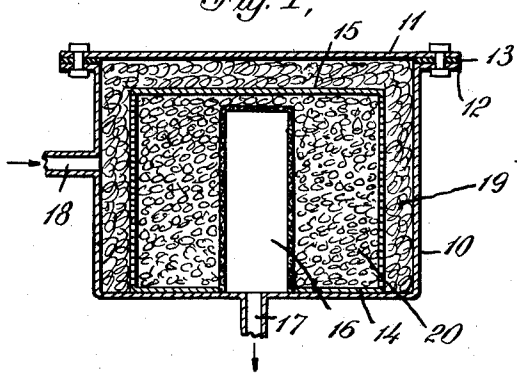


Fig. 2,

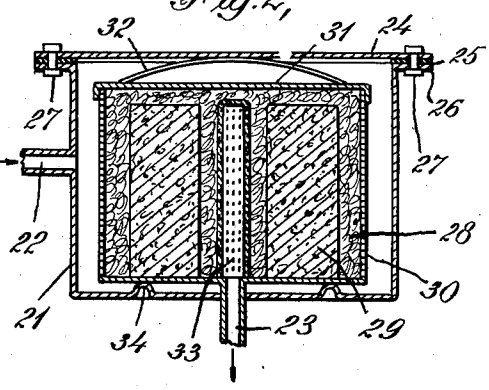


Fig. 3,

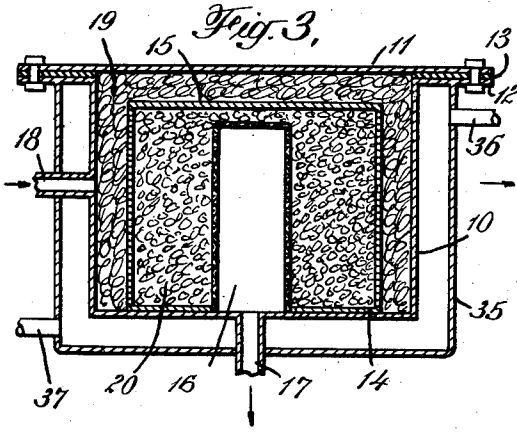


Fig. 4,

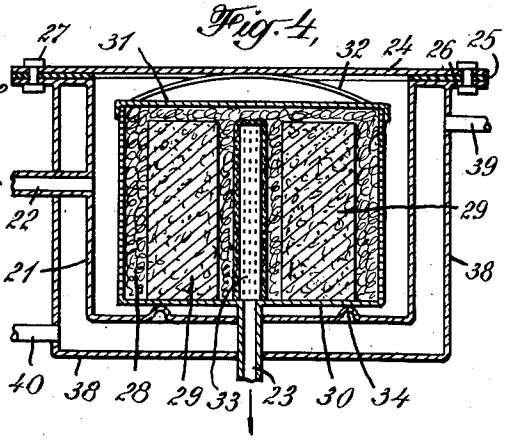
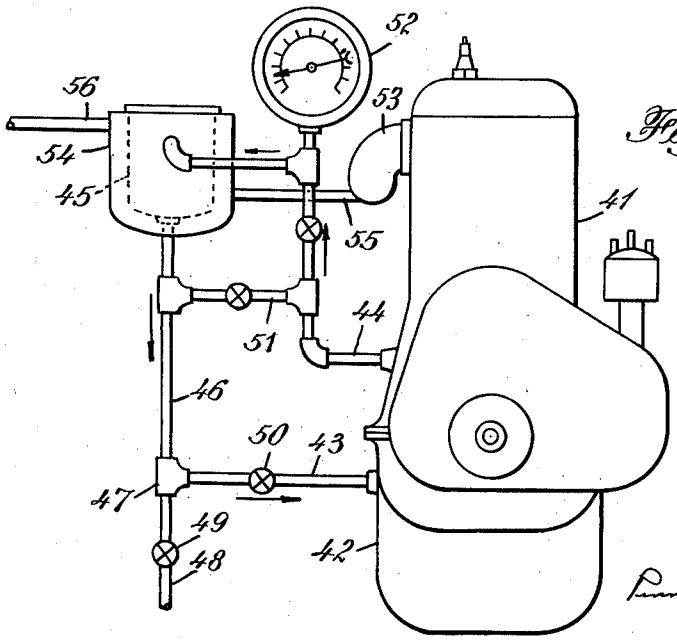


Fig. 9.



