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LUBRICATION OF ALLOY BEARINGS

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This invention relates to improvements in the lubrication of special alloy bearings; and it comprises lubricating compositions and lubricants containing small amounts of improvement agents which mitigate or retard the normal destructive action of lubricating oil deterioration products on certain bearing surfaces, the improvement in this respect being noteworthy with even such bearing materials as alloys of cadmium with copper and silver, of cadmium with copper and nickel, of lead with copper and nickel, etc. even under relatively high temperatures, speeds and pressures, this improvement of the mineral oil being effected and its performance improved by the presence therein of a small amount of phenothiazine or like thio-diaryl-amine compounds obtained by reacting sulphur with di-aryl amines; and it also comprises a method of lubricating bearing surfaces in internal combustion engines, when subjected to conditions of operation, by maintaining between bearing surfaces, one of which is an alloy formed chiefly of a metal consisting of the classes of cadmium and copper, 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 a reaction product of a di-aryl amine and sulfur, specifically phenothiazine, in a small amount but sufficient proportion to substantially retard the said corrosion; all as more fully hereinafter set forth and claimed.

Recent developments in the design of mechanical equipment for generating and transmitting power, and particularly in the automotive field, have necessitated new bearing metals with special properties in this relation. Among these new bearing materials are binary and ternary alloys of the metals mentioned above. Cadmium-silver-copper, cadmium-nickel-copper, copper-lead-nickel, etc., alloys are in use. One ternary alloy currently used in automobile engines is an alloy of cadmium with minor amounts of both silver and copper. Under the conditions imposed by modern engineering design, these new alloy bearings are commonly subjected to more severe operating conditions than were usual in the older art: to higher bearing loads, higher rubbing speeds and higher temperatures of operation. It is found that in actual use under these conditions there often develops quite serious destructive action on the bearing surface by mineral lubricating oils, even by those standard commercial oils giving particularly good results with the older bearing

metals under the earlier operating conditions. The destruction of the bearing metal probably results from action of deterioration products developed in the oil. An object achieved in the present invention is the production of lubricating oils improved for these newer conditions of use and which are characterized by reduction or elimination of destructive action on the newer bearing metals by deterioration products in the oil.

We have discovered that the reaction products of sulphur and diaryl amines, particularly phenothiazine, are capable of achieving the objects of the present invention. By adding small amounts of such products to the mineral oil or lubricant, we obtain lubricating compositions which satisfactorily lubricate the said alloy bearings. Incorporated in mineral oil, they retard destruction of the bearing metal. Also, the film strength of the lubricant is increased, these compounds imparting extreme pressure characteristics to the oil. The character and amount of added improvement agents, here employed, are such that the advantageous properties of the oil, such as viscosity, gravity, color, etc., are not substantially altered. Certain properties of the lubricant are improved without sacrificing the other desirable properties.

We obtain improved mineral oils and lubricants suitable for lubricating bearings under a wide range of service conditions. The new compounded lubricant satisfactorily lubricates the new alloy bearings even under high unit pressure, high bearing speeds and high operating temperatures. When prepared from suitable motor oils, the present improved compositions are excellent lubricants for the modern automobile engine. They satisfactorily lubricate the bearings without any corrosion of the special alloys now used, even when there is a free circulation of air.

Ordinarily between 0.10 and 0.50 per cent, by weight on the oil, of these agents is sufficient to produce a satisfactory lubricant. However, the particular proportions depend upon the particular agent and lubricating base employed and the particular type of lubricant desired. The less stable lubricating oils require the higher percentage of phenothiazine.

When the larger amounts of these agents are employed, marked extreme pressure characteristics are imparted to the lubricant in addition to retarding its destructive action on alloy metal bearings; the film strength of the lubricant being increased by as much as 50 to 100 per cent as stated ante. Thus the addition of these agents

the condition of the bearing shell are determined. In determining the loss in weight the bearing shell is washed free of oil and dried before weighing. This test will hereinafter be referred to as our standard laboratory test.

When determining the effectiveness of various improvement agents the usual procedure is to run a "blank" test simultaneously with the oil composition being tested, employing for that purpose a sample of the untreated oil.

In such tests it is advantageous to employ commercial bearing shells. These shells comprise a suitable metal backing faced with the alloy bearing metal. In the above test, the air is bubbled against the alloy bearing face. In this way, the actual bearing face is subjected to severe deteriorative conditions. By comparison of the results of such tests with actual service tests, we have found them to be in substantial agreement as to the suitability of particular lubricants.

In testing our lubricants, we have employed, among others, bearings of the following approximate composition:

1. Cadmium-silver alloy. C-S 7610.

Metal	Per cent
Cadmium.....	98
Silver.....	1
Copper.....	1

2. Lead-copper alloy. 9020 CA.

Metal	Per cent
Lead.....	45
Copper.....	53
Nickel.....	2

Such alloys are used in the tests of illustrative improved lubricants given post. In such tests the loss in weight, while not extremely high when expressed as "per cent loss", is nevertheless very significant, as the bearing shells used have an alloy facing of only .008 inch to .012 inch thickness on a highly resistant backing and the observed losses in the reported tests often represent a loss of the order of ten per cent of the alloy facing.

