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BEARING

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This invention relates to bearings and particularly to an improved aluminum base alloy which is especially suitable for use as a corrosion-resistant bearing material having excellent anti-score properties.

Aluminum and most of its alloys are generally quite unsuitable for use in bearings for ferrous metal machine parts because the aluminum tends to adhere to, or combine with, the ferrous metal, thereby causing scoring or seizing. I have found, however, that by suitable combination of alloying constituents, this difficulty can be overcome and a bearing alloy produced having not only anti-friction properties but other characteristics especially suitable in a bearing material.

Many aluminum base alloys, such as the type disclosed in Patent No. 2,338,399, which issued April 15, 1941, in the name of Alfred W. Schluchter, are satisfactory bearing materials in most respects. However, many of these alloys do not possess sufficient resistance to corrosion to enable them to be satisfactorily used under highly acidic conditions, such as are sometimes found in lubricating oils during use. The bearing material of the present invention, therefore, is an improvement on the alloy disclosed in the above patent.

Accordingly, a principal object of this invention is to provide an inexpensive aluminum base bearing alloy which has excellent corrosion resistance, as well as satisfactory hardness and high score resistance. A further object of this invention is to provide a corrosion-resistant aluminum base alloy which possesses desirable frictional properties when used as either a cast alloy or a wrought alloy.

In accordance with my invention, therefore, the foregoing and other objects and advantages are attained to a particularly high degree in an aluminum base alloy containing minor proportions of silicon, cadmium and indium. Inasmuch as an alloy of this composition is a stronger metal than many of the alumium alloys generally heretofore used for bearing purposes, solid bearings may be formed from it and no backing of steel or similar metals is necessary for many applications. If desired, a bearing formed from my alloy may be advantageously provided with a thin overlay of lead or a lead base alloy. Examples of these overlays include the lead-tin and lead-indium alloys which are used for this purpose and in which lead is the major constituent.

Thus I have found that satisfactory bearing properties are obtained with an alloy comprising, by weight, approximately 0.5% to 9% silicon, 0.2% to 5% cadmium, 0.03% to 0.5% indium, and the balance substantially all aluminum. Various incidental impurities may be included in this alloy in the usual small amounts without any substantial detrimental effects. Hence the term "aluminum," as used herein, embraces the usual impurities which are found in aluminum ingots of commercial grade or which are introduced during the handling operations incident to ordinary melting practice. For example, iron, which together with silicon is found in commercial aluminum, may be present in amounts not greater than approximately 0.5% without causing any harmful results. For optimum results I have found that an alloy should be used which consists essentially of approximately 3% to 5% silicon, 0.7% to 2% cadmium, 0.1% to 0.15% indium, and the balance substantially all aluminum.

Under severe test conditions, alloys having the above composition show excellent anti-friction properties so that bearings formed of this alloy not only do not score or gall when in contact with a rotating steel shaft, but neither the shaft nor the bearings show an appreciable amount of wear after long and severe use. I have also found that the resistance of this alloy to cracking or crumbling is extraordinarily high.

The addition of cadmium greatly improves the score resistance of the alloy. Despite the fact that it has been generally recognized that the addition of cadmium to aluminum causes slight loss of strength, I have found that cadmium, in the presence of silicon, may be beneficially introduced in amounts as large as 5% without causing a measurable loss of strength. In fact, the resultant alloy is remarkably resistant to disintegration under impact or "pounding" such as occurs in severe bearing service. Moreover, the presence of cadmium does not affect the hardess if the alloy is subsequently heat treated. Although the effect of cadmium on both strength and hardness is negligible in any event if added in quantities no greater than 5%, cadmium is a relatively soft metal and hence the cadmium content should not be higher than this amount.

I have also found that a cadmium content greater than 5% tends to cause this element to segregate out and settle to the bottom of the casting during the solidification thereof in the form of the apparently nearly pure metal. Thus, too high a cadmium content raises the cost of the alloy by increasing personnel expenses because of increased handling costs and the necessity of more detailed and careful supervision. Moreover, inasmuch as cadmium is also a relatively expensive and somewhat rare metal, it is desirable to add only as much of this metal as is necessary to produce the desired results.

There is a marked improvement in score properties if cadmium is added in quantities up to 2%, but increasing the cadmium content beyond this amount does not appreciably increase the score resistance of the alloy. Hence, cadmium preferably should be present in an amount ranging from approximately 0.7% to 2% in order to provide the most desirable anti-friction properties. Inasmuch as cadmium also tends to volatilize at the temperature of molten aluminum, however, it often may be desirable to add slightly greater amounts of cadmium to offset any losses due to this tendency for volatilization. A cadmium content of at least 0.2% is necessary in all instances to provide adequate score resistance.

The inclusion of silicon in my aluminum base bearing alloy also enhances its score resistance. This property of silicon, plus the manner in which it influences the effects of the cadmium present in the alloy and the fact that solidification shrinkage is lower as the silicon content is raised, dictates that the alloy contain at least 0.5% silicon. Inasmuch as a high silicon content increases the brittleness of the final alloy and interferes with rolling processes, however, the maximum amount of silicon to be added necessarily is governed by the method in which the bearing is formed. Accordingly, silicon should not be present in amounts greater than approximately 5% in the wrought alloy because such an alloy needs to be rolled, while it may be added in amounts as high as about 9% in the cast alloy. While an increased silicon content improves score resistance, the addition of silicon in amounts greater than 5% provides only slight additional beneficial properties in this

respect. Accordingly, best results are obtained for most purposes when the silicon content is kept within a preferred range of 3% to 5%.