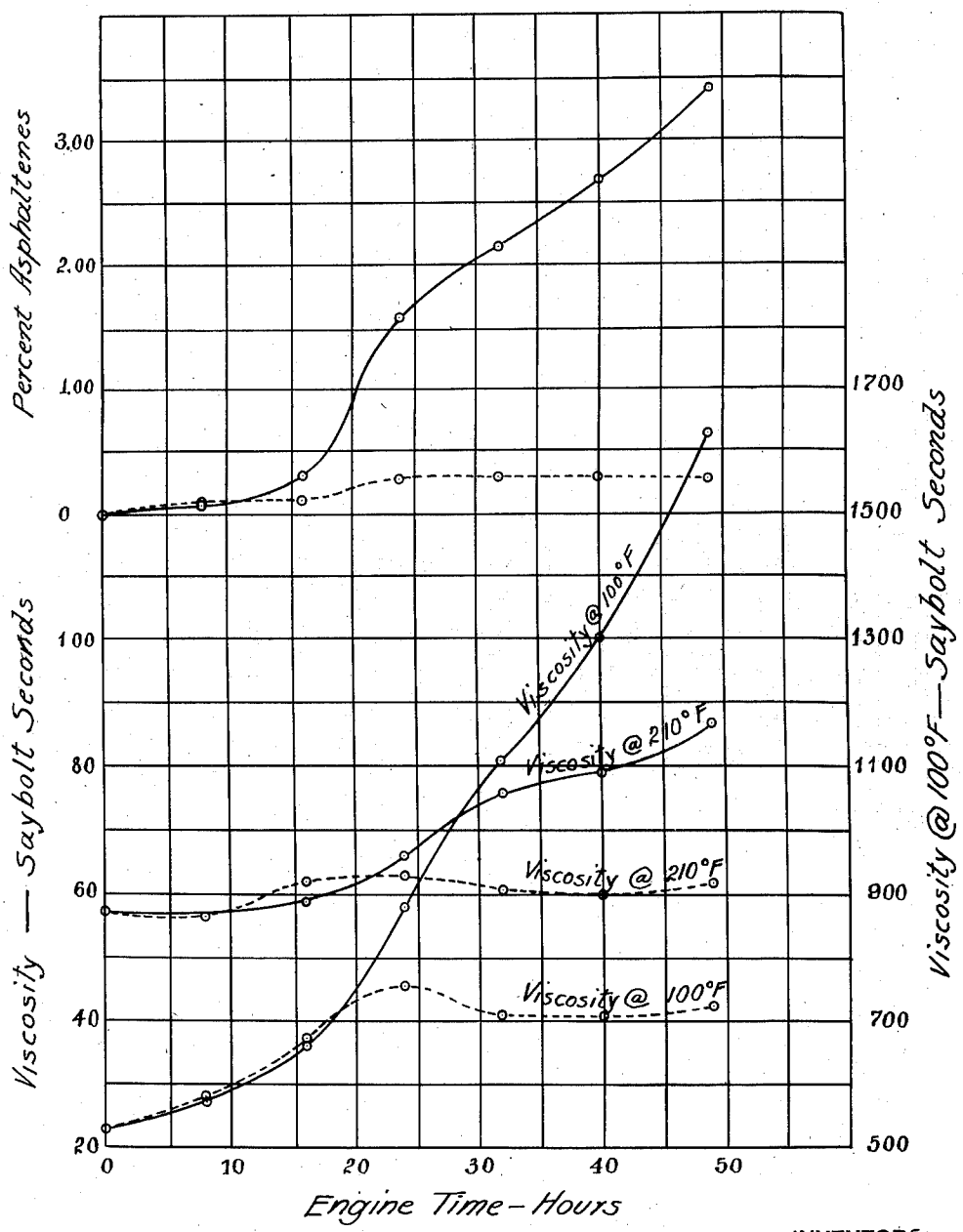
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LUBRICATION

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Fig. 5.



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LUBRICATION

Filed July 15, 1938 4 Sheets-Sheet 3

Fig. 6

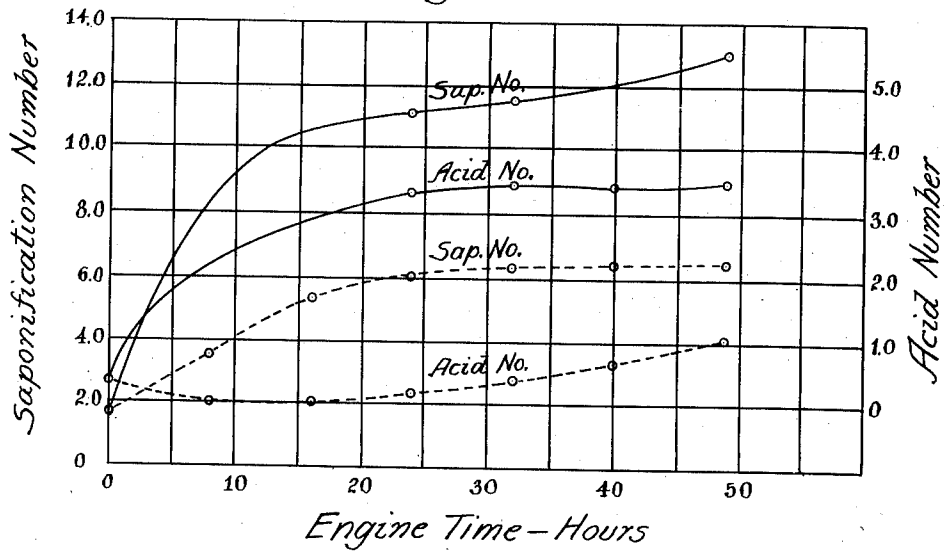
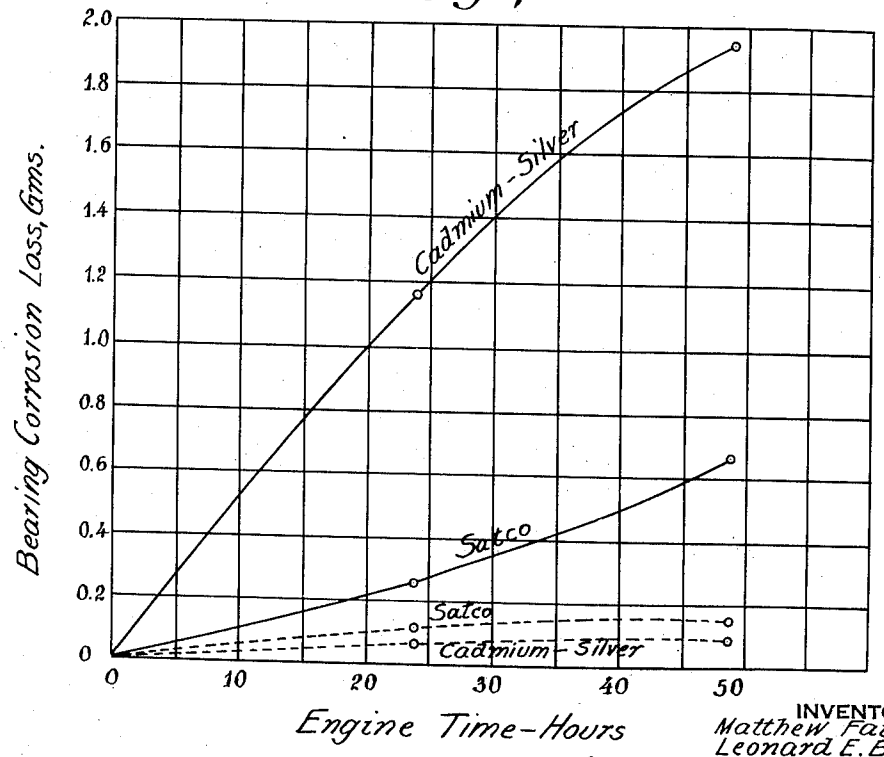


