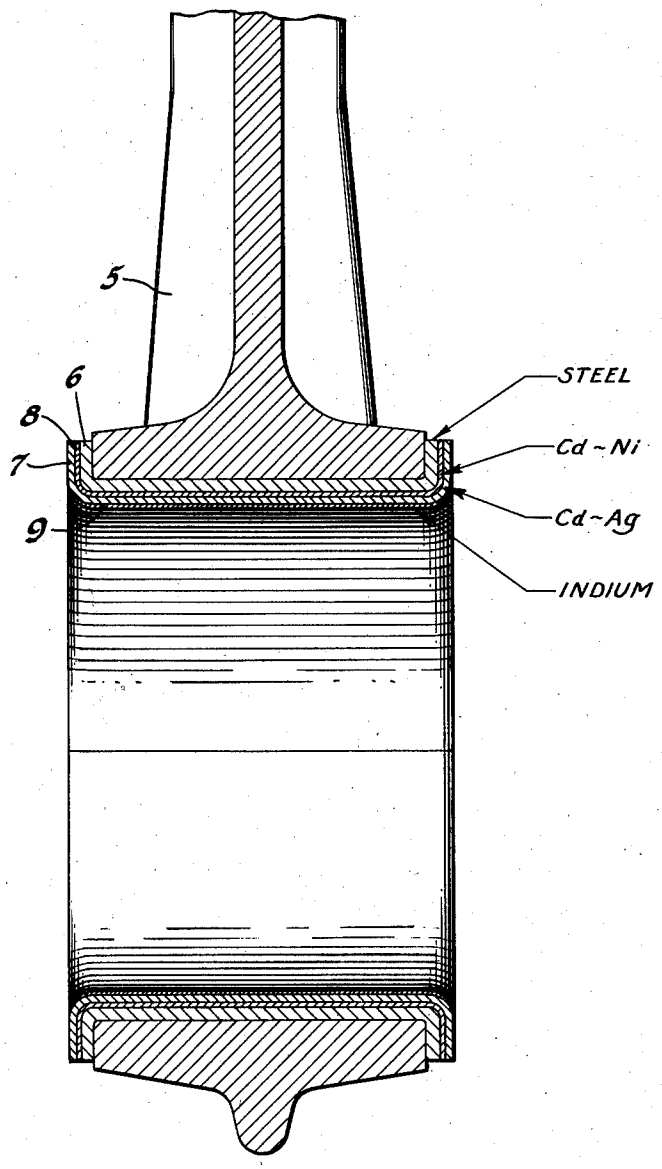
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BEARING

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BEARING

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20 Claims. (Cl. 308—237)

This invention relates to bearings and more particularly to those in which cadmium and lead are present. Various alloys of cadmium or lead without tin have been proposed for use in the surface portions of relatively moving parts. Such alloys may include, for example, copper-lead (plastic bronze), cadmium-copper, cadmium-nickel, cadmium-silver, cadmium-cobalt, cadmium-magnesium and various other alloys containing two or more metals including cadmium in the absence of tin. In general, the additional metals added to the cadmium and lead act as hardening and strengthening agents. Cadmium alone has been proposed as a bearing surface for contacting areas of cylinders and pistons.

I have found, for example, alloys of cadmium and silver to be highly satisfactory for friction surfaces, particularly in the presence of small percentages of additional metals, such as nickel, copper or antimony, which form relatively hard inclusions or particles within the ground mass of the alloy.

The proportion of the ingredients of the cadmium-silver alloy is preferably within the limits of .5–5% silver, .25–1% of a hardening metal or metals and the balance cadmium. More specifically I prefer the composition silver 1.75–2.50%, copper, nickel or antimony, separately or in mixtures, .25–.5%, cadmium 97–98%.

One cadmium-copper alloy employed for bearings includes 95–97% cadmium and from 3–5% of copper. Magnesium up to .5% may be added to this alloy. Another known cadmium-copper-magnesium bearing alloy contains copper .2–1.5%, magnesium .1–.75%, balance cadmium.

The cadmium-nickel bearing alloy ordinarily contains .25–7% nickel and the balance substantially cadmium. Magnesium, zinc, copper, antimony and aluminum up to 3% may be added to this alloy. It has also been proposed to employ an alloy for bearings composed of cadmium and magnesium without copper. In this case the magnesium may be present in amount up to 5%, with the balance cadmium.

