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LUBRICANT

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9 Claims. (Cl. 87—9)

This invention relates to lubricants and, in particular, to addition agents imparting to lubricants improved properties.

Our invention has particular utility in preventing and/or inhibiting the corrosion of "hard metal" alloy bearings such as copper-lead, cadmium-nickel, and cadmium-silver bearings which, to a large extent, have replaced soft metal bearings such as Babbitt metal in the trend toward internal combustion engines having high compression ratios and having increased acceleration and increased speed characteristics. The use of the "hard metal" bearings has created lubrication and corrosion problems, particularly in connection with "highly refined" oils, some of which may be very corrosive to the "hard metal" bearings.

By "highly refined" lubricating oils we mean viscous oils which have a minimum viscosity in the range of S. A. E. 10 oils and which have been subjected to such refining processes such as, for example, solvent extraction, that the paraffinicity of the oil is markedly increased. It has been found that highly refined lubricating oils cause corrosion to alloy bearings of the cadmium-silver type to the extent of 5 mg./cm.^{2} and even greater when such bearings are submerged for 25 hours or less in an air agitated oil which has been preoxidized at about 340° F. for 25 to 50 hours. The motor oils may be highly refined lubricating oils as such or mixtures of highly refined lubricating oils with less highly refined lubricating oils, or stated in another way, mixtures of corrosive oils and non-corrosive oils, examples of the latter being lubricating oil fractions from Winkler crude or crudes of the Winkler type.

We have found that the corrosion to hard metal alloy bearings by highly refined lubricating oils can be inhibited by adding to such oils up to 2% but preferably 0.05% to 0.75% of an organic ester of boric acid selected from the group consisting of boric acid esters having the general formulae $B(XR)_3$ and $X{=}B(XR)$ in which R is a radical selected from the group consisting of alkyl, aryl, hydroaryl, aralkyl; and X is an element selected from the group consisting of oxygen and sulfur.

Esters of the above classes may be prepared by the following reactions:

$$3RXH+B(Y)_3=B(XR)_3+3HY$$
$$2RXH+B_2X_3=2X{=}B(XR)+H_2X$$
$$6RXH+B_2X_3=2B(XR)_3+3H_2X$$

in which X is either oxygen or sulfur, and Y is a halogen. By using an excess of the boron trihalide intermediate products having the general formula $(RX)_wB(Y)_{3-w}$ (in which w is a whole number 1 or 2) can be formed.

Examples of specific compounds of the above esters of boric acid are: Tributyl borate, tributyl thioborate, triamyl borate, triamyl thioborate, dibutyl ethyl borate, butyl diethyl borate, hexyl meta borate, amyl meta thioborate, tri isoamyl borate, triphenyl borate, triphenyl thioborate, diphenyl propyl borate, trilauryl borate, trimyricyl borate, and tri isoamyl thioborate.

To test the effectiveness of these compounds in inhibiting corrosion to hard metal alloy bearings of the cadmium-silver type in the presence of a highly refined lubricating oil, test strips of cadmium-silver alloy bearing metal are submerged in a highly refined lubricating oil both with and without 0.25% of the inhibitor. The oils are maintained at a temperature of about 341° F. while passing 10 liters of air per hour through the oil, and the time required for the test strips to lose 5 mgs. per sq. cm. of bearing surface determined.

Using tributyl borate as the inhibitor the following results are obtained:

Oil	Time for 5 mg. loss per sq. cm. bearing surface
Control	Less than 1 day.
Control +0.25% tributyl borate	3-4 days.

To determine the effectiveness of the boric acid esters in actual engine operation a mixture of 0.25% tributyl borate in a 20 S. A. E. highly refined motor oil was tested in an internal combustion engine provided with cadmium-silver alloy bearings under conditions more severe than those encountered during normal operations. The engine was operated at 2500 R. P. M. at 30 B. H. P. output with a water jacket temperature of 250–260° F. and an oil sump temperature of about 300° F. Operating the engine under these conditions with the oil containing no inhibitor and with the oil containing the inhibitor the following results were obtained:

Oil	Duration of test	Loss in grams per bearing
	Hours	
Control (20 S. A. E. oil)	15	2.981
Control +0.25% tributyl borate	15	0.396

The above data strikingly show the effective-

ness of the organic esters of boric acid in preventing and/or inhibiting corrosion to hard metal alloy bearings of the cadmium-silver type in internal combustion engines in actual operation, and confirm the laboratory results.