Fig. 7,



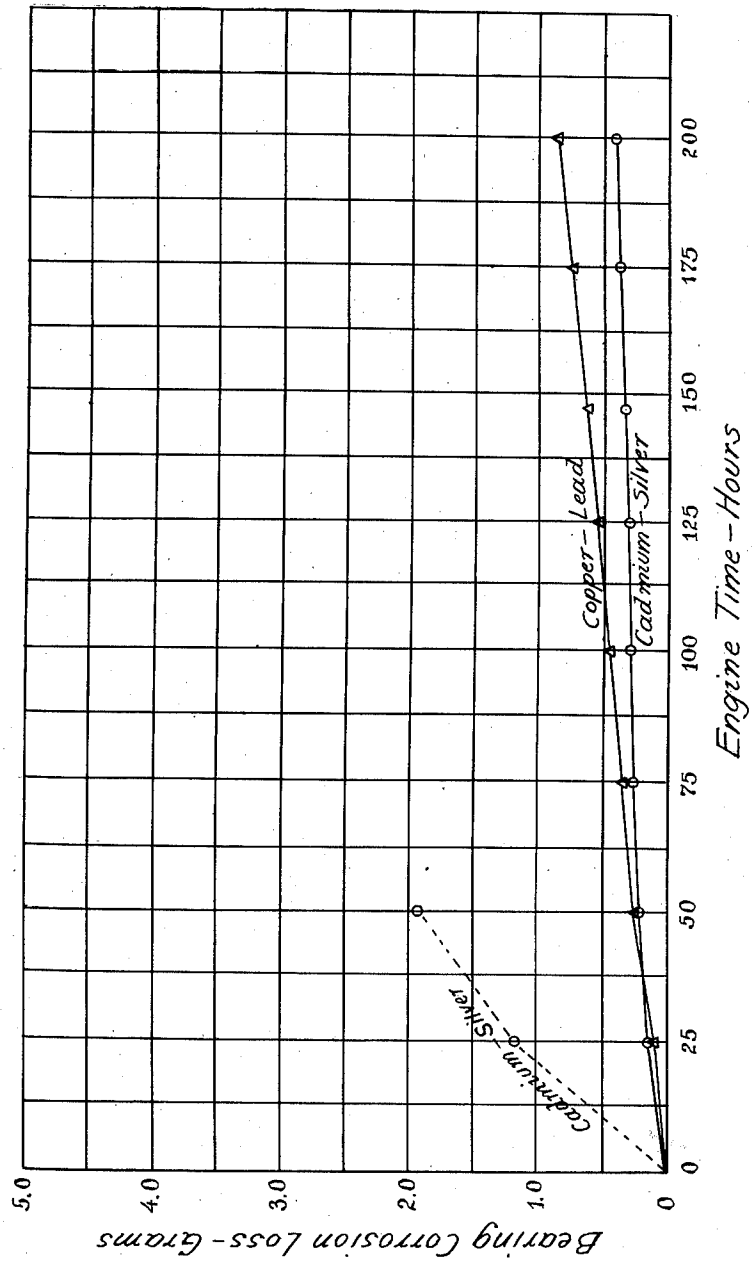
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LUBRICATION

Filed July 15, 1938 4 Sheets-Sheet 4

Fig. 8,



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2,262,526

UNITED STATES PATENT OFFICE

2,262,526

LUBRICATION

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Application July 15, 1938, Serial No. 219,456

8 Claims. (Cl. 123—196)

This invention relates to lubrication and particularly to lubrication of internal combustion engines with petroleum oils containing soaps of one or more of the three alkaline earth metals, calcium, strontium and barium. The invention aims to prolong the useful life of such oils, improve their lubricating qualities during such life, and inhibit the attack of such oils upon metals—particularly alloy bearings such as cadmium-silver, copper-lead, etc.

