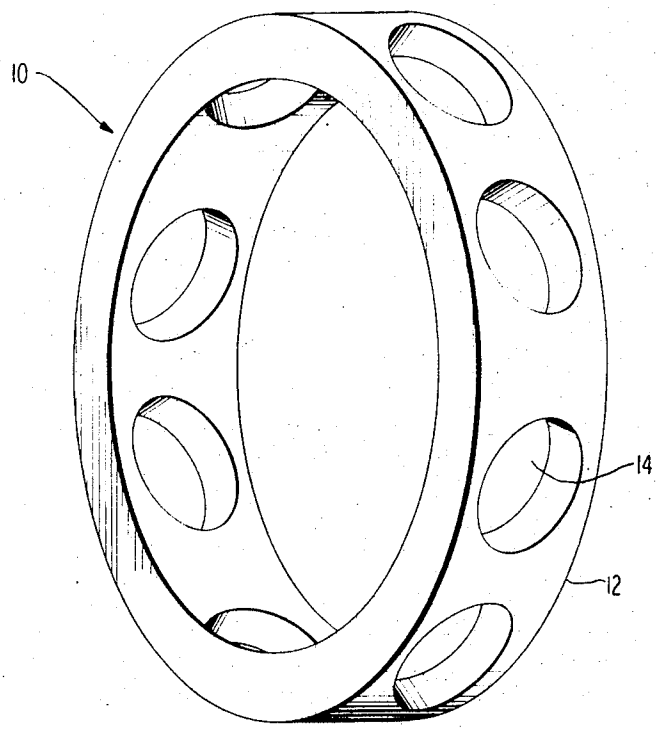
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HIGH-STRENGTH, CENTRIFUGALLY CAST COPPER-BASE ALLOY BEARING CAGE

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HIGH-STRENGTH, CENTRIFUGALLY CAST COPPER-BASE ALLOY BEARING CAGE

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ABSTRACT OF THE DISCLOSURE

Alloys consisting essentially of from about 26.0 to about 34.0% zinc, from about 4.5 to about 10.0% (preferably from about 4.5 to about 6.0%) manganese, from about 0.5 to about 1.5% iron, from about 1.0 to about 2.5 aluminum, and the balance copper. Lead can be optionally added, in amount of from about 0.5 to about 1.5%. The alloys have improved physical properties, particularly at elevated temperatures, and can be centrifugally cast for manufacture in antifriction bearing cages.

BACKGROUND OF THE INVENTION

For decades, it has been the practice to manufacture cages for ball or roller bearings from an alloy known as "Alcop." This alloy has a nominal composition of 63% copper, 35% zinc, 1% aluminum, and 1% lead.

Alcop was developed in the 1930's to combat a rash of bearing cage failures which occurred at that time, when it was conventional to manufacture the cages from red brass containing 85% copper, 5% tin, 5% lead, and 5% zinc.

Alcop was very successful in overcoming the problems of the day, and over the years became a very popular material for antifriction bearing cages. As minimum physical properties, Alcop has a yield tensile strength of 25,000 p.s.i., an ultimate tensile strength of 65,000 p.s.i., a Rockwell hardness of 55 on the "b" scale, and 25% elongation in a 2" gauge length.

As the years went by, however, bearing service applications became more severe and a need developed for bearing cage alloys having increased strength, particularly at high temperatures, and having extended service life. A main object of the invention is the fulfillment of this need.

There are a number of known expedients for strengthening copper-base alloys. However, attempts to apply such expedients to the strengthening of Alcop have encountered complicating factors. One of such factors appeared in the bearing cage manufacturing process.

In the manufacturing of bearing cages, one of which is generally indicated at **10** in the drawing, it is common practice to first centrifugally cast a hollow cylinder and then cut transverse slices from the cylinder at closely spaced locations along the longitudinal axis of the cylinder to produce a plurality of rings, as **12**. Each ring is then machined at spaced locations around its periphery to form apertures, as **14**, which receive the individual balls or rollers of the bearing. There are many, many variants which can be practiced within the framework of this basic procedure, but the essentials of the process remain the same.

The centrifugal casting of the cylinders is a delicate operation. Each cylinder is cast in a permanent, cylindrical, mold or die which is disposed with its longitudinal axis in horizontal or vertical orientation and which is rotated at high speeds around the axis while molten metal is introduced into one end of the die. The die size and speed of rotation, desired cylinder wall thickness, G-forces on the molten metal, and other factors, all must be carefully interrelated to successfully produce sound

castings. One of the reasons that Alcop was so successful is that it lent itself well to this process. Attempts to change the chemistry of Alcop encountered difficulties in the cylinder casting procedure. The cast cylinders tended to be unsound because of cracks formed during the centrifugal casting process.

Accordingly, another object of the invention is the provision of improved and strengthened copper-base alloys and bearing cages which can be successfully centrifugally cast.

Other objects and advantages of the invention will appear to those skilled in the art from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The sole figure, to which reference has already been made, is a perspective view of a bearing cage for a ball bearing.

DETAILED DESCRIPTION

It has been found that copper-base alloys containing particular amounts of zinc, manganese, iron and aluminum have the necessary improved strength properties for bearing cages subjected to severe present-day service conditions, while being susceptible of successful centrifugal casting. The alloys have improved room-temperature yield tensile strength, ultimate tensile strength, fatigue strength, and hardness, and moreover, retain good ductility. Further, the alloys have surprising elevated-temperature properties, which are important because in present-day technology many bearings must operate successfully at elevated temperatures.

