

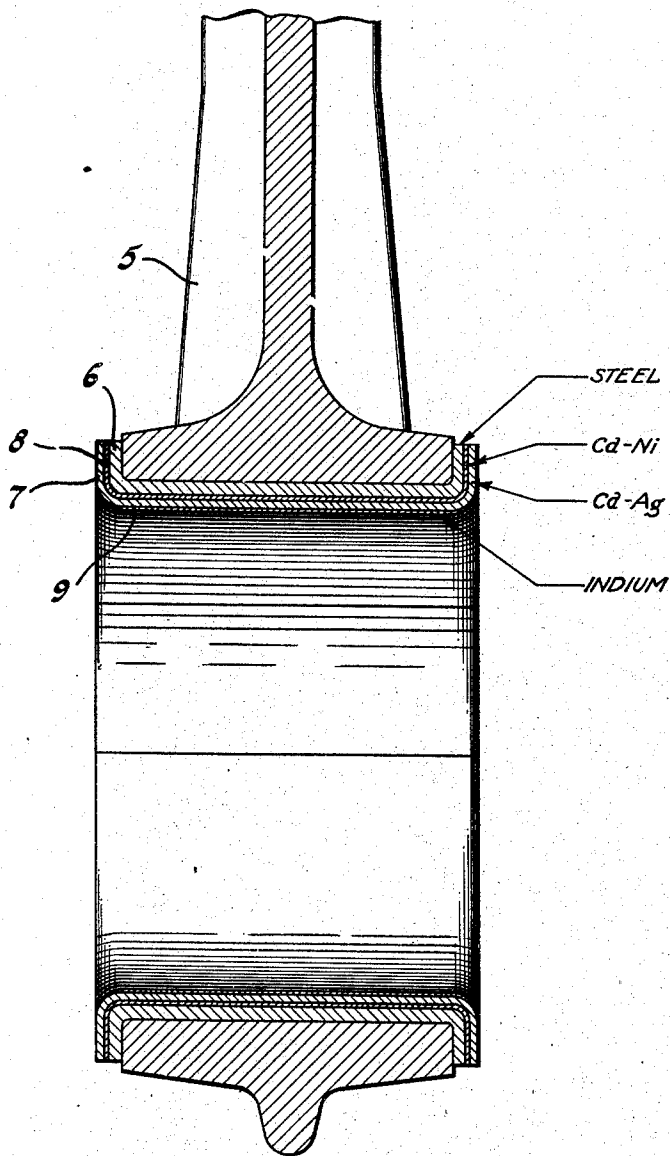
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METAL ALLOY

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METAL ALLOY

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This invention relates to alloys and more particularly to alloys containing a substantial amount of cadmium. Various alloys of cadmium without tin have been proposed for use in the surface portions of relatively moving parts. Such alloys may include 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 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 are preferably within the limits of 5-5% silver, 25-1% hardening metal 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 alloys have usually contained from .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.

Cadmium and the above described alloys thereof, as well as other alloys containing a substantial amount of cadmium, are subject to attack by various acids and other corrosive media. The commercial use of the cadmium base alloys for bearings, for example, has 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 cor-

rode cadmium and cadmium base alloys. 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 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 of cadmium and alloys thereof by certain acids and other corrosive media may be substantially prevented by the presence of small quantities of indium. I contemplate the use of the indium either as a constituent in a substantially homogeneous alloy or by applying the indium to the surface of the cadmium or cadmium alloys, for example, by electrolytic processes.

When applied electrolytically, or otherwise, to the surface it may be desirable to thereafter subject the alloy to heat treatment to diffuse the indium into the alloy to some extent. Such heat treatment may be carried out by merely subjecting the material which has been preliminarily coated with metallic indium, to a temperature below the melting point of the material 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. The indium is apparently alloyed after a heat treatment at 340° F. for about thirty 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 present in, or formed during use of certain lubricants is relatively small. When the indium is introduced into the bearing by formation of a homogeneous alloy, from one-tenth of one per cent to one per cent is found to be sufficient, the amount varying, of course, with the degree of inhibition desired or to the extent to which corrosive acids are present or are produced in lubricants. 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 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.

Alloys containing substantial amounts of tin, as the usual Babbitt metals, are not subject to attack by the acids occurring in lubricating oils. Tin may be added to cadmium and alloys thereof in order to protect the cadmium from corrosive agencies. However, when tin is added to cadmium in sufficient quantity to protect the same from acids in lubricating oils the alloy is too brittle for satisfactory use in bearings.

The amount of indium necessary to protect cadmium and alloys containing a substantial amount of cadmium from other corrosive media will, of course, depend on the corrosive characteristics of the particular medium. In general, from .1%-1% of indium has a substantial effect in preventing or resisting corrosion of the cadmium or cadmium base alloys. For some purposes where the cost of the indium is not a deciding factor and/or the medium has excessive corrosive properties greater amounts of indium may be added.

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 a 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 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 electro-deposition. 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.

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 of 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 effect of indium in preventing the corrosion of cadmium and cadmium base alloys and especially the inhibiting effect of indium in preventing corrosion due to organic acids in lubricating oils, and it is therefore desired to cover such discovery in broad terms.

This application is a continuation in part of my copending application S. N. 43,468 filed October 4, 1935.

I claim:

1. A corrosion-resisting alloy consisting of indium .1-1% and the balance substantially cadmium.

2. A corrosion-resisting alloy consisting of indium .1-1%, a small amount of a hardener and the balance cadmium.

3. A corrosion-resisting alloy consisting of the following elements as essential constituents, indium .4-8% and the balance substantially cadmium.

4. A corrosion-resisting alloy consisting of indium .1-1%, up to 10% of a hardener and the balance approximately all cadmium.

5. A cadmium base alloy containing 0.1-1% of indium and at least 90% of cadmium, said alloy being characterized by substantial freedom from corrosion caused by acid products in lubricants.

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