

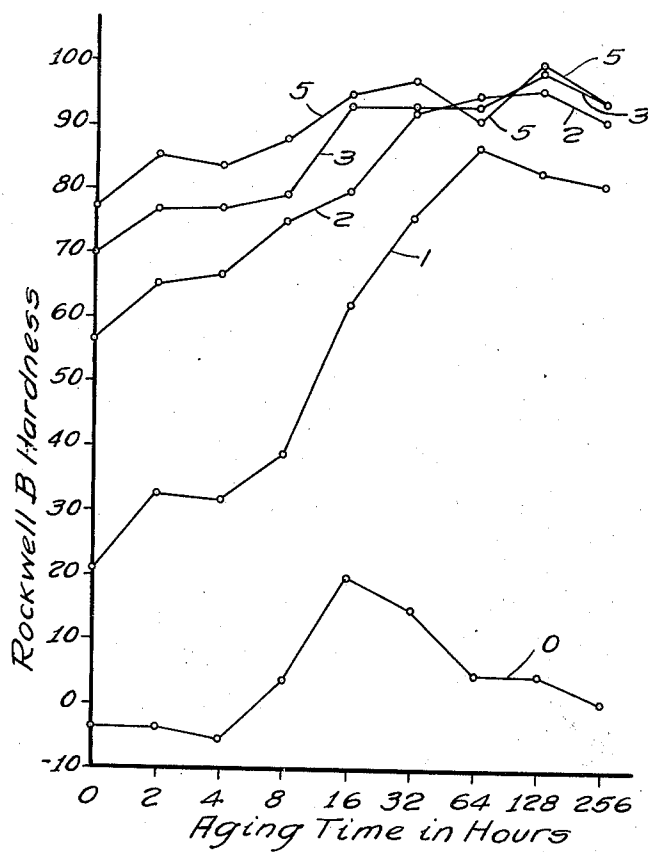
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COPPER BASE ALLOY

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WITNESSES:

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COPPER BASE ALLOY

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This invention relates to copper base alloys and in particular, to copper base alloys of the aluminum bronze type.

Alloys of aluminum and copper are known in the industry and are employed where the characteristics of corrosion resistance is required. The known copper aluminum alloys are, however, limited to certain applications which do not require high physical strength and hardness.

It is an object of this invention to provide a copper base alloy of the aluminum bronze type which will have high physical strength, together with corrosion resistant characteristics.

Another object of this invention is to provide a copper base alloy of the aluminum bronze alpha type which may be precipitation hardened to impart high physical strength thereto, the resulting alloy being resistant to corrosion.

Other objects of this invention will become apparent from the following description when taken in conjunction with the accompanying drawing, the single figure of which is a graph, the curves of which illustrate the hardness values obtained with representative alloys of this invention.

The alloys of this invention are prepared in accordance with standard melting practice from copper, aluminum, cobalt and iron. Sufficient aluminum is employed to give an aluminum content of from 5% to 7% while each of the cobalt and iron contents in the copper base ranges from .5% to 5%. These alloying elements cooperate to give an aluminum bronze alloy of the alpha type which is resistant to oxidation and which can be heat treated to impart a high strength to the alloy whereby the alloy is satisfactory for use as a casting alloy.

In order to develop the mechanical strength of the alloy, castings therefrom are subjected to a precipitation hardening treatment comprising subjecting the alloy to a high temperature below the melting point of the alloy for obtaining a high solid solution of the cobalt and iron in the alloy, quenching the alloy from the high temperature to retain the cobalt and iron in solid solution and then reheating or ageing the alloy at a lower or ageing temperature for a period of time sufficient to precipitate the cobalt or certain of the cobalt compounds formed therein and the iron from the solid solution state. In practice, heating the alloy at a temperature between 750° C. and 1025° C. is found to effect a high solid solution of the cobalt and iron in copper while reheating or ageing the alloy at a temperature of between 350° C. and 650° C. effects the precipitation

of the cobalt or cobalt compounds and iron to impart the desired characteristics to the resulting alloy.

As a specific example of the improved hardness characteristic obtained with the alloy of this invention, reference may be had to the accompanying drawing, the curves of which represent the values obtained for different representative alloys illustrating this invention. In the drawing, the abscissa represents the ageing time in hours and the ordinate represents the Rockwell B hardness values obtained. The curves of the drawing are based on hardness values obtained on the five alloys of the following table, the aluminum alloying content of these alloys being maintained a constant in order to better illustrate the beneficial effects of the cobalt and iron as alloying elements in alpha bronzes of the copper aluminum type.