The cadmium-cobalt bearing alloys consist of cobalt 1.5–10% and the balance cadmium.

The alloy known as plastic bronze is an alloy containing a large percentage of lead with the balance approximately all copper, for example, from 30% lead and 70% copper to 50% lead and 50% copper. One analysis of a copper-lead alloy found especially suitable for bearings in accordance with the invention contains approximately 45% lead and 55% copper. Alloys containing other ratios of lead and copper, also may be used as bearing materials.

Cadmium and lead and the above described alloys thereof, as well as other alloys containing a substantial amount of cadmium or lead, are subject to attack by various acids and other corrosive media. The commercial uses of the copper-lead and cadmium base alloys for bearings, for example, have been retarded due to the corrosive action of acids present in, or formed during the use of certain lubricants. Some lubricants or ingredients thereof, such as lard oil, contain organic acids that tend to corrode cadmium and lead. Other lubricants, for example, some mineral oil lubricants, when subjected to high temperatures, as 275° F. or higher, in the presence of air tend to oxidize to produce acids which have a similar effect. Long life of bearings containing a substantial amount of cadmium or lead may, therefore, be seriously affected by the presence of such acids, particularly under hard service conditions, such as those that occur in automobile engines.

I have found that corrosion by such organic acids may be substantially prevented by the presence in the alloy or upon its surface of small quantities of indium. I contemplate the use of the indium either as a constituent in a substantially homogeneous alloy with the other constituents of the bearing or by applying indium to the surface, for example by electrolytic processes. When applied electrolytically it may be desirable to subject the bearing to heat treatment after deposition of the indium thereon to diffuse the indium into the alloy to some extent. Such heat treatment may be carried out by merely maintaining the bearing, which has been preliminarily coated with metallic indium, at a temperature below the melting point of the bearing alloy but sufficiently high, e. g., 340–500° F. for sufficient time to cause the indium to alloy with the other constituents to the desired extent. In the case of the cadmium base alloys the indium is apparently alloyed after a heat treatment at 340° F. for about third minutes. Diffusion through .10''–.15'' of a cadmium or a cadmium base alloy is accomplished in about two hours at 340° F.

The amount of indium required to effect a commercially satisfactory prevention of attack by the acids in question is relatively small. When the indium is introduced into the bearing by formation of a homogeneous alloy including cadmium from one-tenth of one percent to one percent is found to be sufficient, the amount varying, of course, with the degree of inhibition desired or

the extent to which corrosive acids are present or produced in the lubricant. Larger amounts might, of course, be used but the cost of indium renders it desirable to restrict the content to the amount necessary to effect the desired inertness to attack by acid products in lubricating oil. In many instances indium within the range .2–.4% has proven sufficient to substantially retard corrosion of cadmium and cadmium base alloys when subjected to corrosive media such as the acids present in lubricating oils. However, where conditions are quite severe a higher content of indium is preferred. For example, indium within the range .4–.8% substantially prevents corrosion even when the bearing alloy is tested in prepared oils having a much greater corrosive effect than average lubricating oils after high temperature service.

If however, the indium is applied to the surface portion only of the cadmium or alloy thereof, the amount required obviously will depend upon the extent of absorption of the indium or the depth of penetration in the cadmium or cadmium alloy. In cases in which it is desired to substantially uniformly diffuse the indium throughout the cadmium or alloy thereof the amount necessary will be comparable with that in which the bearing is originally made from a homogeneous alloy.

When the indium is employed as a constituent of a homogeneous alloy including a cadmium its presence has effects similar in some respects to those produced by silver. It is therefore possible to reduce the silver content of cadmium-silver alloys to some extent while still retaining the desirable hardness and toughness imparted otherwise by a larger silver content. The following may be given as an example of a composition which has been found to have satisfactory properties as a bearing alloy and suitable resistance to corrosion of acids resulting from oxidation of mineral oils:

	Per cent
Silver	1–1.25
Copper	0.25
Indium	0.2–0.4

The remainder substantially cadmium.

The alloy given in this example compares favorably in properties with a similar alloy omitting indium and having 2% or more of silver with the advantage for the indium containing alloy of greatly increased resistance to acid.