For best results, the indium content should be approximately 10% of the amount of cadmium present. Therefore, an indium content between about 0.03% to 0.5% of the total weight of the alloy is satisfactory for increasing the corrosion resistance of the cadmium, while the preferred cadmium content is between 0.1% and 0.15%. The cadmium and indium combine to a certain extent into a cadmium-indium alloy which is formed principally at the grain boundaries, while a portion of the indium combines with the aluminum. Of course, the as-cast metal may be heat treated, if desired, to place the cadmium-indium alloy in a spheroidal form. If the final aluminum base alloy is to be used as a wrought alloy to form a bearing, it is particularly important that the indium content does not exceed approximately 0.5% inasmuch as greater amounts of indium make the alloy too brittle. Hence, in order that the material may be properly rolled, the indium content should not exceed the aforementioned maximum amount.

An example of the above alloy which possesses the aforementioned desirable characteristics to an outstanding degree, therefore, is one consisting of 4% silicon, 1.5% cadmium, 0.15% indium, and the balance substantially all aluminum. As hereinbefore stated, various incidental impurities may be present in the above alloy, but for best results the amounts of these other elements should be confined to relatively low proportions.

In order to obtain the high degree of resistance to pounding, such as is encountered in a bearing, it is preferable that the alloy have a physical structure typified by the absence of continuous networks of relatively brittle eutectic mixtures. Conventional alloy procedures may be employed with intermediate alloys, such as aluminum-silicon, being used to introduce the silicon. It is desirable to add the cadmium last in order to prevent its vaporization. In general, it is advisable to use the lowest temperature possible to keep the cadmium from vaporizing. For example, I have found that the aluminum and silicon may advantageously be fused at a temperature in the order of approximately 1200° F., the melt then preferably being removed from the furnace. The indium and cadmium may next be successively or simultaneously added to the melt, which is subsequently stirred and cast, usually in metal or graphite molds. The highest temperature suitable for casting is that point at which the cadmium just begins to vaporize or "smoke" and, in order to avoid loss of metal, it is desirable not to raise the temperature of the melt above this point. Accordingly, care should be taken to prevent the temperature from exceeding approximately 1400° F. The alloy may be either cast in the desired form for use in bearings or it may be cast in ingots, rolled down to strip material of the desired thickness, and bearing liners or other bearing elements formed from the rolled stock.

Cast articles having a metallographic structure showing a continuous network of segregated metal compounds may be improved as to strength and fatigue resistance by suitable heat treatment. For example, I have found that a solution treatment at a temperature between approximately 900° F. and 1050° F. for a period of eight to fifteen hours is particularly effective to increase the amount of constituent elements in solid solution. Upon removing the alloy from the furnace following the solution treatment, it is preferable to cool it immediately by quenching in water. This treatment provides the alloy with the high degree of ductility, such as is desirable for rolling operations; and it may then be easily rolled down to strip material of the desired thickness.

The specific gravity of the above-described alloy is about one-third that of a tin-bronze bearing alloy, and has much greater resistance to fatigue or to cracking under the pounding action to which bearings, such as connecting rod bearings, are subjected. This property renders such an alloy particularly suitable as a bearing for use under extreme conditions, tests on such bearings indicating the remarkable absence of wear, either of the bearing or the shaft. In addition, this bearing alloy is highly resistant to corrosion by acid constituents of lubricating oils which attack many other bearing compositions.

It is to be understood that, while the invention has been described in conjunction with certain specific examples, the scope of the invention is not to be limited thereby except as defined in the appended claims.

I claim:

1. A corrosion-resistant bearing formed of an alloy capable of being rolled into sheet form from cast ingots and having high anti-friction properties and fatigue resistance, said alloy consisting essentially of approximately 3% to 5% silicon, 0.7% to 2% cadmium, 0.1% to 0.15% indium, and the balance substantially all aluminum.

2. The bearing set forth in claim 1 in which a surface thereof is provided with a thin overlay of a metal selected from the class consisting of lead and lead-base alloys.

3. A bearing characterized by high anti-friction properties and resistance to disintegration under impact and to attack by acids developed in lubricating oils, said bearing being formed of an alloy consisting essentially of 3% to 5% silicon, 0.7% to 2% cadmium, 0.03% to 0.5% indium, iron not in excess of 0.5%, and the balance aluminum.

4. An alloy comprising approximately 0.5% to 9% silicon, 0.2% to 5% cadmium, 0.03% to 0.5% indium, and the balance substantially all aluminum and incidental impurities.

5. A corrosion-resistant alloy capable of being rolled into sheet form from cast ingots and having high anti-friction properties and fatigue resistance, said alloy consisting essentially of approximately 3% to 5% silicon, 0.7% to 2% cadmium, 0.1% to 0.15% indium, and the balance substantially all aluminum.

6. A heat treatable wrought alloy comprising approximately 0.5% to 5% silicon, 0.2% to 2% cadmium, 0.03% to 0.5% indium, iron not in excess of 0.5%, and the balance substantially all aluminum.

7. A bearing formed of an alloy containing approximately 0.5% to 9% silicon, 0.2% to 5% cadmium, 0.03% to 0.5% indium, and the balance substantially all aluminum, the physical structure of said alloy being substantially free of continuous networks of brittle eutectic mixtures.

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