The specific examples and tests given post are illustrative of detail embodiments of the present invention.

Example 1.—Into a suitable vessel there are introduced 200 pounds of diphenyl amine. The vessel is heated to a temperature sufficient to melt the amine and then 64 pounds of flower of sulfur (approximately 1 mol of sulfur to 2 mols of amine) are gradually added to the molten amine. Then the mixture is brought to 250° F. and agitated until the sulfur is dissolved. While continuing the stirring 132 pounds of anhydrous aluminum chloride (5 per cent of catalyst by weight on the mixture) is added. Then the mixture is gradually heated to 350° F. and maintained at that temperature and agitated until the reaction is substantially complete, about 8 hours being required with the reaction mixture employed.

The reaction products are cooled and the solid material so obtained is powdered. This powder is extracted with water to remove the aluminum chloride and other water soluble impurities. The extracted material is then dried in a current of warm air. The dried product is a

greenish-gray powder having a melting point of 330° F. It analyzed as follows:

	Per cent
Carbon.....	72.4
Nitrogen.....	7.25
Hydrogen.....	4.52
Sulfur.....	15.20

This dried, extracted reaction product is useful as an improvement agent for mineral oils. If desired it may be further purified by recrystallization from ethyl alcohol. The crystallized material so obtained has a melting point of 350° F. The purified product is advantageous in making certain improved lubricants, such as motor oils, wherein a higher degree of purity is desired.

Example 2.—Into a suitable vessel there are introduced 1000 gallons (7200 lbs.) of Pennsylvania motor oil SAE 10 grade and the oil warmed to 160° F. Then 14.4 pounds of phenthiazine (0.20 per cent by weight on the oil) are gradually added and the mixture agitated until a uniform blend is obtained; about 1 hour being required. The improved motor oil is then cooled and is a finished product. In agitating the mixture, ordinary mechanical agitators may be employed or a current of air may be passed through the warm mixture to produce uniform blending.

The properties of the original and improved motor oil are as follows:

Table A

	Original oil	Improved lubricant
Gravity: °API.....	33.0	32.9
Viscosity, SUV:		
100° F.....	180.2	180
210° F.....	40.2	40.2
Flash, O. C.: °F.....	420	420
Fire, O. C.: °F.....	490	490
Four: °F.....	0	0
Color: NPA.....	1.25	1.75
Carbon residue: percent.....	0.02	0.02
Copper strip test.....	Satisfactory	Satisfactory

From the above table, it is clear that the addition of phenthiazine does not substantially change the ordinary properties of the oil. However, the improved lubricant obtained is satisfactory for lubricating the newer alloy bearings. When tested by the standard laboratory test given ante, using a commercial bearing shell faced with the cadmium alloy (C-S 7610), the following results were obtained in a 48 hour test run.

Table B

Bearing shell weight—	Original oil	Improved lubricant
Before test.....	Grams 27.8072	Grams 27.0445
After test.....	26.6225	27.0450
Total change.....	1.1847	+0.0005
Comment: Bearing appearance (after test).....	B a d l y etched and pitted.	Good.

From the above results, the beneficial effect of the phenthiazine as an improvement agent for the oil is quite apparent. This improved lubricant when tested in an automobile engine equipped with like bearings was highly satisfactory and no corrosion of the bearing was observed after a severe test run. Thus the

standard test and actual service test gave similar results.

Example 3.—Employing the procedure of Example 2, using 0.50 per cent of phenthiazine and a SAE 20 grade motor oil in lieu of the particular materials in Example 1, another improved motor oil is obtained. It is likewise satisfactory for lubricating the newer alloy bearings without substantial deterioration of the bearing metal. When likewise subjected to the standard laboratory test the following results were obtained:

Table C

Bearing shell weight—	Original oil	Improved lubricant
Before test.....	Grams 26.7291	Grams 27.1137
After test.....	26.4205	27.1182
Total change.....	-0.3086	+0.0045
Comment: Bearing appearance (after test).....	Bad	Good

The above examples are but illustrative embodiments of the present invention and in practice other embodiments may be used. That is, the percentage of improvement agent to the lubricant to improve it may be varied, as indicated, according to the particular properties desired in the final lubricant and the lubricating base used. Likewise, the lubricating base itself may be selected according to the type of the final lubricant to be produced.

As stated ante, the incorporation of these reaction products with the lubricating base produces several improvements in the final lubricant without deleteriously affecting the desirable

properties. While the exact reasons for the improvements obtained are not fully known, we are satisfied with observing and utilizing the actual improvements obtained by adding and incorporating these improvement agents with commercial lubricants.

What we claim is:

1. A method of lubricating bearing surfaces in internal combustion engines when subjected to conditions of operation which comprises maintaining between bearing surfaces, one of which is an alloy formed chiefly of a metal selected from the class consisting of cadmium and copper, 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 a reaction product of a diaryl amine and sulphur in a small but sufficient proportion substantially to retard the corrosion.

2. A method of lubricating bearing surfaces in internal combustion engines when subjected to conditions of operation which comprises maintaining between bearing surfaces, one of which is an alloy formed chiefly of a metal selected from the class consisting of cadmium and copper, 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 phenthiazine in a small but sufficient proportion substantially to retard the corrosion.

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