In general, the presence of soaps of the alkaline earth metals in lubricating oil improves the lubricating quality of the oil and improves its thermal stability, i. e., its power to retain its lubricating quality under conditions of elevated temperature or pressure, or both. An example of a lubricating oil containing soap of an alkaline earth metal is that described and claimed by Arnold C. Vobach in United States Patent 2,081,075, granted May 18, 1937. Such oil contains calcium phenyl stearate with or without calcium stearate or phenyl stearic acid. The amount of calcium phenyl stearate plus calcium stearate or phenyl stearic acid in the oil preferably ranges from 0.5% to 2.5% of the oil, the latter being of petroleum origin having a viscosity upwards of 50 to 70 seconds at 100° Fahrenheit, Saybolt Universal.

Lubricating oils of petroleum origin and containing calcium soap or the soaps of barium or strontium are distinguished by good performance characteristics under severe operating conditions, for example, the conditions in the Diesel type of engines in which lubricating oils are subjected to extremely high temperature and pressures. Under such conditions, petroleum oils containing alkaline earth metal soaps and particularly petroleum oils containing the phenyl stearate of calcium or strontium are notable for their high thermal stability and reduced tendency to form insoluble sludge. In addition, oil containing phenyl stearate of calcium or strontium has the properties of rendering deposits of sludge and "carbon" in an engine soft and friable rather than hard and coherent, and removing such deposits as an incident to the normal operation of the engine. However, under severe operating conditions, oils containing such soaps do deteriorate eventually and, although their operating life is longer than that of most other lubricants under like conditions, it is desirable to still further prolong such life.

Although the principles of lubrication, that is to say how a given substance acts as a lubricant and what factors contribute to its lubricating qualities are not completely understood, it has been observed that increases in the viscosity, sludge content and acidity of a petroleum oil during service in an engine are indicative of deterioration of lubricating qualities. Moreover, the gradual formation of tar or asphaltenes in petroleum oils during service, due to polymerization or other chemical action is accompanied by difficulty in properly supplying the lubricant to metal surfaces and in maintaining cleanliness of reciprocating parts. Furthermore, many petroleum lubricating oils after a period of service manifest some tendency to corrode metal. In the case of oils containing alkaline earth metal soap in service at elevated temperatures and in contact with certain types of metals, the tendency toward corrosion is marked. This tendency is relatively mild when the oil is new, but increases after the oil has been in service for some time at elevated temperatures, probably due to the formation of oil acids or other oxidation products. Certain special alloys, such as the cadmium-silver and copper-lead alloys now used extensively as bearings in internal combustion engines, are particularly susceptible to corrosion by oils containing soaps of the alkaline earth metals at relatively elevated temperature.

As a result of our investigations, we have discovered a method of and apparatus for prolonging the life and lubricating properties of petroleum-base lubricating oils containing alkaline earth metal soaps even under severe operating conditions and for inhibiting the corrosive effect of such oils upon metals with which they come in contact. We have discovered that the tendency of such oils to increase in viscosity and acidity and to form sludge during service is inhibited by bringing the oil periodically into contact with an alkaline earth metal (calcium, strontium or barium) or an inorganic compound thereof. Thus, calcium, strontium or barium in elemental form or as inorganic compounds, for example the carbides, carbonates, oxides or hydroxides, act to inhibit an increase in the viscosity, acidity and sludge formation of oils containing calcium soaps. Moreover, such treatment results in a marked reduction in the amount of "gum" and sludge deposited on important reciprocating parts during service and at the same time reduces the corrosion of bearings and other metal surfaces with which the oil comes in contact. Oddly enough, magnesium and its inorganic compounds, although like calcium and its corresponding compounds in many respects is not useful in the practice of our invention.

Generally speaking, the tendency of petroleum-base lubricants to deteriorate during service increases as the temperature of service increases. However, we have found that this is not the case with petroleum-base lubricating oil containing an alkaline earth metal soap, provided that during service such oil is brought periodically into contact with an inorganic solid containing calcium, strontium or barium in elemental or combined form. Under such circumstances, an increase in temperature of the oil, within limits, by providing increased and optimum temperatures of contact of the oil with the inorganic mass, actually decreases the tendency of the oil to deteriorate and lose its lubricating qualities. For example, the useful life of oil containing calcium phenyl stearate is longer at temperatures of 250° F. than at a lower temperature, say 225° F. provided that during service the oil is circulated in contact with an inorganic solid containing calcium, strontium or barium in elemental form or as a compound.

We have found, moreover, that at relatively low contact temperatures, i. e., substantially below 140% F., the favorable effect exerted by the alkaline earth metals (in elemental or combined inorganic form) upon oil containing soap of the alkaline earth metals is not marked. Hence, it is advantageous to bring the oil into contact with calcium or the like under conditions of relatively elevated temperatures. The precise temperature at which the effect of the alkaline earth metal is optimum is dependent upon the form in which the metal or metal compound is used. In the case of calcium hydroxide in contact with an oil containing calcium phenyl stearate the optimum contact temperature is in the neighborhood of 250° F., to 275° F. and in general such temperature is optimum. However, good results are obtained up to a temperature of about 300° F.

