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# ALUMINUM BASE BEARING

Alfred W. Schluchter, Dearborn, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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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 bearing material in the "as-cast" condition.

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 my co-pending patent application S. N. 328,265, filed December 27, 1952, 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 for many purposes, and bearings formed from such alloys have relatively short lives because of the tendency to corrode in the presence of the acids which are formed in lubricating oils during use.

Accordingly, a principal object of the present 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 not only has desirable frictional properties when used as a bearing, but which also may be used either as 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, lead, chromium and tin. Inasmuch as an alloy of this composition is a stronger metal than the aluminum alloys generally heretofore used for bearing purposes, solid bearings may be formed from it and no packing of steel or similar metals is necessary. 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.

The alloy formed in accordance with the present invention is characterized by greater corrosion resistance, increased hardness and a correspondingly longer fatigue life than related aluminum base alloys heretofore used. As a result of this hardness, solid bearings made from this alloy retain their original shapes better than many of the bearings which up to the present time have been formed of softer alloys. The former do not take a set at temperatures to which they are normally subjected, and they undergo a negligible amount of shrinkage after extensive use. This type of inexpensive bearing alloy is found to

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be particularly valuable for low speed applications where it may be used in the as-cast condition. Hence it may be satisfactorily employed as a cast bell end bearing in fractional horsepower motors. Furthermore, if the silicon content is not used near its upper limit, the alloy can be easily rolled down by conventional methods and used as a wrought alloy.

Accordingly, I have found that satisfactory bearing properties are obtained with an alloy comprising, by weight, approximately 0.2% to 10% silicon, 0.1% to 3% lead, 0.1% to 0.6% chromium, 0.01% to 0.3% tin, 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. Thus 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 2% to 5% silicon, 0.5% to 1.5% lead, 0.2% to 0.35% chromium, 0.05% to 0.15% tin, and the balance substantially all aluminum.

Under severe test conditions, alloys having the above compositions show excellent anti-friction properties so that bearings formed of this alloy do not score or gall when in contact with a rotating steel shaft, and neither the shaft nor the bearing 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 inclusion of silicon in my aluminum base bearing alloy improves its frictional properties and also increases its strength. Hence, in order to obtain a high degree of score resistance and adequate strength, it is necessary that the alloy have a silicon content of at least 0.2%, and for best results it is desirable to use at least 2% silicon. More than approximately 10% silicon should not be included in the alloy, however, because of casting difficulties; and the resultant bearing is too brittle for practical applications if the silicon content is excessive. Inasmuch as a high silicon content also interferes with rolling processes, the maximum amount of silicon to be added necessarily is governed by the method to be used in forming the bearing or other article. Accordingly, although silicon may be added in amounts as high as 10% in the cast alloy, it should not be present in amounts greater than about 5%, and preferably not in excess of 4%, in the wrought alloy because such an alloy needs to be rolled. Furthermore, 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 the preferred range of approximately 2% to 5%.

In the present aluminum base bearing alloy, the lead performs the important function of conferring desirable frictional properties to the alloy. In order to obtain these properties to a satisfactory extent, it is necessary that the alloy have a minimum lead content of at least 0.1%; and at least 0.5% lead should be present for optimum score resistance, particularly if bismuth is omitted from the alloy. The lead should not be included in amounts above 3%, however, because a lead content greater than this amount results in segregation of the lead with localized areas having poor frictional properties. It should also be noted that the presence of lead has very little effect on the ductility of the aluminum base alloy. Hence an alloy containing about 0.1% to 1.5% lead can readily be rolled into a thin strip using conventional methods for rolling an aluminum alloy. It is generally preferred that the lead content not be raised above 1.5%, however, if the alloy is to be used in the wrought form.

For best results, the amount of tin present should range from approximately 5% to 15% of the lead. Therefore, a tin content between about 0.01% to 0.3% of the total weight of the alloy is satisfactory for increasing the corrosion resistance of the lead, while the preferred tin content is between 0.05% and 0.15%. The lead and tin combine to a certain extent into a lead-tin alloy which is formed principally at the grain boundaries. Of course, the as-cast metal may be heat treated, if desired, to place the lead-tin 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 tin content does not exceed approximately 0.3% inasmuch as greater amounts of tin make the alloy too brittle. Hence, in order that the material may be properly rolled, the tin content should not exceed the aforementioned maximum amount.

