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FREE CUTTING ALLOYS

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1 Claim. (Cl. 75—1)

The invention relates to aluminum base alloys and is particularly concerned with alloys of this nature containing substantial amounts of copper.

Despite the manifold advantages connected with the use of aluminum and its alloys in commercial fields, there is an inherent drawback which somewhat curtails their use in certain potential adaptations. Aluminum alloys, for instance, containing from about 4 per cent to about 12 per cent of copper have a wide range of usefulness because of their favorable mechanical properties and their susceptibility to improvement by suitable thermal treatments. Mechanical cutting operations, however, such as boring, drilling, planing, or lathe-cutting are successfully carried out only by using certain precautions which increase the expense of the operation and which occasionally necessitate the substitution of another alloy which may be machined more readily but which is otherwise not so desirable from the standpoint of physical properties. When alloys are difficult to machine this disadvantage becomes evident, in many cases, through rapid wear of the cutting tool edge which necessitates frequent resharpening. In such cases where machining is difficult, continual lubrication is required; the machined surface is rough and irregular, and the chip has a tendency to form continuous curls or spirals that may foul the tool or the operating parts of the machine. These drawbacks retard production and increase the cost of operation. Many articles require a variety of machining operations before being applied to their final purpose and it is particularly desirable that these articles be finished economically and satisfactorily.

An object of this invention, therefore, is the production of alloys which may be readily machined and which contain substantial amounts of copper.

A further object is the production of such alloys whose mechanical properties in the preferred composition range are perfectly adequate to suit most commercial purposes.

These objects we have effected by the addition to aluminum-copper-cadmium alloys of at least one of the elements lead, bismuth or thallium. For the purposes of our invention these elements are substantially equivalent, their behavior in alloys of the class herein described being similar in respect to machining characteristics.

We have discovered that cadmium, when used in amount between 0.05 per cent and 1.5 per cent in aluminum base alloys containing from about 4 per cent to about 12 per cent of copper, forms a

particularly desirable base alloy to which can be added one or more of the alloying elements lead, bismuth, or thallium. The lead may be present in amount between about 0.1 per cent and 10 per cent, the bismuth between about 0.05 per cent and 1.5 per cent, and the thallium between about 0.05 per cent and 3 per cent. These added elements, in combination with cadmium in aluminum-copper alloys, have a very favorable effect on the machining properties of the alloys. In this sense the elements cadmium, lead, bismuth, and thallium may be termed "free machining" constituents, just as the alloys they form are now called "free machining" alloys, to indicate the fact that they may be machined more rapidly, and with a chip which flows more freely from the tool leaving a cleaner machined surface than similar alloys not containing the cadmium, bismuth, lead, or thallium.

Cadmium within the above disclosed range effects an increase in the tensile strength, shear strength, and Brinell hardness of the aluminum-copper alloys while the elongation is caused to drop off correspondingly. The remaining constituents, namely, lead, bismuth, or thallium, appear not to materially affect the mechanical properties of the aluminum-copper alloys except in so far as they are beneficial to the machining properties. We have found that when the cadmium is used in combination with one or more of the other free machining elements lead, bismuth or thallium, the advantageous effect of the cadmium on the tensile strength, shear strength, and hardness of the aluminum-copper alloys is not diminished materially whereas the machining properties of the resulting alloys are very materially accentuated.

The simultaneous presence of more than one of the disclosed free machining elements is more advantageous than that of the same total amount of either of the elements used separately. If, for instance, we are working with an aluminum base alloy containing about 6 per cent of copper and 1.0 per cent of cadmium, and in a particular application we desire to add about 1.5 per cent of free machining constituents in combination with the cadmium, it is more advantageous to make up this 1.5 per cent by using more than one of the constituents lead, bismuth, or thallium, than to add 1.5 per cent of one element alone. In conformity with the same principle, the addition of one of the elements lead, bismuth, or thallium to the aluminum-copper alloys in which cadmium is present is more helpful to the machining properties than the use of an equivalent

total amount of the cadmium alone. One of the advantages of our invention lies in the retention of the improvement in tensile properties due to cadmium and the accentuation of the beneficial effect it exerts on cutting characteristics of the alloys.

If only one of the elements lead, bismuth, or thallium is to be added to aluminum-copper-cadmium alloys we prefer to use about 1.0 per cent of the element. As a preferred base alloy we use an aluminum alloy containing 6.0 per cent of copper and 0.25 per cent of cadmium. If more than one of the elements lead, bismuth, or thallium is to be added to an aluminum-copper-cadmium alloy the preferred amount of free machining elements, inclusive of the cadmium, should be about 1.0 per cent, although amounts in excess of this composition, and up to the total amount of each disclosed hereinbefore, continue to exert a beneficial effect on the cutting properties of the alloy. The preferred limit of 1.0 per cent of total free machining constituent represents a point at which the mechanical properties and the machining properties of the alloy reach a most favorable balance although of course there may be many commercial applications wherein improved machining characteristics caused by further additions of free cutting constituents may more than compensate for the lowering of mechanical properties.

The lead, thallium, cadmium, and bismuth may be added by introducing these constituents in solid form into a molten heat of the aluminum base alloy since they melt at a temperature considerably below those customarily encountered

in the commercial handling of molten aluminum or its alloys in the foundry. Since the specific gravity of the free machining elements is considerably higher than that of aluminum, and their liquid solubility is limited, the melt should be heated somewhat above the ordinary temperature and stirred vigorously to assure a thorough mixture of the alloying constituent. The method of adding heavy low melting point metals to aluminum here referred to is more fully described in copending application Serial No. 689,885, filed September 18, 1933 now Patent No. 1,959,029, granted May 15, 1934. Alloys disclosed but not claimed herein are claimed in our copending applications, Serial Nos. 19,604, 19,605, and 19,606, filed May 3rd, 1935.

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

The term "aluminum" as used herein and in the appended claim 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.

We claim:

An aluminum base alloy containing from about 4 to 12 per cent of copper, from about 0.05 to 1.5 per cent of cadmium, and between about 0.1 and 10 per cent of lead, 0.05 and 1.5 per cent of bismuth, and 0.05 and 3 per cent of thallium, the balance being aluminum.

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