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EXTREME PRESSURE LUBRICATING COMPOSITIONS

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14 Claims. (Cl. 87—9)

This invention relates to new and useful compositions of matter and to methods of preparing the same. In particular, it relates to the preparation of lubricating compositions, particularly of the type known generally as "extreme pressure lubricants", such, for example, as will satisfy the severe requirements demanded in the proper lubrication of hypoid and the like gears, and bearing surfaces, metal cutting tools, and the like, subjected to unusually heavy loads per unit area of bearing surface.

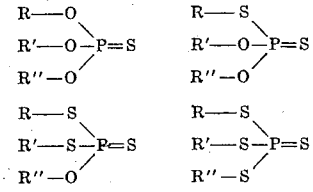
In general, the primary requirement of such an "extreme pressure lubricant" is that it shall possess high lubricating film strength; preferably it also has low rates of wear and low coefficients of friction, and it is an object of the present invention to disclose and provide a novel type of lubricating composition which fulfills these requirements. It is a further object of this invention to disclose and provide extreme pressure lubricants that do not suffer a loss or deterioration of high film strength, low rate of wear, or low coefficients of friction in long-continued use under severe conditions, and which have no tendency to cause gumming or fouling of the lubricated metal parts or surfaces under such long continued service.

As now known, one class of compositions designed for use as "extreme pressure lubricants" comprises mineral lubricating oils to which have been added, preferably in oil-soluble form, sufficient amounts of various active agents discovered to possess the properties of increasing the film strength and/or decreasing wear and/or decreasing coefficients of friction of the mineral oil base to which they have been added. Mineral oil lubricants containing added metallic soaps, notably lead soaps, and/or sulfurized fatty acids or fatty oils, such as sulfurized animal or vegetable oils, are examples of such compositions. Certain of the compositions of this type have the very serious defects that they tend to cause gumming of the metal parts; certain of them tend to separate into their constituent parts upon long continued subjection to severe operating conditions. Another class of compositions, designed for such service comprises mineral lubricating oils, either alone or in admixture with fatty oils, to which has been added sulfur in elemental or uncombined form. Compositions containing such uncombined sulfur have the serious defect that they cause undue corrosion and wear of the metal parts to be lubricated, or the parts adjacent thereto, such as bushings, etc., which result not only in deterioration of the said metal parts but lead directly to a short life of the lubricating compositions themselves.

I have now discovered that the addition of small amounts of esters of thiophosphoric acids, in admixture with hydrocarbon or fatty lubricating oils, provide lubricating compositions which satisfy all of the primary requirements of extreme pressure lubricants, and, in addition, are stable in long continued use, do not separate into their constituent parts and do not tend to gum, foul or corrode metal surfaces.

The amounts of thiophosphates required to be added to hydrocarbon or fatty lubricating oils for the preparation of the compositions of my invention vary somewhat, depending upon the severity of the service for which they are designed and, to some extent, upon the character of the hydrocarbon or fatty lubricating stock used as a base; these amounts are in all cases small, however, compared with the amounts of active agents of the prior types, and in general vary between about 1% and about 5% of the oil base, by weight.

The thiophosphates to be added to mineral or fatty lubricating oils may contain one, two, three or four sulfur atoms per thiophosphate group, and may thus correspond to any one of the following type compounds:



in which R, R' and R'' represent any aliphatic or aromatic radicals which may or may not contain another thiophosphate group such as is here described; the compositions may contain mixtures of any two or more compounds of these types.

In these compositions I have found that that sulfur atom doubly bonded to phosphorus is the most effective in increasing film strength, and I therefore preferably employ thiophosphates in which at least one of the sulfur atoms is thus doubly bonded; this is to say that if a compound containing but one sulfur atom is to be employed, I prefer to employ a thion-, rather than a thiol-compound.

As examples of the compositions of my invention, I describe below its practice in connection with two specific thiophosphates, representative

of the general class of compounds contemplated for use in extreme pressure lubricants of this type.

Example 1.—I dissolved 2.0% by weight of triphenylthiophosphate in a viscous mineral lubricating oil stock, and tested the composition thus prepared on the Timkin film strength testing machine described by O. L. Maag in the National Petroleum News for November 16, 1932, page 53, article entitled "Extreme Pressure Lubricants". The "O. K. load in pounds" or the "load carrying capacity" of the prepared lubricant was found to be 820 pounds, whereas the mineral lubricating stock itself, when tested alone under identical testing conditions, gave an "O. K. load in pounds" or "load carrying capacity" of 150 pounds.

In this case my triphenylthiophosphate contained 9.4 weight percent of sulfur, and, by employing it in an amount of 2.0% by weight of the oil, I introduced but 0.19% sulfur into the finished lubricating composition.

Example 2.—Again, I prepared a composition containing 2.0 weight percent of triamylthiophosphate, using the same mineral lubricating stock used above. On the Timkin film strength testing machine this composition gave an "O. K. load in pounds" or a "load carrying capacity" of 370 pounds. This triamylthiophosphate contained 10.0% sulfur, and by incorporating it in a lubricating stock at 2.0% by weight, I therefore introduced but 0.20% sulfur into the finished extreme pressure lubricant.