Bearing alloys containing a substantial amount of lead ordinarily require a somewhat greater amount of indium than the cadmium base alloys in order to be protected from the effect of corrosive lubricating oils. For example, with the copper-lead alloys the amount of indium necessary may be within the range .5–8.0% of the weight of the copper and lead combined. Even greater amounts may be used without detrimental effect on the other properties of the alloy, but the cost factor of the indium is such that it is desirable to use the minimum amount necessary to effect the desired result as regards resistance to corrosion.

With the copper-lead alloys it is desirable that the indium be applied first to the surface of the copper-lead, for example, by electrodeposition, and then diffused therein, as by being heated to 340–500° F. for a time interval sufficient to affect the desired diffusion. As an example, a copper-lead alloy having an electrodeposited coating of indium may be heated to about 340° F. for eighteen hours. The heat treatment is such that a portion at least of the indium remains on the surface of the copper-lead alloy and forms the bearing surface.

For most purposes a copper-lead alloy facing of approximately .016"–.020" thickness having an electrodeposited coating of indium of from .0001"–.001" in thickness and heat treated produces an excellent bearing surface that is highly resistant to the effect of the acids present in or produced during use of certain lubricating oils. In some instances thicknesses of indium slightly less may be employed. Considerably greater thicknesses may be used also, but the cost of the indium is such that it is desirable to use the least possible amount necessary to obtain the desired result.

Alloys containing material amounts of tin, as the usual Babbitt metals, are not liable to attack by the acids occurring in mineral lubricating oils as the tin serves to protect the lead usually present in such alloys. Tin, however, is not used in the so-called "plastic bronze" copper-lead alloys due to the low melting point of the tin-lead eutectic formed, and I have found that tin when added to cadmium in sufficient quantity to excercise the desired protective effect renders the alloy too brittle for use in bearings.

As an illustration of the application of my invention to bearings, I have shown in the accompanying drawing a sectional view of a connecting rod bearing comprising a connecting rod 5, a sleeve or backing 6 of relatively hard and strong metal such as steel, or other ferrous metal or alloy, or bronze and facing 7 of an alloy of cadmium and silver, with or without a small amount of one or more additional metals, bonded to the surface of the sleeve by an alloy layer 8 containing cadmium and nickel or cadmium and zinc, the facing 7 having at least at the surface a content or coating of indium 9. The cadmium-nickel bonding alloy may be composed of nickel from .75–2% with the balance substantially all cadmium. Preferably, the nickel is used in a percentage of around 1¼. The cadmium-zinc bonding alloy may contain zinc from 5–20% and cadmium from 80–95%.

Some difficulty is experienced in satisfactorily bonding a homogeneous cadmium base alloy containing indium to a steel backing. For this reason it is highly desirable to bond the cadmium or cadmium alloy to the steel backing and thereafter apply the indium to the bearing surface, as by electrodeposition. Thereupon the indium may be diffused into the bearing by heat treatment at a temperature of 340° F. or higher. In this way the alloy may be readily bonded to the steel backing.

The cadmium-nickel bonding alloy is greatly preferred since with this alloy the bond is not weakened during the subsequent step of diffusing the indium into the bearing. For example, I have found that a bearing alloy composed of silver 2.25%, 0.25% copper and the balance cadmium may be readily bonded to a steel backing by the use of a cadmium-nickel bonding alloy. Thereupon the bearing surface may be electroplated with the desired amount of indium and heated to a temperature of 340° F. Tests show that strength of the bond apparently is not affected even after holding at this temperature for sixty hours.

In cases in which a copper-lead alloy is used the backing may be of steel or other ferrous metal, or bronze as in the example given with the cadmium base alloy.

In this case the facing 7 will be of copper-lead having a coating of indium thereon as disclosed. The copper-lead facing may be integrally bonded to the steel backing by being heated to a brazing temperature in a hydrogen atmosphere furnace. Hence, the bonding layer 8 employed with the cadmium base alloys may be dispensed with.

It will be understood that the structure illustrated is merely an example of one use of the invention and is not intended as any limitation on the scope of the invention.