While we have described the use of the organic esters of boric acid in lubricating oils, we may also employ a mixture of the organic esters of boric acid and a small amount of butyl phosphite in the lubricating oil. The butyl phosphite is preferably a mixture of mono-, di- and tributyl phosphite, the mono-butyl phosphite being present in an amount less than 3% of the phosphite mixture.

In addition to being effective in preventing corrosion, the herein described compounds are also effective in reducing engine wear.

While we have described our invention by reference to a preferred embodiment thereof it is to be understood that the same is merely illustrative of our invention and is not a limitation thereof except insofar as the same is defined by the appended claims.

We claim:

1. A lubricating oil non-corrosive to hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises a highly refined petroleum lubricating oil normally corrosive to bearings of the cadmium-silver type and from about 0.05% to about 2% of an organic ester of boric acid selected from the group consisting of boric acid esters having the general formulae $B(XR)_3$ and $X{=}B(XR)$ in which R is a radical selected from the group consisting of alkyl, aryl, hydroaryl, aralkyl, and X is an element selected from the group consisting of oxygen and sulfur.

2. A lubricating oil non-corrosive to hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises a mineral lubricating oil normally corrosive to bearings of the cadmium-silver type and an organic ester of boric acid having the general formula $B(XR)_3$ in which R is a radical selected from the group consisting of alkyl, aryl, hydroaryl, and X is an element selected from the group consisting of oxygen and sulfur said organic ester of boric acid being added in a small but sufficient amount to render said lubricating oil non-corrosive to said hard metal alloy bearings.

3. A lubricating oil non-corrosive to hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises a mineral lubricating oil normally corrosive to bearings of the cadmium-silver type and corrosion inhibiting amounts up to about 2% of an alkyl borate.

4. A lubricating oil non-corrosive to hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises a mineral lubricating oil normally corrosive to bearings of the cadmium-silver type and corrosion inhibiting amounts up to about 2% of an aryl borate.

5. A lubricating oil non-corrosive to hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises a mineral lubricating oil normally corrosive to bearings of the cadmium-silver type and corrosion inhibiting amounts up to about 2% of tributyl borate.

6. The method of lubricating internal combustion engines provided with hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises applying to said bearings a lubricant comprising a mineral oil normally corrosive to bearings of the cadmium-silver type and a small amount sufficient to render said lubricating oils noncorrosive to said bearings of an organic ester of boric acid selected from the group consisting of boric acid esters having the general formulae $B(XR)_3$ and $X{=}B(XR)$ in which R is a radical selected from the group consisting of alkyl, aryl, hydroaryl, and X is an element selected from the group consisting of oxygen and sulfur.

7. The method of lubricating internal combustion engines provided with hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises applying to said bearings a lubricant comprising a mineral oil normally corrosive to bearings of the cadmium-silver type and corrosion inhibiting amount up to about 2% of an organic ester of boric acid having the general formula $B(XR)_3$ in which R is a radical selected from the group consisting of alkyl, aryl, hydroaryl, aralkyl and X is an element selected from the group consisting of oxygen and sulfur whereby said mineral oil is rendered non-corrosive to said hard metal alloy bearings.

8. The method of lubricating internal combustion engines provided with hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises applying to said bearings a lubricant comprising a mineral oil normally corrosive to bearings of the cadmium-silver type and from about 0.05% to about 2% of an alkyl borate.

9. The method of lubricating internal combustion engines provided with hard metal alloy bearings having the corrosive susceptibility of alloys of the group consisting of cadmium-silver, cadmium-nickel and copper-lead alloys which comprises applying to said bearings a lubricant comprising a mineral oil normally corrosive to bearings of the cadmium-silver type and from about 0.05% to about 2% of tributyl borate.

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CERTIFICATE OF CORRECTION.

Patent No. 2,160,917. June 6, 1939.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 27, claim 6, after "hydroaryl," insert the word and comma aralkyl,; 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 25th day of July, A. D. 1939.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)