In the operation of an internal combustion engine in accordance with our invention, the oil containing a soap of an alkaline earth metal preferably is brought to optimum treatment temperature, either by heating or cooling. In the case of Diesel type engines and the like, oil in the lubricating system may attain a temperature above the optimum, in which case it is desirable to cool the oil before or during its contact with the solid containing the alkaline earth metal (i. e., the contact mass). On the other hand, oil in the lubricating system of automobile engines and the like usually will not attain the optimum temperature for treatment as a normal incident of operation. Hence it may be desirable in the application of our invention to an automobile engine, to heat the oil or the contact mass containing the alkaline earth metal or both, so that treatment of the oil with the contact mass takes place under optimum conditions.

The contact mass containing the alkaline earth metal in elemental or combined form preferably is porous and relatively finely divided, the oil being circulated through it. Optimum conditions of treatment may be attained by enclosing this mass in a jacket through which a heating or cooling medium is passed. In the case of automobile engines and the like, in which optimum conditions require the addition of heat, the latter may be supplied by passing the exhaust gases from the engine through the jacket. Where cooling is desirable, cold water or cool air or other cool fluid may be passed through the jacket.

Our invention therefore contemplates passing a liquid petroleum-base lubricant containing a soap of an alkaline earth metal periodically during service in contact with a solid containing calcium, strontium, or barium in elemental or combined inorganic form, for example, metallic calcium or the hydroxide or carbide thereof. Preferably, the treatment of the oil with the compound is conducted at elevated temperature, the optimum temperature being that at which the organic acidity is substantially continuously neutralized and the resultant soaps are dissolved in the oil. Generally speaking, the temperature of treatment should lie between 140° F. and 300° F.

These and other aspects of our invention will be more completely understood in the light of the following detailed description of presently preferred practices of our invention taken in conjunction with the accompanying drawings, in which:

Fig. 1 illustrates a form of filter containing a contact mass for use in the practice of our invention;

Fig. 2 illustrates a second form of filter for use in the practice of our invention;

Fig. 3 illustrates a jacketed filter for use in the practice of our invention when it is desired to raise the temperature of the oil to attain or approximate optimum treatment conditions;

Fig. 4 illustrates a jacketed filter for use in the practice of our invention when it is desired to lower the temperature of the oil to attain or approximate optimum treatment conditions;

Fig. 5 is a graph of results obtained as to the viscosity and percent asphalteness of oil containing calcium phenyl stearate during 50 hours of service in a Waukesha four-cylinder gasoline engine, the results obtained while using a calcium hydroxide contact mass being compared with those obtained under identical conditions except that the contact mass was not used;

Fig. 6 is a graph of results obtained as to the saponification number and acid number of oil containing calcium phenyl stearate during the test of Fig. 5;

Fig. 7 is a graph showing corrosion of certain alloy bearings during the test of Fig. 5;

Fig. 8 is a graph showing the corrosion of copper-lead and cadmium-silver bearings during a 200 hour test in a Waukesha engine with oil containing calcium phenyl stearate circulated through a calcium hydroxide contact mass, as compared with results obtained under identical conditions, except that the filter was not used; and

Fig. 9 shows a calcium hydroxide filter in place on the oil circulating system of the engine employed in the tests.

Passing now to a consideration of the drawings, the filter of Fig. 1 comprises a cylindrical metal shell 10 having a cover plate 11 bolted to a flange 12 around its top with a gasket 13 interposed between flange and top to insure a tight joint. Disposed concentrically within the shell is a canister 14 made from perforated Monel metal screen or other pervious corrosion-resistant material. The canister is annular in form with an enclosing top portion 15 so that it surrounds a space 16 immediately above an outlet pipe 17. An inlet pipe 18 is provided in the outside of the shell, and the space in the shell around the canister is filled with cotton wool 19. The inside of the canister is filled with a pervious mass of an inorganic solid 20, containing calcium, strontium or barium in elemental or combined form. Thus the canister

may be packed with twisted calcium foil, but for economic reasons it is desirable to fill the canister with pea-size or finer meshed lumps of say 8–14 or 14–30 mesh of calcium hydroxide or calcium carbide or a mixture of the two. Oil to be treated is introduced into the filter through the inlet, and forced through the cotton wool and the packing of alkaline earth metal or inorganic compound thereof to the outlet.

The tendency of the contact mass to escape from the filter is relatively slight. Lumps of calcium hydroxide are relatively friable in the air, but when once wetted with oil there is little tendency for them to break apart. The cotton wool is provided as a safeguard against the passage of calcium hydroxide, etc., into the engine. The cotton also serves to distribute the oil through the filter and thus prevents channeling. A conventional filter may be placed in the system following the filter of our invention as an additional safeguard.

As a further precaution against the escape of the packing into the engine, it is advisable to soak it with oil prior to installing the filter on the engine. This may be done conveniently by pumping oil through the filter, so that fine particles which tend to escape from the contact mass or packing may be removed prior to placing it in service in the lubricating system of the engine.