Alloy No.	Composition			
	Percent Co	Percent Fe	Percent Al	Percent Cu
3869	1	1	7	93
3866	1	1	7	91
3877	2	2	7	89
3878	3	3	7	87
3879	5	5	7	83

In the drawing, curves 0, 1, 2, 3 and 5 represent results obtained with the alloys in the order given in the table and containing 0, 1, 2, 3 and 5% respectively of each of iron and cobalt after they were subjected to a heat treatment consisting of quenching them from a temperature of 950° C. and ageing them at a temperature of 500° C. for different periods of time. From these curves, it is quite apparent that the iron and cobalt cooperate with each other and with the aluminum in the copper base to give an alloy of improved characteristics. This is quite apparent from a comparison of curves 1, 2, 3 and 5 which represent the results obtained with alloys of this invention with the results shown by curve 0 which represents the results obtained with a binary copper aluminum alloy having the same aluminum content.

The alloys of this invention have very good thermal endurance characteristics, that is, the characteristic to retain hardness or strength at elevated temperatures. These copper-cobalt-iron-aluminum alloys have been found to retain their high strength even when subjected to temperatures of 850° C. for periods of time of 60 hours.

Since the copper base alloys containing the aluminum, cobalt and iron within the ranges given are suitable for casting and can be precipitation hardened to impart strength thereto, they can be used in making articles where casting to a predetermined shape is a prerequisite and where high strength castings are required. It also has been found that cold work can be applied to the heat treated alloys of this invention to further improve their strength. As illustrative of the high tensile strength obtained with alloys of this invention both in the heat treated cast condition and also in the heat treated and cold worked condition, reference may be had to the following table in which the results obtained with the alloys identified in the table given hereinbefore are listed.

Alloy No.	Tensile strength, pounds per square inch	
	Treatment A	Treatment B
3869	31,400	48,000
3868	54,000	84,000
3877	71,500	122,000
3878	98,000	120,000
3879	84,200	90,000

In obtaining the results listed in the foregoing table, each of the alloys was subjected to each of two treatments, Treatment A consisting of quenching the alloy from a temperature of 1000° C. and ageing it for 20 hours at a temperature of 500° C. while Treatment B is a similar heat treatment with the addition of supplementary cold work in the amount of a 25% reduction in area of the article worked. Thus the alloys of this invention, due to the cooperation of the cobalt and iron, have all the advantages of the alpha type binary alloys with the addition that they are susceptible to precipitation hardening heat treatment.

The alloys of this invention containing from 5% to 7% of aluminum and from .5% to 5% of each of cobalt and iron, with the balance copper, also have the desirable characteristic of being resistant to oxidation when subjected to heat at elevated temperatures. In order that the alloy may have oxidation resistant characteristics

it is preferred that the aluminum content be not less than 5%. As a specific example of the oxidation resistant characteristic alloys of this invention, it is found that articles formed therefrom are entirely free from any evidence of oxide formation thereon even after being exposed in circulating air at a temperature of 850° C. for a period of time of 60 hours.

From the foregoing it is quite apparent that a copper base alloy containing aluminum, iron and cobalt within the ranges given is produced which is entirely satisfactory as a casting alloy since the alloying elements cooperate when subjected to precipitation hardening to impart high strength thereto. The alloy having the composition of 2% iron, 7% aluminum, 2% cobalt and 89% copper is quite satisfactory, since the results obtained therewith approximate the results obtained with the maximum alloying contents. All the alloys containing the alloying element within the ranges given are resistant to oxidation and because of their high strength will find many and varied applications where such characteristics are necessary.

Although this invention has been described with reference to a particular embodiment thereof, it is, of course, not to be limited thereto except insofar as is necessitated by the description thereof and the scope of the appended claims.

I claim as my invention:

1. An alloy comprising from 5% to 7% of aluminum, from .5% to 5% of iron, from .5% to 5% of cobalt, and the balance substantially all copper.

2. An alloy comprising from 5% to 7% of aluminum, from 2% to 5% of iron, from 2% to 5% of cobalt, and the balance substantially all copper.

3. As an article of manufacture, an alloy comprising from 5% to 7% of aluminum, from .5% to 5% of iron, from .5% to 5% of cobalt, and the balance substantially all copper, cast to a predetermined shape and precipitation hardened to give it high physical shape, said article being resistant to oxidation at temperatures of up to between 750° C. and 850° C.

4. An alloy composed of about 7% of aluminum, about 2% of cobalt, about 2% of iron and the balance copper.

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