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LUBRICANT

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13 Claims. (Cl. 87-9)

This invention relates to lubricants and partic-
ularly to the inhibiting of corrosion by lubricants.

In recent years there has been a marked tend-
ency toward the use of bearing alloys which are
not of the Babbitt type. Prominent among the
newer alloys in use are those consisting essen-
tially of cadmium and silver and known to the
trade as silver-cadmium bearings. These bear-
ings have advantages over the older Babbitt types
particularly because of their greater hardness
and strength permitting the use of smaller bear-
ings operating at higher unit bearing loads.

The general use of these bearings is, however,
seriously hampered by their lack of resistance to
corrosion when used in combination with certain
mineral lubricants. This undesirable condition is
particularly serious because many of the lubri-
cants which have the much desired properties of
high viscosity index, low pour point, freedom from
sludge and high stability have the undesirable
property of being highly corrosive to silver-cad-
mium bearings.

An object of the present invention is to provide
materials which, when added to lubricating oils
reduce the tendency of the oils to corrode silver-
cadmium bearings. Another object is to pro-
vide, in combination with a bearing metal of the
cadmium-silver bearing type, means for lubri-
cating such bearings comprising a lubricating oil
having incorporated therein a material which
will inhibit corrosion of the bearing metal by the
oil. Further objects are to provide new compos-
itions of matter and to advance the art. Still
further objects will appear hereinafter.

These objects may be accomplished in accord-
ance with my invention which comprises employ-
ing, in combination with a bearing metal of the
cadmium-silver alloy type, means for lubricating
the bearing metal which comprises a lubricating
oil normally tending to corrode said bearing metal
and having incorporated therein in an amount
sufficient to inhibit said corrosion an organic
ester of a phosphoric acid. This invention is
based upon the discovery that oils, which are
particularly corrosive toward silver-cadmium
bearing metals, can be tremendously improved
by the addition to the oil of small quantities of
alkyl or aryl phosphates. We have also found
that the corrosiveness of oils, which are generally
considered satisfactory for use with these bear-
ings, can be further improved in this respect by
the addition of similar compounds.

Examples of the effect of the addition of these
compounds to oils of considerably different type
are given in the table below.

The method of testing the corrosiveness was as
follows:

A sample of the oil to be tested was placed in
a large glass test-tube which was immersed in a
bath kept at a temperature of 350° F. A glass
tube connected to an air supply was inserted in
the test-tube. The oil was then placed in the
test-tube and weighed strips of the metal to be
tested suspended in the oil. When the test oil
reached the proper temperature, air was bubbled
into the oil at a rate of 10 liters per hour. After
72 hours, the test pieces were removed, washed
free of oil and weighed. The loss in weight is re-
corded in mg./sq. in.

Oil A

Saybolt Universal viscosity (at 100° F.) 3030
Saybolt Universal viscosity (at 210° F.) 145
Viscosity index 90
Pour point ° F. 25

Oil A represents the type which has caused con-
siderable trouble from corrosion of silver-cad-
mium bearings.

Oil B

Saybolt Universal viscosity (at 210° F.) 60
Saybolt Universal viscosity (at 100° F.) 633
Viscosity index 40
Pour point ° F. 5

Oil B is from a different base than Oil A.

The results of test on these two oils as well as
the same oils containing the compounds of our
invention are tabulated below:
Compound P-1—Technical tricresyl phosphate.
Compound P-2—A mixture of the mono and di-
phosphates of C₈ and C₁₀ straight chain pri-
mary alcohols.

Change in weight of test piece mg./sq.in. in 72
hours

	No ad- dition	Plus 1% compound P-1	Plus 1% compound P-2
Oil A	60	7	21
Oil B	47	35	4

The very considerable improvement obtained
by the addition of the phosphate esters is obvious.
The greater effect obtained on Oil A is due to the
fact that this type of oil is particularly cor-
rosive to this type of bearing metal.

