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LEAD BASE ALLOY

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1 Claim. (Cl. 75—166)

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This invention relates to lead base alloys having characteristics comparable to those of tin base alloys, and more especially it deals with alloys consisting of suitable proportions of lead, tin, antimony, manganese and iron.

In the field of so-called Babbitt metals, a material distinction is recognized between tin base alloys on the one hand and lead base alloys on the other. Though both types have found extensive use, tin base alloys are generally regarded as possessing the more desirable properties for use in anti-friction bearings and for other purposes for which such alloys are utilized. One of the chief advantages of the tin base alloys as a group is the considerably greater ductility they possess, as compared with the lead base alloys. However, due to the greater cost of tin base alloys, it has long been recognized that it would be commercially and technically desirable to provide a lead base alloy having properties comparable to those of the tin base type.

I have succeeded in accomplishing the foregoing object by my present invention. I have found that when small amounts of manganese and iron are added to an alloy composed of a substantial proportion of lead and minor proportions of tin and antimony, the resulting alloy exhibits properties which are substantially equivalent to those of the tin base alloys. In addition, my novel alloy is materially lower in cost than tin base alloys.

The above mentioned alloys can be produced by first melting tin in a kettle and bringing the temperature up to about 1500° F. or more then adding powdered manganese and stirring in. After the proper amount of manganese has been dissolved, the powdered iron is added in the amount required. When this mixture has been thoroughly alloyed, the antimony is added during which period the temperature drops slowly and the lead is then added. The alloy is then poured into pigs at a temperature of about 800° F.

However, I prefer to produce my bearing metal alloys by first making an iron-manganese-tin hardener or individual hardeners of iron-tin and manganese-tin. The final bearing metal alloy is made by adding the correct amounts of hardener to a previously prepared bath of lead and antimony. The desired hardener is made by melting tin to a temperature of about 1500° F. or more and adding enough powdered manganese and powdered iron to make an alloy around 1.5% iron and somewhat less manganese, although this proportion may vary.

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In making the iron-tin hardener, a similar procedure was followed but in this case the iron was usually only brought up to about 1%, the balance tin. Depending upon the grade of hardener made, it may or may not be necessary to add additional iron and/or manganese to obtain the final alloy desired.

As already stated, the ingredients employed in my novel alloy consist of lead, tin, antimony, manganese and iron. As will be understood by those skilled in the art these metals often contain minor impurities which do not substantially affect their use and the results obtained with them.

However, copper and nickel are especially detrimental impurities and should both be less than .02% to obtain the best results with my bearing metal alloy.

The amounts of the various ingredients employed in my novel alloy can be varied without deleteriously affecting the properties of the alloy, but only within certain ranges. Thus, I have found that the desired results are obtained when from 9 to 12.5 per cent of tin, 8.5 to 10.5 per cent of antimony, 0.01 to 0.5 per cent of manganese and the same amount of iron are employed, the balance being lead. When proportions differing from those stated are employed, the resulting alloy loses some of its desirable properties, the ductility of the alloy in particular being adversely affected when the proportions of manganese or iron, or both, are substantially outside the ranges given. It was surprising to find that even the small amount of manganese or iron used would increase the hardness substantially and otherwise cause pronounced changes in the microstructure of the alloy as seen under a microscope, and would also refine the structure of the alloy as seen in the fracture.

The important and pronounced difference in mechanical properties between the two known classes of babbitts is in regard to their ductility, as the following table will show:

Table I[1]

Known Type of Babbitt	Brinell Hardness Number (100 kg., 30 sec.)	Ultimate Tensile Strength	Elongation (in 2 inches)
		P. s. i.	*Per Cent*
Tin-base alloy	22.0	12,000	11.0
Lead-Base alloy	20.5	10,500	2.0

[1] Values reported are averages of a number of tests, and were made at room temp.

The composition of the above typical tin base alloy was copper 3.5 per cent, antimony 7.5 per cent, and balance tin. The typical lead base alloy indicated above was composed of: tin 10 per cent, antimony 15 per cent, and balance lead.

The low elongation value and poor ductility that is characteristic of such known lead base babbitts is also an indication of their well known brittleness, as contrasted to such known tin base babbitts of the same general hardness. This low value is a further indication of poor resistance to impact stresses and pounding. Thus it becomes apparent that lead-base babbitts are subject to severe limitations of usefulness, particularly if the stresses are high, or reciprocating, or in the nature of an impact. It is primarily the very fact that tin base babbitts do show superior properties in the above mentioned regard, together with slightly better bonding properties, that has made them universally more desirable for bearings which are highly stressed or where the service conditions are severe.

On the other hand, as already noted, because of the high price of tin, compared to lead, tin base babbitts are much more expensive than lead base babbitts—generally from three to five times the cost of the latter. Nevertheless, this added cost has been fully justified in many installations because experience has shown that a bearing failure will occur much sooner when lead base babbitt is substituted. Technically, the important physical property that makes the difference is the ductility of the alloy, and the higher price has been therefore justified to obtain this necessary property.