The presence of chromium greatly contributes to the hardness and machinability of the resultant alloy. While the hardness may be substantially reduced if the chromium content is too low, the addition of approximately 0.3% chromium is all that is necessary in order to obtain a completely satisfactory degree of hardness. Moreover, a chromium content of only 0.2% chromium increases the hardness of the alloy considerably and makes it suitable for many bearing applications.

The addition of chromium in amounts greater than about 0.6%, however, reduces the ductility of the resultant alloy to too great an extent, a high ductility being particularly necessary if the material is to be used as a wrought alloy. It is also not feasible to add more than 0.6% chromium because increasing the chromium content above this amount raises alloy costs by greatly increasing the difficulty in casting and fabrication of the cast parts. Too high a temperature is required to place and hold greater quantities of chromium in solution in the liquid state, the chromium segregating out unless the temperature of the melt is raised excessively. The resultant formation of hard spots in the alloy prevents the obtaining of a uniform casting. A chromium content below 0.1%, on the other hand, is insufficient to confer the necessary hardness and strength to the alloy. Furthermore, the score resistance of the alloy is slightly improved as the chromium content is increased. As a result of the above considerations, I have found that a chromium content within the preferred range of approximately 0.2% to 0.35% provides excellent results in all respects.

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% lead, 0.3% chromium, 0.15% tin, and the balance all aluminum and incidental impurities.

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. Unlike many of the aluminum base bearing alloys heretofore used, alloying the above composition does not involve problems due to vaporizing of any of the constituents, and close controls are not required because all of the elements used have relatively low vapor pressures. The temperature of the melt may be raised as high as approximately 1600° F. before difficulty is encountered because of vaporization of lead, the element in the present alloy having the highest vapor pressure. Simple, conventional alloying procedures may be employed in the present instance, therefore, with intermediate alloys, such as aluminum-silicon and aluminum-chromium alloys, being used to introduce the silicon



and chromium. The lead may then be added to the melt, which is subsequently stirred and cast, usually in metal or graphite molds. The alloy may be either cast in the desired form for use in bearings or, if bismuth is not added, it may be cast in ingots, rolled down to strip material of the desired thickness, and bearing elements formed from the 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. 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.

A precipitation treatment may thereafter be employed to substantially increase the hardness of the alloy. This process is preferably carried out by heating the article for five to ten hours at a temperature in the range between approximately 300° F. and 400° F., a precipitation treatment at 370° F. for eight hours being particularly satisfactory. The alloy then may be again cooled, preferably in water, and suitably machined. Such a heat treating process results in an article which is three or four times as hard as it was in the as-cast condition and whose fatigue strength is proportionally improved.

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 many types of bearings are subjected. This property renders such an alloy suitable as a bearing for use under extreme conditions, tests on such bearings indicating the relative absence of wear, either of the bearing or the shaft. In addition, the alloy appears to be 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 by means of certain specific examples, the scope of the invention is not to be limited thereby except as defined in the following claims.

I claim:

1. A bearing formed of an alloy consisting essentially of approximately 0.2% to 10% silicon, 0.1% to 3% lead, 0.1% to 0.6% chromium, 0.01% to 0.3% tin, and the balance substantially all aluminum.

2. A 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 2% to 5% silicon, 0.5% to 1.5% lead, 0.2% to 0.35% chromium, 0.05% to 0.15% tin, and the balance substantially all aluminum.

3. A bearing as in claim 2 in which a surface thereof is provided with a thin overlay of a metal of a class consisting of lead and lead base alloys.

4. 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 2% to 5% silicon, 0.5% to 1.5% lead, 0.2% to 0.35% chromium, 0.05% to 0.15% tin, iron not in excess of 0.5%, and the balance substantially all aluminum.

5. A bearing formed from 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 2% to 5% silicon, 0.5% to 1.5% lead, 0.2% to 0.35% chromium, 0.05% to 0.15% tin, and the balance aluminum.

6. A bearing formed from a heat treatable wrought

alloy consisting of approximately 0.2% to 4% silicon, 0.1% to 3% lead, 0.1% to 0.35% chromium, 0.01% to 0.3% tin, iron not in excess of 0.5%, and the balance substantially all aluminum.


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