Other compounds which may be employed in accordance with my invention are:

- Dilauryl phosphate
- Dicetyl phosphate
- 5 Dicyclohexyl phosphate
- Dioleoyl phosphate
- Trinaphthyl phosphate
- (1) Di-"Lorol" phosphate
- Lecithin
- 10 (2) A mixed phosphate ester of "Lorol" and "Ocenol"
- β -Naphthylamine salt of di-"Lorol" phosphate
- Dilauryl dithio phosphate
- 15 Diethyl phosphate
- Triethyl phosphate
- Mixed cyclohexyl-cyclohexyl phosphates
- Tri-"Ocenol" phosphate
- Tributyl phosphate
- 20 Dioctyl phosphate
- Mixed octyl lauryl phosphate (di-ester)
- Tri-methylricinoleyl phosphate
- Lauroxy-ethanol phosphate
- 25 The monophosphate of the diglyceride obtained by partial hydrolysis of linseed oil
- Mixed phosphate esters of hydroxy stearic acid
- Di-phenyl phosphate
- Di-cresyl phosphate
- 30 Tri-nitrophenyl phosphate
- Mixed tertiary amylphenyl phosphates
- Mixed dodecahydro-diphenylol-propane phosphates
- Mixed mono- and di-decahydro- β -naphthyl phosphates
- 35 Mixed tetrahydro- β -naphthyl phosphates
- Di-"Lorol" cresyl phosphate
- Dibutylamine salt of mixed phosphates of "Lorol"
- 40 Benzylamine salt of mixed phosphates of "Lorol"
- Amylamine salt of mixed phosphates of "Lorol"
- Mixed mono- and di-butyl phosphates
- 45 Dilauryl trithio phosphate
- Diamyl dithiophosphate
- Triphenyl monothio phosphate
- Dioleoyl dithio orthophosphate
- Tristearyl dithio orthophosphate
- 50 Trimyristyl monothio orthophosphate
- Monomyristyl monothio metaphosphate
- Monocetyl monothio orthophosphate
- Trilauryl trithio orthophosphate
- Dicetyl monothio orthophosphate
- 55 Tetracetyl dithio pyrophosphate
- Trilauryl tetrathio orthophosphate
- Tetramyristyl trithio pyrophosphate
- Tetraeicosyl pentathio pyrophosphate
- Tri-hexoxyphenyl phosphate
- 60 Methyl diphenyl monothio phosphate
- Ethyl diphenyl monothio phosphate
- Dimethyl phenyl monothio phosphate
- Methyl dicresyl monothio phosphate
- Trilauryl monothio orthophosphate
- 65 Mono decyl monothio phosphate
- Tricresyl monothio phosphate
- Tricresyl dithio phosphate
- Tricresyl trithio phosphate
- Triphenyl dithio phosphate
- 70 Triphenyl trithio phosphate
- Triphenyl tetrathio phosphate
- Tricresyl tetrathio phosphate
- Dicresyl dithio phosphate
- Diphenyl dithio phosphate
- 75 Trinaphthyl monothio phosphate

(3) Di-naphthenyl ortho phosphate

(3) Di-naphthenyl dithio phosphate

(1) This is a mixture of phosphates obtained by reacting an esterifying derivative of ortho-phosphoric acid with the mixture of primary normal aliphatic alcohols of 8 and 10 carbon atoms resulting from the carboxylic reduction of coconut and/or palm kernel oils and known as "Lorol" alcohols.

(2) "Ocenol" comprises a mixture of primary aliphatic alcohols containing 12 to 18 carbon atoms, having an iodine number of about 50 and is mostly oleyl alcohol.

(3) These are mixed esters prepared from the mixture of alcohols obtained by the carboxylic reduction of the naphthenic acids from petroleum.

Similar compounds may be prepared from other alcohols such as decyl, undecenyl, ceryl eleosteryl, linoleyl, ricinoleyl, abietyl, cyclohexanol, ethyl octyl, tertiary amyl, butyl, propyl, benzyl, dodecahydro-diphenylol-propyl, naphthenyl, and mixtures thereof, particularly mixtures obtained by carboxylic reduction of naturally occurring fatty oils. Other aromatic esters may be prepared from phenol, cresols, naphthols, nitrophenols, alkoxy-phenols, hexoxy-phenols, decahydro-naphthols, tetrahydro naphthols and the like. Still other compounds may be prepared from the aliphatic and aromatic mercaptans corresponding to the above alcohols and phenols. Other compounds containing two or more different aliphatic or aromatic radicals or both aliphatic and aromatic radicals may be employed.