While I have set forth herein specific examples of alloys protected against acid attack by the presence of indium, it is not intended to restrict the invention to any specific alloy nor any particular amount of indium. I believe that I am the first to have discovered the protecting or inhibiting effect of indium in preventing corrosion due to the organic acids in lubricating oils and particularly those resulting from oxidation of mineral oils at high temperatures, and it is therefore desired to cover such discovery in broad terms.

This application is a continuation in part of my prior applications Serial Number 43,468, filed October 4, 1935, and my application Serial Number 167,707, filed October 7, 1937.

I claim:

1. A bearing comprising a backing of relatively hard and strong metal and a facing thereon composed of a cadmium base alloy containing a small amount of indium sufficient to substantially prevent corrosion of the facing caused by acid products in lubricants, said small amount of indium being not less than .1% of the facing composition.

2. A bearing as in claim 1, in which a layer of cadmium-nickel alloy is between the backing and the facing.

3. A bearing comprising a backing of relatively hard and strong metal, a facing composed of a cadmium base alloy having a small amount of indium therein sufficient to substantially prevent corrosion of the facing caused by acid products in lubricants, and a layer composed of a cadmium-nickel alloy for bonding said facing to said backing, the content of indium in the facing being greater at the surface than at points spaced therefrom.

4. A bearing having a surface portion composed essentially of cadmium, a minor amount of a hardener and indium in small amount sufficient to protect the bearing from acid products in lubricants, the cadmium constituting the major proportion of the composition of said surface portion.

5. A bearing having a facing containing copper and lead and having a coating of indium on the surface thereof in amount sufficient to protect the bearing from acid products in lubricants.

6. A bearing as in claim 5, in which the facing contains 50–70% copper and 30–50% lead.

7. A bearing having a facing containing copper and lead and a heat treated coating of indium on the surface thereof.

8. A bearing having a facing containing copper and lead and having a coating of indium on the surface thereof of from .0001"–.001" in thickness.

9. A bearing as in claim 8 in which the facing and coating are heat treated to cause the indium to diffuse into the facing.

10. A bearing comprising a backing of relatively hard and strong metal, a facing containing lead and a small amount of indium, the quantity of indium at the surface being greater than at points spaced therefrom.

11. A bearing containing lead and having a coating of indium.

12. A bearing containing a substantial amount of lead and having an electrodeposited coating of indium.

13. A bearing formed of a bearing alloy subject to attack by acid products in lubricants and having a coating of indium.

14. A bearing formed of a bearing alloy subject to attack by acid proucts in lubricants and having an electrodeposited coating of indium.

15. A bearing having at least its surface portion formed of a cadmium base or a copper-lead bearing alloy subject to attack by acid products in lubricants, to which has been added a small amount of indium sufficient to substantially prevent corrosion caused by said acid products in lubricants.

16. A bearing having a portion formed of a cadmium base bearing alloy subject to attack by acid products in lubricants and having a coating of indium.

17. A bearing having at least its surface portion composed of a cadmium base bearing alloy subject to attack by acid products in lubricants, in which is incorporated a small amount of indium sufficient to substantially prevent corrosion caused by acid products in lubricants.

18. A bearing having at least its surface portion formed of an alloy consisting essentially of cadmium, indium and a hardener, the hardener being present in effective amount up to about 10%, the indium in small amount sufficient to substantially prevent corrosion caused by acid products in lubricants and being at least about .1%, and the balance substantially cadmium.

19. A bearing comprising a backing of relatively hard and strong metal, a facing containing cadmium and a small amount of indium, the quantity of indium at the surface being greater than at points spaced therefrom.

20. A bearing having a facing containing cadmium and having a heat treated coating of indium on the surface thereof.

CLARENCE F. SMART.

CERTIFICATE OF CORRECTION.

Patent No. 2,288,656. July 7, 1942.

CLARENCE F. SMART.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 38-39, for "antimany" read --antimony--; and second column, line 45, for "third" read --thirty--; page 3, second column, line 25, claim 14, for "proucts" read --products--; lines 28 and 29, claim 15, for "cadmium base or a copper-lead" read --plastic bronze--; and line 33, same claim, after "lubricants" and before the period insert the comma and words --, said plastic bronze containing about 50 to 70% copper and about 30 to 50% lead--; 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 18th day of August, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)