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FREE CUTTING ALLOYS

Louis W. Kempf and Walter A. Dean, Cleveland, Ohio, assignors to Aluminum Company of America, Pittsburgh, Pa., a corporation of Pennsylvania

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7 Claims. (Cl. 75—1)

This invention relates to aluminum base alloys and it is especially concerned with those alloys containing a substantial amount of zinc.

This application is a division of our co-pending application, Serial No. 689,883, filed September 18, 1933. Alloys disclosed but not claimed herein are claimed in our above mentioned application, Serial No. 689,883 and in our co-pending application, Serial No. 19,624, filed May 3, 1935.

Aluminum base alloys containing zinc as a major alloying component have been widely used in both cast and wrought form because of their good casting and working qualities combined with satisfactory physical properties such as strength and ductility. Certain alloys having an aluminum-zinc base have been developed which have unusually high tensile and shear strengths on the order of 65,000 and 40,000 pounds per square inch, respectively. Thermal treatments are generally employed to improve the strength of the alloys and attain the high values indicated. An alloy in which such properties are attainable under suitable treatment is one containing from about 7 to 15 per cent of zinc, 0.5 to 2.5 per cent of copper, 0.2 to 2.5 per cent of magnesium, and 0.1 to 1.5 per cent of manganese. This alloy is especially well adapted to the production of forged articles such as typewriter segments, gasoline pump handles, and the like, because of the excellent hot working quality of the metal. In finishing such articles as those named and many others, it is necessary to employ some machining operation such as boring, drilling, planing, shaping and the like to complete the article for use. While these operations have been performed on the aforesaid alloy in the past, the machining quality has not been such as to facilitate the finishing operations because of the precautions necessary to obtain an acceptably smooth surface without the dragging of metal on the cutting tool edge. The deficiency in machinability is also evidenced by the long curled chips that are produced which may foul the cutting tool or operating parts of the machine. The tendency of the metal to drag under the tool edge results in an uneven cut and a dull irregular machined surface which is obviously undesirable.

It is accordingly an object of our invention to overcome these obstacles to easy and economical machining of alloys of the type disclosed above. Another object is to accomplish the foregoing purpose without detrimental effect upon the casting, working, and physical properties or susceptibility to thermal treatments.

Our invention is predicated upon the discovery that the machining quality of the aluminum base alloys containing from about 7 to 15 per cent of zinc, 0.5 to 2.5 per cent of copper, 0.2 to 2.5 per cent of magnesium, and 0.1 to 1.5 per cent of manganese, may be markedly improved by the addition thereto of at least one of the elements lead, thallium, and bismuth. These elements are advantageously added in amounts of from about 0.1 to 6 per cent either separately or in combination. Alloys so formed possess excellent machining characteristics which may be described as being "free machining" or "free cutting". Alloys of this nature may be readily cut on automatic machines at higher speeds than other allows while still retaining dimensional accuracy and a satisfactory machined surface. For the purpose of our invention the elements lead, thallium, and bismuth are designated "free machining constituents" or elements and are regarded as being substantially equivalent by reason of the similarity in effect upon the machining quality of the alloys herein disclosed.

While lead, bismuth, and thallium may be used in amounts of from about 0.1 to 6 per cent as set forth hereinabove, we prefer to use between about 1 and 4 per cent of these free machining constituents in alloys of the class described. The advantages gained from the use of the above named elements are especially evident in alloys containing from about 8 to 12 per cent of zinc, from about 0.5 to 1.5 per cent of copper, from about 0.5 to 1.5 per cent of magnesium, and 0.5 to 1 per cent of manganese, the balance being substantially all aluminum. As an example of the improvement in machinability gained through the use of free machining constituents the case of an alloy may be cited where the alloy was composed of about 9.5 per cent of zinc, 0.8 per cent copper, 0.5 per cent magnesium, and 0.8 per cent manganese, the balance being aluminum. By the addition of about 4 per cent of lead a smooth bright regularly cut machined surface was obtained on the article when machined. The chips were short and easily broken so that danger of fouling the cutting tool was eliminated as compared to the long spirals obtained from the alloy containing no free machining constituent. The tensile properties of the alloy were not materially affected by the presence of lead. The elements bismuth and thallium produce an improvement in machining quality similar to that obtained through the use of lead.