The filter of Fig. 2 is similar in principle to that of Fig. 1, but is somewhat more elaborate. As in the case of Fig. 1, a cylindrical metal shell **21** having a side inlet **22** and a bottom center outlet **23** is provided, the shell being sealed by a cover **24** and a gasket **25** held to an annular flange **26** on the shell by bolts **27**. The interior structure of the filter of Fig. 2 is, however, so constructed that the cotton wool **28** and the packing **29** containing the elemental alkaline earth metal or its inorganic compound are retained in a single canister **30** so that both may be removed together. The canister is a perforated cylindrical shell of Monel or the like having a lid **31** which is held on by a spring leaf **32** that bears against the edges of the lid and against the center of the outer cover. Within the canister is a central upright felt-covered perforated discharge pipe **33** which is coupled to the outlet. Disposed around the pipe is the packing **29** in the form of an annular pervious mass, preferably made by molding relatively coarse calcium hydroxide particles or pellets with a small amount of binder such as plaster of Paris. The cotton wool is packed in the canister inside and outside the pervious mass. The canister is raised slightly from the bottom of the shell by means of an upset annular ridge **34**.

The apparatus of Fig. 3 is similar to that of Fig. 1, except that a jacket 35 is provided outside the filter shell through which exhaust gases or other hot fluid may be passed from an inlet pipe **36** to an outlet pipe **37** to raise the temperature within the filter. Similarly, the apparatus of Fig. 4 is identical with that of Fig. 2, except for a jacket **38** through which a cooling fluid (say, water) may be passed from an inlet pipe **39** to an outlet pipe **40**.

A convenient method of handling the contact mass is to have the desired quantity made up in a light cloth, canvas, or metal mesh bag, so that when exhausted it may be quickly removed en masse and another unit installed. This is much more convenient than to handle oil saturated particles.

The application of our invention to the lubricating system of an internal combustion engine is shown in Fig. 9, in which an engine **41** is lubricated by means of oil forced into its crank case **42** through a pipe **43**. The oil is withdrawn from the crank case through a line **44**, and conducted into a filter **45** such as those shown in Figs. 1 to 4. After passing through the filter, the oil returns to the crank case of the engine through a pipe **46** which joins the pipe **43** at a T **47**. Extending from the T is a rate checking line **48** provided with a valve **49**. A valve **50** is provided in the line **43**.

A valved by-pass **51** connects the pipes **44** and **46** and a pressure gauge **52** is attached to the line **44** between the crank case and the filter. Gases from an exhaust manifold **53** of the engine may be conducted through a jacket **54** on the filter to heat it to optimum temperatures, the gases passing from the exhaust manifold to the jacket through a line **55** and being exhausted from the jacket through a second line **56**.

In operation, the oil is circulated substantially continuously through the crank case and the filter at the rate of about 3000 cc. per minute and at a temperature between 250° and 300° F. The rate of circulation required to keep the oil noncorrosive is, however, largely dependent upon the amount of oil in the lubricating system of the engine. If the oil content of the engine is large, the actual rate of circulation has to be increased so that a reasonably large fraction of the oil in the engine is contacted every minute. While the required fraction of the oil content contacted per minute is dependent also upon the severity of the engine service with respect to oxidation, a quantity between 25 per cent and 100 percent of the crank case contents should be contacted per minute. In the example cited, approximately 60 percent of the crank case contents are circulated per minute. The crank case holds about 5000 cc. of oil.

In a 50 hour test of lubricating oil containing about 1.33% of calcium phenyl stearate, this oil was circulated through a Waukusha engine of the type shown in Fig. 9 for a period of 50 hours. At intervals of ten hours, samples of the oil were withdrawn and subjected to analysis. Fig. 5 shows the results obtained when the oil was circulated through a filter containing a contact mass of calcium hydroxide as illustrated in Fig. 1, these results being contrasted with results obtained under exactly similar conditions, except that no contact mass was present in the filter.

The engine was run at 1000 R. P. M. The temperature of the oil in the crank case was about 250° F. Results obtained with the oil used in conjunction with the calcium hydroxide filter are shown with dotted lines, as contrasted with results obtained without the calcium hydroxide filter which are shown in solid lines. It will be observed that the use of the contact mass of inorganic alkaline metal solid (in this case, calcium hydroxide), was very effective in inhibiting the increase in viscosity of the oil during service. Thus, during 50 hours of service, the viscosity of the oil at 100° F. increased but slightly when the contact mass was used, but increased markedly when the mass was not used. Similar effects were observed in the case of viscosity measurements taken at 210° F.

Analysis of the oil for asphaltene content showed that there was practically no increase in the per cent of asphaltenes when the calcium hydroxide contact mass was employed, while service without the mass brought a very great

increase in the content of asphaltenes in the oil.

The saponification number and the acid number of the oil were also determined by analysis at the end of each ten hour interval of the above-described tests. Saponification numbers and acid numbers are indicative of the amount of deleterious decomposition products accumulating in the lubricant during service. The dotted lines in Fig. 6 indicate results obtained with the calcium hydroxide contact mass, while the solid lines indicate the results obtained without the use of calcium hydroxide. It will be observed that the use of the calcium hydroxide contact mass had a marked effect in inhibiting the increase in acid number and saponification number of the lubricant as contrasted with the case in which no such mass was employed.

The engine used in the above-described tests was equipped with cadmium-silver and so-called "Satco" bearings, so that the corrosion-inhibiting effect of the contact mass with respect to such bearings could be determined. The cadmium-silver bearings contained approximately 99% cadmium and 1% silver. The approximate composition of the "Satco" bearings was 95% lead, 3 to 4% sodium or calcium, and 1–2% of other metals as impurities.