In place of the phenyl and amyl derivatives in the above example, ethyl, benzyl, and the like esters of thiophosphoric acid may be used, with comparable and equally satisfactory results.

In the preparation of the compositions of my invention, the desired thiophosphate or mixture of thiophosphates in suitable amounts, is admixed with a hydrocarbon or fatty lubricating oil and the admixture merely agitated mechanically in order to obtain complete and homogeneous solution. I have found in general that the thiophosphates are easily soluble in hydrocarbon and fatty oils, and that no difficulty is encountered in incorporating them therein.

A particular feature of my invention lies in the preparation of bases or concentrates containing relatively large amounts of thiophosphates in admixture with hydrocarbon or fatty oils. Such concentrates may be stored or transported in this form and before actual use in extreme pressure lubrication service may be diluted with the same or other lubricating oil to any desired concentration. Admixtures of the thiophosphate and lubricating oils containing upward of 50% of my active agents, by weight, may in this way be prepared. In preparing concentrates or bases of this character complete solution of thiophosphate is not in all cases necessary, although most of them are freely oil-soluble to this extent. Blending agents, such as amyl or higher alcohols, may be employed as homogenizers in the case of those thiophosphates not freely oil-soluble to this exent, if desired; incorporation of the less soluble active agents in suspended form, however, is sufficient to allow the thiophosphates to function in decreasing film strength in actual use.

Obviously the character and viscosity of the lubricating oil to which the thiophosphate is added will be dependent to some extent upon the character of service to which the composition is ultimately to be put, and I am not to be limited in the character of the lubricating composition used as a base in the preparation of my compositions.

For example, the life of metal cutting tools is very remarkably lengthened by the incorporation of small amounts of thiophosphates in either the mineral hydrocarbon or fatty oils used ordinarily in this service. Moreover, miscible metal cutting oils may be prepared in which the usual oil component is replaced with an oil containing small amounts of thiophosphates in solution; the life of the cutting tools is greatly lengthened and the character of the metal surfaces cut much improved, especially in severe cutting service. Further, semi-solid and solid lubricating greases may be prepared, in the usual manner, wherein small amounts of thiophosphates may be incorporated in the hydrocarbon and fatty oils ordinarily used therein; the lubricating film strength is in all cases increased to a degree comparable to the increases pointed out in the examples above.

While I have described in detail the character of my invention and given illustrative examples of the preparation and application of the compositions of my invention, I have done so by way of illustration only and with the intention that no limitation should be imposed upon the invention thereby. It will be obvious to one skilled in the art that numerous modifications and variations of the above illustrative examples may be effected in the practice of my invention, which, broadly, includes within its scope any and all lubricating compositions containing thiophosphates incorporated therein.

I claim:

1. A composition of matter comprising an admixture of a lubricating oil and an ester of a thiophosphoric acid.

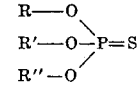
2. A composition of matter comprising an admixture of a hydrocarbon lubricating oil and an ester of a thiophosphoric acid.

3. A composition of matter comprising a hydrocarbon oil containing between about one and about five percent of an ester of a thiophosphoric acid, by weight.

4. A lubricating composition containing a lubricating oil and an organic ester of a thiophosphoric acid.

5. A lubricating composition containing a lubricating oil and an ester of a thiophosphoric acid in which at least one sulfur atom is doubly bonded to phosphorus.

6. A lubricating composition containing a lubricating oil and a compound of the type—



in which R, R', and R'' represent any aliphatic or aromatic radicals, and in which any or all oxygen atoms may be replaced by sulfur atoms.

7. A lubricating composition containing a lubricating oil and triphenyl thiophosphate.

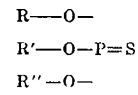
8. A lubricating composition containing a lubricating oil and triamyl thiophosphate.

9. An extreme pressure lubricant base containing an oil and an ester of a thiophosphoric acid, capable of dilution with a lubricating oil to produce an extreme pressure lubricant containing between about one and about five weight percent of the said ester of the said thiophosphoric acid.

10. An extreme pressure lubricant base containing 50 or more percent by weight of an ester of a thiophosphoric acid in admixture with an oil.

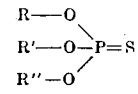
11. A composition of matter consisting of a

hydrocarbon lubricating oil and a compound of the type



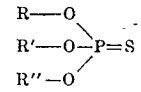
in which R, R' and R'' represent any aliphatic or aromatic radicals, and in which any or all oxygen atoms may be replaced by sulfur atoms.

12. A lubricating composition comprising a lubricating oil containing between about one and about five per cent by weight of a compound of the type



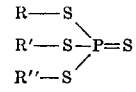
in which R, R' and R'' represent aliphatic or aromatic radicals, and in which one oxygen atom is replaced by sulfur.

13. A lubricating composition comprising a lubricating oil containing between about one and about five percent by weight of a compound of the type



in which R, R' and R'' represent aliphatic or aromatic radicals, and in which two oxygen atoms are replaced by sulfur.

14. A lubricating composition comprising a lubricating oil containing between about one and about five per cent by weight of a compound of the type



in which R, R' and R'' represent aliphatic or aromatic radicals.

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