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COPPER-SILVER ALLOYS

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This invention relates to alloys, and more particularly to copper alloys of improved characteristics.

An object of the invention is to produce an improved copper base alloy.

Another object is to produce a copper-silver alloy which can be age hardened by the additions of beryllium.

Other objects of the invention will be apparent from the following description taken in connection with the appended claims.

The present invention comprises the combination of elements, methods of manufacture, and the product thereof brought out and exemplified in the disclosure hereinafter set forth, the scope of the invention being indicated in the appended claims.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the combination of elements without departing from the spirit of the invention.

We are aware that a great deal of work has been done on silver-copper-beryllium alloys. In most cases, however, the silver content was rather high and we are not aware of any prior art on silver contents below 5%. Silver is a rather expensive element and the alloys produced up to the present time have not found commercial use, because of their high price. In our researches, we have discovered that considerably lower percentages of silver can be employed than heretofore described, and that very excellent properties are obtained with such alloys.

Copper-silver alloys are susceptible to age hardening. This age hardening, however, is manifested more in improvements in electrical conductivity than in improvements in hardness. The hardness of alloys usually has to be obtained by cold working. Due to the fact that the copper-silver system is inherently an age hardening system, the annealing point of such cold worked alloys is fairly high. Silver, furthermore, has the outstanding advantage that it will not decrease the electrical conductivity materially when alloyed with copper. This also is due to the very limited solid solubility of silver in copper.

We have found that at 600 degrees C., approximately 2.5% silver is held in solid solution, while at 200 degrees C., only .3% of silver is held in solid solution, and at room temperature, this solubility is still less. This indicates definitely that with small percents of silver, below 5%, definite effects can be obtained, as far as precipitation hardening is concerned.

By combining the effects of age hardening of the copper-silver and the copper-beryllium system, an alloy can be produced which shows a very high hardness obtained with the copper-beryllium system and an improved electrical conductivity, such as is obtained in the copper-silver system.

It is possible, for instance, to produce an alloy containing 2 to 4% silver and 0.3 to 0.75% beryllium, which after suitable heat treatment will show a conductivity of close to 50%, and a tensile strength of 95,000 p. s. i.

It is also possible to reduce the silver contents to very low limits and obtain an improved alloy, the improvement consisting not only in a higher electrical conductivity and in a higher age hardening temperature, but also in superior characteristics, in regard to corrosion resistance and oxidation characteristics. The alloys are furthermore suitable for electrical contacting purposes, because they retain a comparatively low contact resistance.

The alloys may preferably contain the essential ingredients in the following ranges of proportions:

	Percent
Beryllium	0.03 to 3
Silver	0.05 to 4
Copper	Balance

It has been found very advantageous in many cases to add to the alloys containing copper, beryllium and less than 5% silver, elements from the second group of the periodic system and more particularly zinc, cadmium and magnesium. The percentages which cause substantial improvements covered by the present disclosure, range from 0.05 to 10%.

Within these composition ranges, there are a number of specific alloys which have been found to be of particular importance. Some of the alloys are listed below:

	Percent		Percent
a. Cadmium	0.5 to 1	*b.* Cadmium	0.5 to 1
Beryllium	0.2 to 1	Beryllium	1 to 2.5
Silver	0.1 to 1	Silver	1 to 4
Copper	Balance	Copper	Balance
	Percent		Percent
c. Zinc	0.1 to 5	*d.* Zinc	0.1 to 5
Silver	0.1 to 2.5	Silver	0.1 to 2.5
Beryllium	0.2 to 1	Beryllium	1 to 2.5
Copper	Balance	Copper	Balance
	Percent		Percent
e. Magnesium	0.1 to 2	*f.* Magnesium	0.1 to 2
Beryllium	0.2 to 1	Beryllium	1 to 2.5
Silver	0.1 to 2.5	Silver	0.1 to 2.5
Copper	Balance	Copper	Balance

The alloys can be made according to standard alloying methods, such as melting the copper and adding the desired amounts of silver and if desired, one or more of the elements, zinc, cadmium, and magnesium. Afterwards the correct amount of beryllium may be introduced in the form of a copper-beryllium master alloy or

any other form and the material can be cast either in a chill mould or in a sand mould, at the correct temperature.

After the alloy has been prepared according to standard alloying methods, the heat treatment may be carried out as follows:

The alloy in the form of a billet or a sand casting or any desired form, is raised in temperature to above 700 degrees C. and below its melting point. The alloy is then quenched from this temperature and subsequently aged at temperatures at or below 600 degrees C. This heat treatment results in considerable improvements in the physical properties of the alloy. The alloy is particularly suitable for applications where high hardness and high electrical conductivity are required and where physical properties have to be retained at elevated temperatures. The alloys have found further very extensive use in applications where the material is used for electrical contacting purposes, such as contactor contacts where arcs are drawn and surface oxidation produces high resistance films on ordinary copper alloys.

The alloys have further found considerable use for wear resistance purposes and applications, such as pressure welding electrodes and resistance welding dies in general.

The alloys are furthermore very suitable for springs, particularly springs which have to carry current or which have to withstand certain temperature rises without losing their elastic properties.

The material is also suitable for special applications where springs of intricate design must be formed in the soft condition; that is, after quenching, and where a high hardness can be reached after a suitable age hardening treatment.

The alloys can be manufactured into the form of extruded bars, or sheets of fine wire. The alloys have also particular merit if used in the form of sand castings. Certain compositions, particularly with higher cadmium contents, can not be hot or cold worked, but are ideally suitable for making strong and hard copper base castings.

The alloys are particularly suitable for any parts in electrical machinery where the silver content, in combination with the beryllium content, produces the desirable characteristics required for such applications.

The addition of the elements of the second group of the periodic system and more particularly cadmium alloys to replace part of the expensive silver by cadmium and therefore reduce the cost of the alloy, has been found advantageous.

While the present invention as to its objects and advantages has been described herein, as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. An alloy composed of 0.03 to 3% beryllium, 0.05 to 4% silver, 0.05 to 10% of a material selected from the group consisting of cadmium and zinc and the balance copper.

2. An age-hardened alloy composed of 0.03 to 3% beryllium, 0.05 to 4% silver, 0.05 to 10% of a material selected from the group consisting of cadmium and zinc and the balance substantially all copper, characterized by high hardness and electrical conductivity and further characterized by the fact that its hardness and conductivity are not permanently adversely affected by elevated temperatures.

3. An alloy composed of 0.03 to 0.75% beryllium, 2 to 4% silver, 0.05 to 10% of a material selected from the group consisting of cadmium and zinc and the balance copper.

4. An electrical contacting element formed of an alloy composed of 0.03 to 3% beryllium, 0.05 to 4% silver, 0.05 to 10% of a material selected from the group consisting of cadmium and zinc and the balance copper.

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