The bearings were weighed at the beginning of service, and at the end of 25 hours and 50 hours, respectively, of service. Fig. 7 shows the results obtained, the solid lines indicating the extent of corrosion when no contact mass was used, as contrasted with the results obtained when a calcium hydroxide contact mass was employed. The results show that with either cadmium-silver or "Satco" bearings there is practically no corrosion when an inorganic alkaline metal contact mass is employed, whereas without such mass the corrosion is excessive.

The temperature of the oil in contact with the bearings during the tests, as indicated above, was about 250° F.

Tests of copper-lead and cadmium-silver bearings in service in the engine of Fig. 9 at a crank case temperature of 250° F. and for a period of 200 hours confirm the results shown in Fig. 7, and show further that the rate of corrosion of bearings continues to be almost negligible over a period of long and severe service provided that the lubricant is passed repeatedly in contact with a solid containing an alkaline earth metal either in elemental form or as an inorganic compound. Fig. 8 shows graphically the amount of corrosion resulting when cadmium-silver bearings containing approximately 99% cadmium and 1% silver and copper-lead bearings (typical analysis 43% copper, 57% lead) were placed in service in the hereinbefore-described engine for 200 hours at a crank case temperature of about 250° F. and lubricated with the hereinbefore-described oil containing calcium-phenyl-stearate, which was circulated through a contact mass of calcium hydroxide at a rate of about 3000 cc. per minute. The extent of corrosion is shown by the heavy lines. Both in the case of cadmium-silver and copper-lead, the corrosion was practically negligible. For purpose of comparison, the test results obtained with cadmium-silver bearings without the use of a calcium hydroxide contact mass (as described in conjunction with Fig. 7) are shown in Fig. 8 with a dotted line.

Similar tests conducted at temperatures below 250° F. indicate that the corrosion inhibitive effect of a contact mass containing an alkaline earth metal in elemental combined inorganic form is less marked, while tests conducted at higher temperatures, say up to 300° F., indicate an improvement in the corrosion inhibitive effect of such contact masses.

It is apparent that the beneficial results obtained through circulating oil containing a soap of an alkaline earth metal in contact with a contact mass containing an alkaline earth metal in elemental or combined inorganic form are not to be explained solely on the ground that acids originally present or formed in the oil during service are neutralized. This is shown by the fact that corrosion is inhibited by the elements themselves and by compounds thereof such as the carbides which are neutral or acid in reaction. On the contrary, it would appear that the alkaline earth metals in elemental or combined inorganic form under certain conditions of operation exert a catalytic effect to reduce the rate of oxidation of oxidizable constituents in the oil with resultant decrease in the amount of sludge and oil acids formed. This may be explained by reference to the following analyses of new oil containing calcium phenyl stearate (test 1), this oil after 24 hours' service at 250° F. in a lubricating system equipped with a calcium hydroxide contact mass (test 3), this oil after 24 hours' service at 190° F. in a lubricating system equipped with a calcium hydroxide contact mass (test 4), and this oil in service for 24 hours without benefit of contact with calcium hydroxide (test 2).

	Test numbers			
	1	2	3	4
Rate of passage through contact mass			100	30
Temp. of oil entering contact mass, °F			250	190–200
Temp. of oil leaving contact mass, °F			210	160–170
A. S. T. M. insolubles		70.6	1.4	3.1
Viscosity at 100° F	579		742	882
Viscosity at 210° F	57.9	68.2	59.9	63.0
Neutralization number	0.213	3.62	0.718	1.40
Saponification number	1.98	17.8	5.04	6.63
Calcium content, per cent	0.067	0.067	0.170	0.116
Added titre			2.88	1.37
Actual reduction in neutralization number			2.90	2.22
Actual reduction in saponification number			12.8	11.2

In each instance inspection of the contact mass after service indicated that it had not picked up appreciable sludge or soap. Hence, the results indicate that the calcium hydroxide contact mass brought about a lessening in sludge formation and viscosity rise, as compared with the case (test 2) in which the mass was not employed. The lessened sludge formation (A. S. T. M. insolubles) and the lessened viscosity rise indicate that the contact mass causes a decrease in oxidation rate of constituents in the oil.

More cogent evidence that the benefits of the contact mass are attributable to inhibition of the oxidation rate of constituents in the oil, as well as to neutralization of the oxidation products, is furnished by comparing the amount of calcium absorbed by the oil in each case with the respective amounts of unsaponified but saponifiable oxidation products present. Thus in test 3 the reduction in neutralization number was 2.90, which is a measure of the decrease in the proportion of unsaponified oxidation products. However, this lower proportion of unsaponified oxidation products is not to be explained upon the basis of increased calcium content of the oil after

service in test 3, since this increased calcium content would only be sufficient to bring about a decrease of 2.88 in saponification number. In test 3, and likewise in test 4, there was an actual decrease in the rate at which saponifiable oxidation products formed, and this we attribute to the catalytic effect of the contact mass.

The beneficial effects obtained through the use of contact masses of elemental alkaline earth metals or inorganic compounds thereof apparently are peculiar to these substances. Thus magnesium and its inorganic compounds do not exert such an effect, nor do the hydroxides of iron, chromium, nickel or aluminum. Moreover, tests conducted with oils containing aluminum soaps (employing as a contact mass aluminum or an inorganic compound thereof) showed, surprisingly enough, that aluminum and its inorganic compounds do not exert an effect in oils containing aluminum soaps analogous to the effect of the alkaline earth metals and their compounds upon oils containing their soaps.

