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EXTREME PRESSURE LUBRICATING COMPOSITIONS

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This invention relates to new and useful com-
positions of matter and to methods of preparing
the same. In particular, it relates to the prepara-
tion of lubricating compositions, particularly of
5 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 bear-
ing surfaces, metal cutting tools, and the like,
10 subjected to unusually heavy loads per unit area
of bearing surface, and has reference to the in-
corporation in lubricating compositions of certain
derivatives of organic thio acids.

In general, the primary requirement of such
15 an "extreme pressure lubricant" is that it shall
possess high lubricating film strength; prefer-
ably it also has low rates of wear and low co-
efficients of friction, and it is an object of the
present invention to disclose and provide a novel
20 type of lubricating composition which fulfills these
requirements. It is a further object of this in-
vention 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 co-
25 efficients 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.

30 As now known, one class of compositions de-
signed for use as "extreme pressure lubricants"
comprises mineral lubricating oils to which have
been added, preferably in oil-soluble form, suf-
ficient amounts of various active agents dis-
35 covered to possess the properties of increasing the
film strength and/or of decreasing wear and/or
of decreasing coefficients of friction of the min-
eral base to which they have been added. Mineral
oil lubricants containing added metallic soaps,
40 notably lead soaps, and/or sulfurized fatty acid
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
45 of the metal parts; certain of them tend to sepa-
rate into their constituent parts upon long con-
tinued subjection to severe operating conditions.

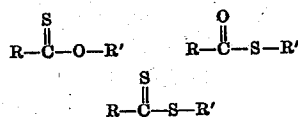
Another class of compositions designed for
such service, comprises mineral lubricating oils,
50 either alone or in admixture with fatty oils, to
which have been added sulfur in elemental or un-
combined form. Compositions containing such
uncombined sulfur have the serious defects that
they cause undue corrosion and wear of the
55 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 lubricat-
ing compositions themselves.

60 We have now discovered that the addition of

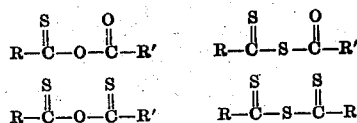
small amounts of organic derivatives of organic
thio acids, particularly the esters and "anhy-
drides" of organic thio acids, in admixture with
hydrocarbon or fatty lubricating oils, provide
lubricating compositions which satisfy all of the
primary requirements of extreme pressure lubri-
cants, and, in addition, are stable in long con-
tinued use, do not separate into their constituent
parts and do not tend to form gum, or to foul or
corrode metal surfaces.

The amounts of the said derivatives of organic
thio acids required to be added to hydrocarbon
or fatty lubricating oils for the preparation of
the compositions of our invention vary somewhat,
depending upon the severity of the service for
15 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,
20 and in general vary between about $\frac{1}{2}$ of 1%
and about 5% of the oil base, by weight.

The esters and "anhydrides" of organic thio
acids to be added to mineral or fatty lubricating
oils in preparing the compositions of this inven-
tion correspond to the like derivatives of ordinary
carboxylic acids, in which one or more oxygen
atoms are replaced by sulfur atoms. They may
thus correspond to any one of the following
type formulae:



in which thio esters R and R' represents any
organic radical, whether alkyl, aryl or aralkyl, as
well as the following:



in which "anhydrides" of thio acids R and R'
likewise represent any organic radical, whether
alkyl, aryl or aralkyl.

It will thus be apparent from a consideration
of the above type formulae that the aryl, alkyl
and aralkyl esters of the aliphatic thio fatty acids,
such as thio acetic acids, thio valeric acid, thio
oleic acid, and the thio naphthenic acids, and the
thio carboxylic acids, as well as the "anhydrides"
of these said type thio acids, are contemplated
to be added to mineral or fatty lubricating oils in
preparing therefrom extreme pressure lubricating
compositions in accordance with our invention.
These compounds are generally oil soluble to the
extent required in the practice of our invention,

and they are likewise generally stable to heat at temperatures of 300° F. or above.

As typical of the results accomplished by the addition of the said derivatives of organic thio acids to lubricating oils, reference is made to the accompanying tabulation, in which three distinct types of sulfur linkage are represented, exemplifying each of the types of sulfur linkage referred to hereinabove and found to be operative to markedly increase the film strength of the lubricating compositions in which they are caused to be present.

Example	Type formula	Sulfur content, percent by weight	Amount added, percent by weight	Sulfur final oil solution, percent by weight	Timken film strength, steel on steel, total load in pounds
I. o-Ethyl thio-benzoate	$\begin{array}{c} \text{S} \\ \\ \text{R}-\text{C}-\text{O}-\text{R}' \end{array}$	19.3	2.0	0.39	340
II. s-Ethyl thio-benzoate	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{S}-\text{R}' \end{array}$	19.3	2.0	0.39	320
III. Benzyl thio-benzoate	$\begin{array}{c} \text{S} \\ \\ \text{R}-\text{C}-\text{S}-\text{R}' \end{array}$	26.2	2.0	0.52	420
Mineral oil stock, 175 vis. at 210° F., universal Saybolt			None		150

In the respective columns in the above tabulation there are set out: First, typical derivatives of thio acids, representative of a great number which may suitably be used in the practice of our invention; second, the type formula of the said thio acid derivatives, particularly setting out the sulfur linkage therein; third, the amount of combined sulfur in each of the said thio acid derivatives, in percentage by weight; fourth, the amount of each of the thio acid derivatives added to a mineral hydrocarbon lubricating oil base batch (kept uniform in amount here only for the purposes of exemplification); fifth, the amount of sulfur in each of the finished extreme pressure lubricants, in percentage by weight; sixth, the film strength of the finished lubricating compositions, as measured on the Timken machine described by O. L. Maag in the National Petroleum News for November 16, 1932, page 53, article entitled "Extreme pressure lubricants", wherein the "O. K. load in pounds", or the "load carrying capacity" of the lubricant, is directly measured. In the above exemplifying tabulation the same mineral oil stock was used throughout.

