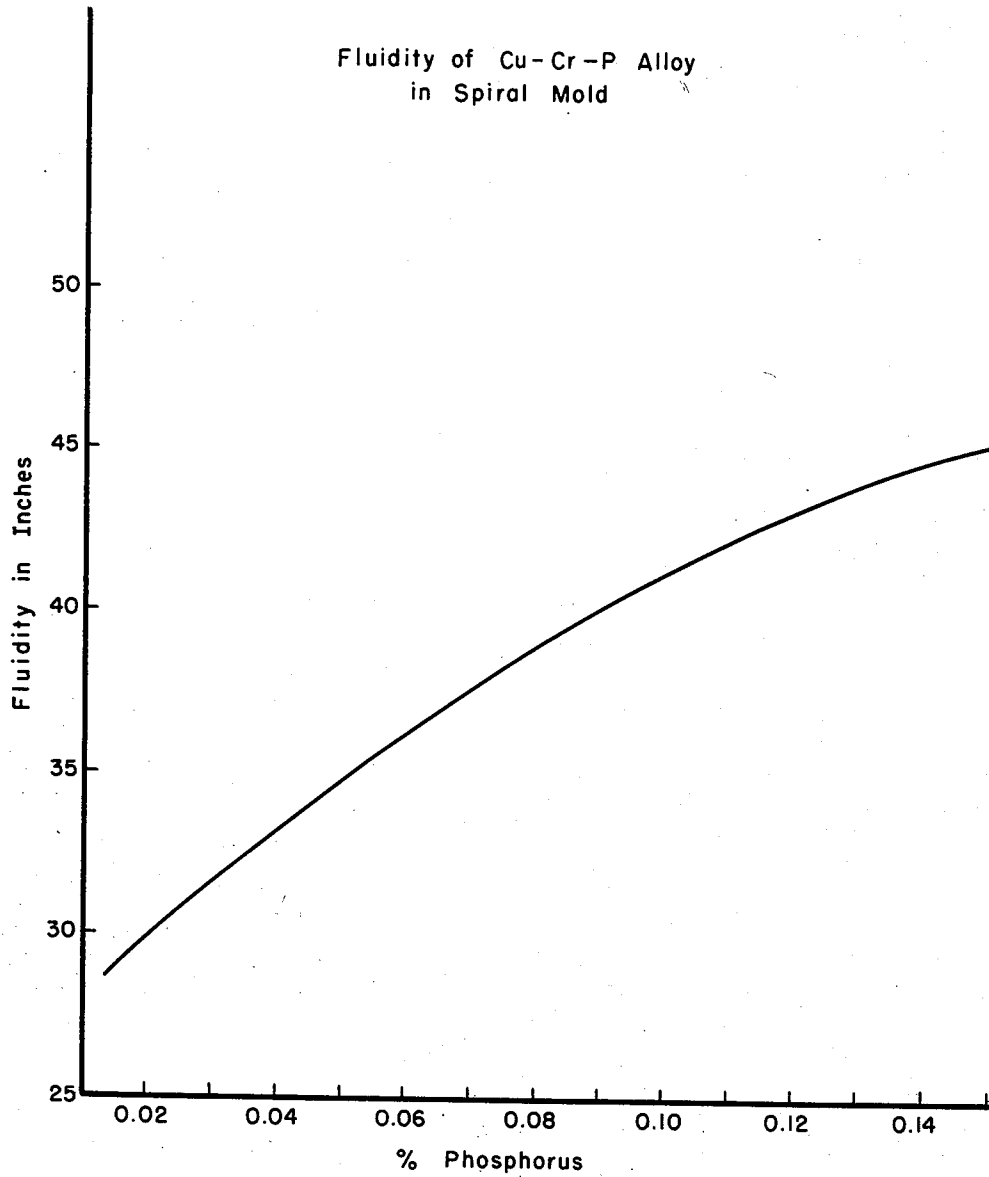


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J. M. KELLY
COPPER BASE ALLOYS
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WITNESSES

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2,795,501

COPPER BASE ALLOYS

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2 Claims. (Cl. 75—153)

This invention relates to copper base alloys.

Alloys of copper and more than about 0.01 percent of chromium, with or without 0.01 to 5.0 percent of silver may be precipitation hardened to develop desirable mechanical and electrical properties. Considering, for example, copper-chromium-silver alloys of the general type disclosed in United States Patent No. 2,033,709, it is characteristic of them that when properly heat treated, for instance by quenching from about 1050° C. followed by aging at a temperature between 250° and 600° C., they possess high electrical and thermal conductivity and mechanical properties adapting them to electrical uses, which properties are maintained at high working temperatures over prolonged periods of time. Such alloys have been used commercially to the extent that the owner of the aforesaid patent has established standard specifications for them in the heat treated condition: ultimate strength 40,000 p. s. i. min.; yield strength 30,000 p. s. i. min.; elongation 15 percent min., Brinell hardness 90 min.

The presence of phosphorus in the foregoing alloys is desirable because it tends to improve fluidity and to flux the tenacious slag films common in chromium-containing alloys. However, the use of phosphorus in these alloys has been regarded with caution because it combines with chromium to form chromium phosphide, and the amount of chromium so fixed becomes unavailable for precipitation hardening. Although phosphorus has been used in these alloys, in consequence of its disadvantageous effect the amount in the alloy itself has been limited to a maximum of 0.02 percent. Greater fluidity and castability of these alloys would be desirable, however, both to improve the surface quality of cast billets and to enhance the ability to cast articles of intricate shape, especially with thin sections.