It has also been found that the elements lead, bismuth, and thallium may be advantageously

used in combination as well as separately to confer free machining characteristics on alloys of the type herein disclosed. When so employed together, the total amount of the added elements should not exceed about 8 per cent and it is preferred to keep the total below about 6 per cent. A surprising fact discovered concerning the behavior of alloys containing two or more of the free machining constituents is that a superior degree of machinability is often obtained in such cases as compared to the same base alloy with an equivalent amount of only one element present. An alloy, for example, containing about 9.5 per cent zinc, 0.8 per cent copper, 0.5 per cent magnesium, 0.8 per cent manganese, 2 per cent of lead, and 2 per cent of bismuth, balance substantially all aluminum, had better machining characteristics than the same alloy containing 4 per cent of bismuth instead of a combination of lead and bismuth.

The tensile properties of the alloys are not materially altered by the addition of the free machining constituents in amounts up to about 4 per cent. Beyond this amount there is a decline in strength but this is accompanied by a somewhat better machinability of the alloy because of the increased amount of free machining constituent. The amount of lead, thallium and/or bismuth to be chosen for a given alloy is dependent upon the strength and degree of machinability required.

The free machining constituents are most conveniently added in solid elemental form to the molten aluminum alloy since they melt at a temperature considerably below that ordinarily encountered in aluminum alloy melting practice. If more than about 1.5 per cent of these constituents is to be added to the alloy, the temperature of the molten bath should be raised above that commonly employed, the desired metals added, and the molten mass vigorously stirred to insure a thorough mixing of the metals. The method here referred to of adding heavy low melting point metals to aluminum is more fully described in co-pending application, Serial No. 689,885, now issued as U. S. Patent No. 1,959,029.

The term "aluminum" used herein and in the appended claims embraces the usual impurities found in aluminum ingot of commercial grade, or picked up in the course of the usual handling operations incident to ordinary melting practice.

The alloys herein disclosed may be subjected to the usual thermal treatments familiar to those skilled in the art for the purpose of improving or altering their physical characteristics.

We claim:

1. An aluminum base alloy containing from about 7 to 15 per cent of zinc, from about 0.5 to 2.5 per cent of copper, from about 0.2 to 2.5 per cent of magnesium, from about 0.1 to 1.5 per cent of manganese and from about 0.1 to 6 per cent of bismuth, the balance being aluminum.

2. An aluminum base alloy containing from about 7 to 15 per cent of zinc, from about 0.5 to 2.5 per cent of copper, from about 0.2 to 2.5 per cent of magnesium, from about 0.1 to 1.5 per cent of manganese, and from about 1 to 4 per cent of bismuth, the balance being aluminum.

3. An aluminum base alloy containing from about 7 to 15 per cent of zinc, from about 0.5 to 2.5 per cent of copper, from about 0.2 to 2.5 per cent of magnesium, from about 0.1 to 1.5 per cent of manganese, and about 4 per cent of bismuth, the balance being aluminum.

4. An aluminum base alloy containing from about 7 to 15 per cent of zinc, from about 0.5 to 2.5 per cent of copper, from about 0.2 to 2.5 per cent of magnesium, from about 0.1 to 1.5 per cent of manganese and about 2 per cent of bismuth, the balance being aluminum.

5. An aluminum base alloy containing about 9.5 per cent of zinc, 0.8 per cent of copper, 0.5 per cent of magnesium, 0.8 per cent of manganese and 4 per cent of bismuth, the balance being aluminum.

6. An aluminum base alloy containing from about 8 to 12 per cent of zinc, from about 0.5 to 1.5 per cent of copper, 0.5 to 1.5 per cent of magnesium, from about 0.5 to 1 per cent of manganese, and from about 0.1 to 6 per cent of bismuth, the balance being aluminum.

7. An aluminum base alloy containing from about 8 to 12 per cent of zinc, from about 0.5 to 1.5 per cent of copper, from about 0.5 to 1.5 per cent of magnesium, from about 0.5 to 1 per cent of manganese and from about 1 to 4 per cent of bismuth, the balance being aluminum.

LOUIS W. KEMPF.
WALTER A. DEAN.