In the preparation of the compositions of our invention, the desired thio acid derivative or mixture of thio acid derivatives, in suitable amounts, is admixed with a hydrocarbon or fatty mineral oil and the admixture merely agitated mechanically in order to obtain complete and homogeneous solution. We have found in general that the organic esters and the "anhydrides" of the organic thio acids are easily soluble in hydrocarbon and fatty oils to the extent required, and that no difficulty is encountered in incorporating them therein.

A particular feature of our invention lies in the preparation of bases or concentrates containing relatively large amounts of thio acid derivatives 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 thio acid derivatives and lubricating oils containing upward of 50% of our active agents, by weight, may in this way be prepared. In preparing concentrates or bases of this character complete solution of the thio acid derivative 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 thio acid derivatives not freely oil soluble to this extent, if desired; incorporation of the less soluble active agents in suspended form, however, is sufficient to allow these esters and "anhydrides" of the organic thio acids to function in decreasing film strength in actual use.

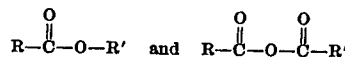
Obviously the character and viscosity of the lubricating oil in which the thio acid derivatives are added will be dependent to some extent upon the character of service to which the composition is ultimately to be put, and we are not to be limited in the character of the lubricating composition used as a base in the preparation of our compositions. For example, we have found that the life of metal cutting tools is very remarkably lengthened by the incorporation of small amounts of esters of organic thio acids and of "anhydrides" of organic thio acids in either the mineral hydrocarbon or fatty oils used ordinarily in this service. Moreover, we have prepared miscible metal cutting oils in which the usual oil component is replaced with an oil containing small amounts of these thio acid derivatives in solution and have found that 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 these thio acid derivatives 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 example tabulated above.

While we have described in detail the character of our invention and given numerous illustrative examples of the preparation and application of the compositions of our invention, we have done so by way of illustration and with the intention that no limitation should be imposed upon the invention thereby. It will be obvious to those skilled in the art that numerous modifications and variations of the above illustrative examples may be effected in the practice of our invention, which is of the scope of the claims appended hereto.

We claim:

1. A composition of matter comprising an admixture of a lubricating oil and an organic derivative of an organic thio acid.

2. A composition of matter comprising an admixture of a lubricating oil and a compound of the class consisting of the types—



in which at least one oxygen atom is replaced by a sulfur atom, and in which R and R' represent any alkyl, aryl or aralkyl radical.

3. A composition of matter comprising an admixture of a hydrocarbon lubricating oil and an organic derivative of an organic thio acid.

4. A composition of matter comprising an admixture of a hydrocarbon lubricating oil and an organic ester of an organic thio acid.

5. A composition of matter comprising an ad-

mixture of a hydrocarbon lubricating oil and an "anhydride" of an organic thio acid.

6. A composition of matter comprising a lubricating oil containing between about 0.5 and about 5.0 per cent by weight of an organic derivative of an organic thio acid.

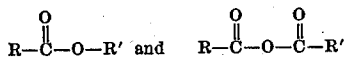
7. A lubricating composition containing a lubricating oil and an ethyl thio benzoate.

8. A lubricating composition containing a lubricating oil and benzyl thiobenzoate.

9. An extreme pressure lubricant base comprising an oil and an organic derivative of a thio acid, capable of dilution with a lubricating oil to produce an extreme pressure lubricant containing between about 0.5 and about 5.0 per cent by weight of the said thio acid derivative.

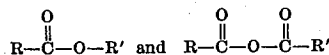
10. An extreme pressure lubricant base containing 50 or more per cent by weight of an organic derivative of a thio acid in admixture with an oil.

11. A composition of matter consisting of a hydrocarbon lubricating oil and a compound of the class consisting of the types—



in which at least one oxygen atom is replaced by a sulfur atom, and in which R and R' represent any alkyl, aryl or aralkyl radicals.

12. A composition of matter consisting of a hydrocarbon lubricating oil containing between about 0.5 and about 5.0 per cent by weight of a compound of the class consisting of the types—



in which one or more oxygen atoms are replaced by sulfur atoms, and in which R and R' represent any alkyl, aryl or aralkyl radicals.

13. A lubricating composition comprising a lubricating oil containing between about 0.5 and about 5.0 per cent by weight of an ethyl thio benzoate.

14. A lubricating composition comprising a lubricating oil containing between about 0.5 and about 5.0 per cent by weight of a benzyl thio benzoate.

15. An extreme pressure lubricant base comprising an oil containing an organic ester of an organic thioacid, capable of dilution with a lubricating oil to produce an extreme pressure lubricant containing between about 0.5 and about 5.0 per cent by weight of the said organic ester of the said organic thioacid.

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