A preferred improved lead base alloy composed of 12 per cent of tin, 9.75 per cent of antimony, 0.1 per cent of iron and 0.1 per cent of manganese, balance lead, was prepared.

The following table shows a comparison in certain mechanical properties of the improved lead base alloy with a typical tin base, and a typical lead base babbitt:

Table II[1]

	Yield Strength, p. s. i.	Ultimate Strength, p. s. i.	Elong. in 2 inches	Reduction of Area
			Per Cent	*Per Cent*
Typical Tin Base Babbitt	10,000	12,000	11.0	13.0
Typical Lead Base Babbitt	8,000	10,000	2.0	1.5
Improved Lead Base Babbitt of this invention	8,500	11,500	9.5	9.5

[1] Average values.

In making the above determinations, standard .505 inch diameter threaded tensile test bars were machined from solid castings 1 inch in diameter by 6 inches long. The castings were poured at 800° F. into a cast iron mold at a temperature of 212° F. All determinations reported herein were made on castings poured as described. The tensile test bars were tested at room temperature on a Tinius-Olsen hydraulic testing machine at a head speed of .05 inch per inch of specimen per minute. The yield strength determination was measured with B. C. Ames extensometer at an elongation of .01 inch per inch of gauge length, under load.

The percentage of elongation is determined by dividing the increase in gage length, as measured on the broken test bar, by the original 2 inch gage length, and multiplying by 100. Similarly, the reduction of area is computed on the same specimen by using a micrometer caliper to measure the reduced diameter at the fracture of the broken test bar, and converting it to the corresponding reduced area. By dividing the change in area by the original area of the bar, and again multiplying by 100, the percent reduction of area is obtained.

The following table indicates the comparative Brinell hardness values of the present alloy with those of typical lead base and tin base alloys. Hardness determinations were also made at elevated temperatures as shown:

Table III

Temperature of Test	70° F.	150° F.	300° F.
Lead Base Babbitt	20.5	9.0	7.0
Tin Base Babbitt	22.0	15.0	12.0
Improved Lead Base Babbitt of this invention	21.5	14.0	11.0

In making the above determinations, specimens ¾ inch long were cut from the 1 inch diameter castings and were tested midway between center and edge of the cross-section. A minimum of six specimens was used for each value reported. The tests were made with a hydraulic hardness testing machine, using a 10 mm. ball, a 100 kg. load applied for 30 seconds, at 70° F., 150° F. and 300° F. The 150° F. and 300° F. specimens were preheated in an automatically controlled electric oven for 17 hours, at the temperature indicated, and then quickly transferred to an oil bath at the same temperature 5 minutes before testing, to facilitate making the impression for hardness determination.

It is evident from the above tables that the new improved lead base babbitt possesses an elongation, in tension, approaching that obtained in a typical tin base babbitt, and very much superior to a typical lead base babbitt. Furthermore, the yield strength, ultimate tensile strength, reduction of area, and Brinell hardness values are all superior to a typical lead base babbitt, and very similar to the properties exhibited by a typical tin base babbitt. Also to be noted is that the loss of hardness at elevated temperatures is parallel to that of tin base alloys.

Test bars have been poured from a considerable number of widely varying tin base compositions, and lead base compositions, some of them proprietary, but all in common usage. In all cases, the present invention shows superior ductility (as measured by elongation) to that of lead base alloys. All other tensile values are either equal to, or slightly below those of tin base alloys. On the other hand, the hardness value of the present invention is either equal to, or superior to that of the lead base alloys, and about the same as that of tin base alloys.

In addition to use in bearings or for other anti-friction elements, my novel alloys can be used for other purposes. For example, type for pattern dies when made from the novel alloys is able to withstand abrasion and rough foundry use. Such type also possesses the desirable

qualities of being low melting and of assuming sharp impressions, as well as being sufficiently hard and non-brittle.

Another possible use for this alloy is in the manufacture of valves and valve seats for gas meters where a combination of hardness and ductility are essential. Other possible uses are for small castings made in permanent molds such as toys and similar objects. For this latter use, high lead alloys are used at the present time in order to obtain the necessary ductility with a cheap metal; however, these alloys do not possess hardness which the present alloy would add with similar ductility.

It will be understood by those skilled in the art that although the metals and proportions named herein, particularly with regard to iron and manganese, are essential to the proper practice of my invention, nevertheless minor changes may be made without departing from the spirit of my invention. All such modifications coming within the scope of the appended claim are intended to be secured herein.

I claim:

A lead base alloy composed of about 12 per cent of tin, about 9.75 per cent of antimony, about 0.1 per cent of manganese, about 0.1 per cent of iron, and the balance of lead.

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