Alloys in accordance with the invention consist essentially of from about 26.0 to about 34.0% zinc, from about 4.5 to about 10.0% (preferably from about 4.5% to about 6.0%) manganese, from about 0.5 to about 1.5% iron, from about 1.0 to about 2.5% aluminum, and the balance copper. The alloys can also contain from about 0.5 to about 1.5% lead as an optional additive where increased machinability is desired. As used herein, the phrase "consisting essentially of" embraces materials, e.g., impurities and diluents, which do not materially affect the basic properties of the composition. All composition percentages herein are by weight.

Alloys in accordance with the invention are characterized by a minimum room-temperature yield tensile strength of about 32,000 p.s.i., an increase of about 28% over Alcop. The minimum room-temperature ultimate tensile strength is about 70,000 p.s.i., an increase of about 8% from Alcop. The minimum room temperature Rockwell "b" hardness is 75, up about 36% over Alcop. Fatigue strength is improved, as are stress-rupture properties. Ductility is good. The strength properties of the alloys can be still further improved by heat treatment. The alloys exhibit a martensitic type of structure after solution treating and quenching. The alloys can be cast into cylinders for manufacture of bearing cages in accordance with conventional procedures.

The foregoing properties are very much sought after and highly desirable, but it is in respect to elevated-temperature properties that outstanding results are obtained. The alloys have excellent strength and hardness stability, at elevated temperatures, and this is very important because many bearings are subject to such temperatures in service.

The manganese content is important. Alloys having manganese contents below the range specified have insufficient strength. Further, alloys with the low manganese tend not to respond to heat treatment. Alloys containing more manganese than the preferred range of from about 4.5 to about 6.0% are difficult to centrifugally cast with success. Close control over the speed of rota-

tion is necessary to avoid formation of cracks or tears in the castings. High casting speeds of rotation should be avoided. Moreover, in alloys having the high manganese contents, there is an unexpected decline in fatigue strength which in the preferred range tends to increase with increasing manganese content.

The present invention is further illustrated by the following specific examples which are not to be taken as limiting the principles of the invention as defined by the appended claims.

	Zn	Mn	Fe	Al	Pb	Cu
Example:						
I	29.0	5.1	0.7	1.1	0.6	63.5
II	29.0	4.7	1.1	2.0	0.7	62.5
III	32.7	6.4	0.9	2.2	0.7	57.1
IV	28.0	9.7	0.9	1.5	1.0	58.9

The alloy of Example I has the following room-temperature properties: A Rockwell "b" hardness of 75; a yield tensile strength of 32,000 p.s.i.; an ultimate tensile strength of 70,000 p.s.i.; and 35% elongation in 2". In fatigue, the alloy can withstand over 6.8 million cycles of fluctuation between 40,000 and 4,000 p.s.i. axial tension. When notched, the fatigue life is over 4.1 million cycles of fluctuation between 25,000 and 2,500 p.s.i. tension.

At 450° F., the alloy of Example I has a yield tensile strength of 30,200 p.s.i. and an ultimate tensile strength of 54,000 p.s.i. The alloy not only retains a Rockwell "b" hardness of 75 after 20.5 hours at 450° F., but also actually increases in hardness to 78.5 Rockwell "b" after 138.5 hours at 450° F. In stress-rupture, the alloy can withstand a stress of 29,000 p.s.i. at 450° F. for 100 hours. Such stress is about 96% of the yield strength at that temperature, and it is surprising that the alloy has such elevated-temperature strength.

At room temperature, the alloy of Example II has the following properties: a Rockwell "b" hardness of 79; a yield tensile strength of 33,000 p.s.i.; an ultimate tensile strength of 80,000 p.s.i.; a fatigue strength of 39,000 p.s.i.; and 34% elongation in 2". At 450° F., the yield tensile strength is 32,000 p.s.i. and the ultimate tensile strength is 55,000 p.s.i. In stress-rupture, the alloy surprisingly can withstand 30,000 p.s.i. (94% of the yield strength) for 100 hours at 450° F.

At room temperature, the alloy of Example III has a

Rockwell "b" hardness of 85, a yield tensile strength of 52,000 p.s.i., an ultimate tensile strength of 95,000 p.s.i., and a fatigue strength of 30,000 p.s.i. At 450° F., the alloy has a yield tensile strength of 52,000 p.s.i. and an ultimate tensile strength of 68,000 p.s.i. In stress-rupture, the alloy can withstand 32,000 p.s.i. stress for 100 hours.

We claim:

1. A centrifugally cast antifriction bearing cage composed of an alloy consisting essentially of from about 26.0 to about 34.0% zinc, from about 4.5 to about 6.0% manganese, from about 0.5 to about 1.5% iron, from about 1.0 to about 2.5% aluminum, from about 0.5 to about 1.5% lead, and the balance copper.

2. A centrifugally cast bearing cage as defined in claim 1, wherein the zinc is present in an amount of about 29%, the manganese is present in an amount of about 5.1%, the iron is present in an amount of about 0.7%, the aluminum is present in an amount of about 1.1%, the lead is present in an amount of about 0.6% and the copper is present in an amount of about 63.5%.

3. A centrifugally cast bearing cage as defined in claim 1, wherein the zinc is present in an amount of about 29%, the manganese is present in an amount of about 4.7%, the iron is present in an amount of about 1.1%, the aluminum is present in an amount of about 2.0%, the lead is present in an amount of about 0.7%, and the copper is present in an amount of about 62.5%.

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