Barium and strontium hydroxides are usually obtained as crystals and lose water at relatively low temperatures. For use in the practice of this invention, these hydroxides should be dehydrated at about 400° F. The resulting dry powders may then be briquetted in a mold by compression under a steam hammer and thereafter chipped and screened to size. Calcium hydroxide for use in the practice of the invention should be treated by making it into a thick paste with water. The paste is then dried, preferably in an atmosphere free from CO_2, ground in an ice chipper or the like and screened to size.

We claim:

1. In the operation of a system for lubricating bearing surfaces with a petroleum base lubricating oil containing a soap of an alkaline earth metal which involves repeated contacting of said oil from a body thereof with the surfaces to be lubricated and circulation of said oil through a treating zone, the improvement which comprises bringing the oil in said treating zone into contact with a solid selected from the group consisting of the alkaline earth metals and inorganic compounds thereof at a rate sufficient to bring into contact with said solid an amount of oil equivalent to a substantial part of said body of oil per minute, and controlling the temperature of the oil in said treating zone to maintain the oil in contact with said solid at a temperature between about 140° F. and 300° F.

2. In the operation of a system for lubricating bearing surfaces with a petroleum base lubricating oil containing a soap of an alkaline earth metal which involves repeated contacting of said oil from a body thereof with the surfaces to be lubricated and circulation of said oil through a treating zone, the improvement which comprises passing the oil in said treating zone through a contact mass containing exposed surfaces of a solid selected from the group consisting of the alkaline earth metals and the oxides, hydroxides, carbonates and carbides thereof at a rate sufficient to bring into contact with the exposed surfaces of said solid an amount of oil equivalent to a substantial part of said body of oil per minute, and controlling the temperature of the oil in said treating zone to maintain the oil in contact with said solid at a temperature between about 140° F. and 300° F.

3. In the operation of a system for lubricating bearing surfaces with a petroleum base lubricating oil containing a soap of an alkaline earth metal which comprises repeated contacting of said oil from a body thereof with the surfaces to be lubricated and circulation of said oil through a treating zone, the improvement which comprises passing the oil in said treating zone through a porous medium comprising a solid selected from the group consisting of the alkaline earth metals and inorganic compounds thereof at a rate sufficient to bring into contact with said solid an amount of oil equivalent to about 25%–100% of said body of oil per minute while maintaining said medium at an elevated temperature.

4. In the operation of a system for lubricating an internal combustion engine with a petroleum base lubricating oil containing a soap of an alkaline earth metal which involves repeated contacting of said oil from a body thereof with the surfaces to be lubricated and circulation of said oil through a treating zone, the improvement which comprises passing the oil in said treating zone at a relatively elevated temperature through a porous medium comprising a solid selected from the group consisting of the alkaline earth metals and inorganic compounds thereof at a rate sufficient to bring into contact with said solid an amount of oil equivalent to about 25%–100% of said body of oil per minute.

5. In the operation of a system for lubricating an internal combustion engine with a petroleum base lubricating oil containing a calcium soap which involves repeated contacting of said oil from a body thereof with the surfaces to be lubricated and circulation of said oil through a treating zone, the improvement which comprises passing the oil in said treating zone in contact with a porous mass comprising a solid selected from the group consisting of metallic calcium and inorganic compounds thereof at a rate sufficient to bring into contact with said solid an amount of oil equivalent to a substantial part of said body of oil per minute and controlling the transmission of heat to the oil passing through said treating zone to maintain the oil in contact with said solid at a temperature between 140° F.–300° F.

6. In the operation of a system for lubricating an internal combustion engine with a petroleum base lubricating oil containing a calcium soap which involves repeated contacting of said oil from a body thereof with the surfaces to be lubricated and circulation of said oil through a treating zone, the improvement which comprises passing the oil in said treating zone through a porous mass comprising calcium hydroxide at a rate sufficient to bring into contact with said calcium hydroxide an amount of oil equivalent to a substantial part of said oil body per minute and controlling the temperature of the oil in said treating zone to maintain a temperature approximating 250° F.–300° F.

7. In the operation of a system for lubricating bearing surfaces of cadmium-silver-alloy with a petroleum base lubricating oil containing a soap of an alkaline earth metal which involves repeated contacting of said oil from a body thereof with the surfaces to be lubricated and circulation of said oil during service through a treating zone, the improvement which comprises bringing the oil containing said soap in said treating zone into contact with a solid selected from the group consisting of the alkaline earth metals and inorganic compounds thereof at a rate sufficient

to bring into contact with said solid an amount of oil equivalent to about 25%–100% of said body of oil per minute.

8. In the operation of a system for lubricating bearing surfaces of lead-copper-alloy with a petroleum base lubricating oil containing a soap of an alkaline earth metal which involves repeated contacting of said oil from a body thereof with the surfaces to be lubricated and circulation of said oil during service through a treating zone, the improvement which comprises bringing the oil containing said soap in said treating zone into contact with a solid selected from the group consisting of the alkaline earth metals and inorganic compounds thereof at a rate sufficient to bring into contact with said solid an amount of oil equivalent to about 25%–100% of said body of oil per minute.

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