The mono- di- and tri-esters corresponding with those heretofore mentioned may also be mentioned. Esters of phosphoric acid will be obtained by the treatment of a mineral or natural oil with the appropriate phosphorus halide and a catalyst such as an aluminum chloride. The esters of the various normal phosphoric acids may also be reacted with sulphur to form the corresponding thio esters. Phosphate esters can also be obtained by the treatment of oils containing ethylene linkages or hydroxyl groups with phosphorus halides, oxy-halides, oxides, P_2S_5 , $PSCl_3$, $P_2S_5Br_4$ and the like. Likewise, oils containing mercaptans may be treated with phosphorus halides, oxy-halides, oxides, sulphides and the like to produce similar compounds. The resulting esters will be found to be effective for my purpose and to come within the scope of my invention.

Of the salts which may be employed in accordance with my invention the most effective or desirable will be the amine salts of the acid-esters of the acids of phosphorus, such as the acid-ester salts of the methyl amines, ethylamines, ethanol amines, propyl amines, butyl amines, particularly the dibutyl amines, amyl amines, benzylamines, aniline, nitroaniline, naphthylamine and other aromatic amines, pyridine, quinoline and similar amines. Examples of such amine salts are the p-nitro aniline salt of dilauryl dithio phosphate and the pyridine salt of dilauryl phosphate.

The terms "long-chain aliphatic" and "long-chain alkyl" as employed herein will be understood to mean aliphatic or alkyl radicals of at least 8 carbon atoms. The term "alkyl" means unsaturated as well as saturated aliphatic hydrocarbon radicals.

The compounds of my invention are in general well known and the methods for making them are also well known and described in the litera-

ture. Other compounds of my invention can be prepared by the methods described in the literature. These methods generally comprise the treatment of alcohols, unsaturated aliphatic compounds or phenols with phosphorus chlorides or with phosphorus oxy-chlorides or oxides. Suitable methods of preparing other compounds of our invention are described in Patents 1,748,619, 1,889,943, 1,945,183, 1,982,903 and the co-pending application of Salzberg and Wertz filed February 19, 1935, Serial No. 7,126. Accordingly, a more detailed description of the methods to be employed for making the compounds referred to in this application is believed to be unnecessary.

While I have disclosed specific embodiments of my invention, it will be readily apparent to those skilled in the art that many modifications and variations may be made therein without departing from the spirit thereof. Accordingly, the scope of my invention is to be limited solely by the appended claims, construed as broadly as is permissible in view of the prior art.

I claim:

1. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, an organic ester of the phosphoric acid.

2. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, an organic ester of a phosphoric acid in which the organic radicals consist of carbon and hydrogen.

3. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, an organic ester of an orthophosphoric acid.

4. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, an organic ester of an orthophosphoric acid in which the organic radicals consist of carbon and hydrogen.

5. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubri-

cating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, an aryl ester of an orthophosphoric acid.

6. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, a triaryl ester of an orthophosphoric acid.

7. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, tricresyl phosphate.

8. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, an alkyl ester of an orthophosphoric acid.

9. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, an alkyl acid-ester of an orthophosphoric acid.

10. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, a long chain alkyl acid-ester of an orthophosphoric acid.

11. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, a mixture of long chain alkyl acid-esters of an orthophosphoric acid.

12. A method of lubricating bearing surfaces which comprises maintaining between the bearing surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating

oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, a mixture of mono- and di-alkyl esters of orthophosphoric acid derived from a mixture of straight-chain primary aliphatic alcohols of 8 and 10 carbon atoms.

13. A method of lubricating bearing surfaces which comprises maintaining between the bearing

surfaces, one of which is an alloy formed chiefly of cadmium and silver, a film of lubricating oil which initially produces an effective lubricating action but which would normally tend to corrode the aforesaid alloy, and maintaining the effectiveness of the lubricating oil by incorporating therein, in an amount sufficient to inhibit said corrosion, a mixture of tertiary amylphenyl phosphates.

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CERTIFICATE OF CORRECTION.

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August 1, 1939.

ANTHONY FRANCIS BENNING.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 34, claim 1, for the article "the" before "phosphoric" read a; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of October, A. D. 1939.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.