It is among the objects of this invention to provide copper base alloys containing chromium or chromium and silver together with larger amounts of phosphorus than has heretofore been thought feasible, whose response to heat treatment is not impaired by the phosphorus content, whose electrical, thermal and mechanical properties are acceptable to the trade, which are of improved fluidity and castability as compared with previously used alloys of this type, and which may be cast into billets of improved surface quality and castings of intricate shape.

A further object is to provide a master alloy, or hardener, for the production of alloys in accordance with the foregoing object.

Yet another object is to provide alloys in accordance with the foregoing patent that are at least equal in properties and are of improved utility.

The single figure of the drawing comprises a curve plotting fluidity of a copper-chromium-phosphorus alloy for varying percentages of phosphorus.

For the desired improvement in fluidity these copper base alloys must contain at least about 0.06 percent of phosphorus. Likewise, for development of the necessary mechanical properties the alloys must contain sufficient

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uncombined chromium to permit formation, upon heat treatment, of a solid solution of it that will be metastable upon quenching so as to insure subsequent precipitation hardening with development of the requisite mechanical properties. I have discovered, and it is upon this that the invention is predicated, that within this framework the desired improved fluidity and the ability to meet the foregoing specification on mechanical properties is to be had with copper base alloys of chromium and phosphorus, or chromium-silver-phosphorus, provided the ratio Cr/P is at least 7.5:1. In other words, with ratios of Cr/P of 7.5 or greater the alloys in the heat treated and aged condition will possess hardnesses of at least 90 Brinell and correspondingly possess the other properties required by the aforesaid specification, while hardnesses below 90 Brinell are developed upon heat treatment of similar alloys by having Cr/P ratios less than 7.5.

A series of castings were prepared in a spiral fluidity test mold similar to that shown in Figure 3 on page 200 of the "Metals Handbook—1948 edition." These castings comprised melts of a series of copper-chromium-phosphorus alloys prepared from a copper-chromium base alloy composed of 0.83% by weight of chromium, with a different amount of phosphorus being added to each melt, to produce melts having from about 0.02% to about 0.11% of phosphorus. The several melts were all cast at substantially the same temperature into the spiral mold. After cooling, the spirals of the castings were measured—the more fluid the melt the further it would flow into the spiral and the longer the spiral part of the casting would be. The curve in the drawing establishes a very pronounced increase in fluidity with phosphorus content increase in the range of the present invention.

Within the possible range of chromium and phosphorus permissible to maintain the minimum Cr/P ratio of 7.5, the alloys may for some purposes contain a maximum of about 5 percent of chromium, with the phosphorus such that the critical ratio stated is met or exceeded. For most purposes it is preferred that the alloys contain from about 0.45 to 1.12 percent of chromium with from 0.06 to 0.15 percent of phosphorus. To improve the thermal endurance, the alloys may contain silver also, for instance between 0.01 and 5 percent, although for most purposes satisfactory results are to be had with about 0.08 to 0.12 percent of silver. The remainder of the alloys is copper, together with other elements and impurities in minor amounts that do not impair the characteristic properties.

Cast members comprising the alloys are prepared for use by heat treatment, preferably by solution treatment between 900° and 1075° C. for a period of time to form a solid solution of chromium in copper, followed by rapid quenching and subsequent reheating at a temperature between about 250° C. to 600° C. to develop the desired hardness and electrical conductivity. The heat treatment is set forth in Patent 2,281,691.

The invention is applicable also to the preparation of a master alloy, or hardener that may be used for direct addition to molten copper to prepare the ultimate alloys as described above. In this embodiment the master alloy comprises about 4.5 to 6.5 percent of chromium and 0.5 to 0.75 percent of phosphorus whereby the Cr/P ratio is in accordance with the invention. The remainder of the alloy consisting of copper together with incidental impurities as to which there should be a maximum of the following: 0.2 percent each of silicon, carbon and iron, and 0.015 percent of lead.

The invention is applicable not only to the production of cast alloys but also to the production of wrought articles. The improved fluidity is of particular value not only in the production of intricate castings but also because the surface quality of cast billets intended for forging or the like is materially improved as compared with

the prior practice of holding the phosphorus to a maximum of 0.02 percent.

From what has been said it will be understood that the term "copper base" contemplates alloys containing at least about 90 percent of copper.

According to the provisions of the patent statutes, I have explained the principle of my invention and have described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim as my invention:

1. A cast member comprising a precipitation hardenable copper base alloy consisting essentially of from 0.45% to 1.12% of chromium, from 0.06% to 0.15% by weight of phosphorus, the balance being copper with

elements and impurities in amounts not adversely affecting the characteristic properties of the alloy, the ratio of chromium to phosphorus being at least 7.5 to 1.

2. A cast member comprising a precipitation hardenable copper base alloy consisting essentially of from 0.45% to 1.12% of chromium, from 0.06% to 0.15% by weight of phosphorus, from 0.01% to 5% by weight of silver, the balance being copper with elements and impurities in amounts not adversely affecting the characteristic properties of the alloy, the ratio of chromium to phosphorus being at least 7.5 to 1.

References Cited in the file of this patent

UNITED STATES PATENTS

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