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COPPER BASE ALLOY

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This invention relates to improvements in copper-base alloys.

One object of this invention is to provide an improved copper-base alloy free from fissuring and having high strength and hardness, easy machining qualities, good corrosion-resistance, and a certain well-known red-bronze color desired for hardware use.

Other objects of this invention will appear from the present disclosure.

It has long been desired to have an alloy free from fissuring and having high strength and hardness, easy machining qualities, good corrosion-resistance, a certain well-known red-bronze color desired for hardware use, and a high tensile strength considerably higher than 50,000 lbs. per square inch, and preferably at least 60,000 lbs. per square inch. Previous efforts to produce such an alloy have not been satisfactory as the alloying metals added to give the required characteristics have caused excessive difficulty in producing the rods, or an unwarranted increase in cost, or an intolerable change in the particular important red-bronze color. We have invented, however, an alloy which we are about to set forth which possesses all of the desired properties even including substantial freedom from fissuring, the desired red-bronze color, with no sacrifice of workability and at less cost due to the subtantial freedom from losses due to fissuring, and in rods in sizes of from one-inch to two-inch diameter has a tensile strength of at least 60,000 lbs. per square inch, and in sizes under one-inch diameter has a tensile strength of at least 65,000 lbs. per square inch.

This improved alloy contains by weight, copper from 85% to 90%, nickel from ½% to 1¼%, phosphorus from 0.06% to 0.3% and from ⅓ to 1/10 of the weight of the nickel content but preferably about ⅕ of the nickel, from 0.2% to 2½% of metal from the group consisting of lead, tellurium and selenium to render the alloy freely machinable, and the balance substantially of zinc, the zinc being from 7% to 14%, and the total of the copper and zinc being at least 95%. Where lead is used, it would be from ¾% to 2½%. Where tellurium and/or selenium is used, it would total from 0.2% to ¾%.

A more preferred alloy is to have the foregoing alloy modified by having the nickel from 0.6% to 1%, and the phosphorus from 0.08% to 0.2%.

A still more preferred alloy is to have the copper from 85% to 90%, the nickel about ¾%, phosphorus about 0.15%, from 0.3% to 2½% of material from the group consisting of lead, tellurium and selenium to render the alloy freely machinable, and the balance substantially all zinc, the zinc being from 7½% to 14%, and the total of the copper and zinc being at least 96%. Where lead is used, it would be from ¾% to 2½%. Where tellurium and/or selenium is used, it would total from 0.3% to ¾%.

If any bismuth is to be present in the alloy, it should not exceed 0.1% as it very seriously embrittles the alloy. If any aluminum is to be present in the alloy, it should not exceed 0.2% as it prevents obtaining the desired red-bronze color. If any silicon is to be present in the alloy, it should not exceed 0.1%, as with lead it forms a lead silicate which is very abrasive on cutting tools, and with tellurium or selenium forms a refractory scale and renders control of the alloy composition difficult.

A lot of alloy made in accordance with the present invention was melted in an induction furnace and cast in the form of round billets 7¾ inches in diameter. The actual composition of this alloy was copper 87.65%, nickel 0.49%, phosphorus 0.08%, lead 1.98%, zinc 9.8%. The billets were cut to about 30-inch lengths and extruded at about 1600° F. in a hydraulic extrusion press to 2-inch round rods. No difficulty was encountered, the hydrostatic pressure required being only about 3,000 lbs. per square inch, whereas the well known hardware bronze requires about 4,000 to 4,500 lbs. per square inch. The rods were scalped according to usual procedure and some were drawn to various diameters from about one to two inches, and others were cold-rolled in grooved rolls and then drawn to smaller sizes. No difficulties were encountered in drawing or annealing. Surprisingly, rods of our improved alloy were substantially immune to fissuring when subjected to commercial heating, as compared to rods of the well known hardware bronze. No fissures were encountered even when drawn rods were pulled directly into a very hot furnace, whereas fissures always occur in rods of the well known hardware bronze under such circumstances. Inasmuch as the fissures usually extend throughout the length of a rod and to a depth near to or beyond the center of the rod, a rod in which fissuring occurs becomes useful only as scrap, thus resulting in serious loss, and increase of cost for such rods as do not become fissured.

Our improved alloys can be rendered soft and ductile by annealing or heating at temperature in the range from about 1200° F. to about 1600° F. to constitute a solution treatment for the age-

hardening nickel and phosphorus, and quenching, or cooling sufficiently rapidly, from such temperature to hold age-hardening material in solution, and can be subsequently age-hardened by re-heating or aging at temperature in the range from about 700° F. to about 1000° F. for from about one-half to six hours or longer, depending on the temperature, to precipitate age-hardening material out of solution. Further, it was found that our alloys could be cold-drawn either before or after the aging and give improved tensile and yield strength either way.

It was found, also, that it was not necessary to apply the usual solution treatment by heating at a high temperature and quenching when producing large rods, since it was found that heating to above 1450° F. for extrusion, together with the normal rate of cooling during and after extrusion, apparently constitutes a sufficiently adequate solution treatment, so that simple aging after extrusion gave substantially the same results as when the usual solution plus aging treatments were used. In fact, it was further found that during reduction from the two-inch extruded size to smaller finishing sizes, the intermediate anneals followed by ordinary air cooling, also constituted a sufficient solution treatment.

Of the several possible treatment procedures, all show decided improvements in tensile properties over those obtainable with the well known hardware bronze. The preferred treatment, however, consists in annealing at about 1200° F. to about 1350° F. and air-cooling, and later aging for about two hours at about 800° F., and cold-drawing to produce a reduction of area of 20% or more, depending on the size and shape of the rod and the exact properties desired. A rod finished on 1⅜ inches diameter and so treated showed the following properties:

Tensile strength	p. s. i.	64,700
Yield strength	do	62,000
Elongation in 2"	per cent	25
Rockwell "F" hardness		99
Rockwell "B" hardness		74

The invention may be carried out in other specific ways than those herein set forth without departing from the spirit and essential characteristics of the invention, and the present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

We claim:

1. A copper-base alloy consisting substantially of: copper from 85% to 90%; nickel from ½% to 1¼%; phosphorus from 0.06% to 0.3%; from 0.2% to 2½% of material from the group consisting of lead, tellurium and selenium; and the balance substantially of zinc and at least 7%, and the total of the copper and zinc being at least 95%; the alloy being characterized by a red-bronze color, and by being relatively free from fissuring.

2. A copper-base alloy consisting substantially of: copper from 85% to 90%; nickel from 0.06% to 1%; phosphorus from 0.08% to 0.2%; from 0.2% to 2½% of material from the group consisting of lead, tellurium and selenium; and the balance substantially of zinc and at least 7%, and the total of the copper and zinc being at least 95%; the alloy being characterized by a red-bronze color, and by being relatively free from fissuring.

3. A copper-base alloy consisting substantially of: copper from 85% to 90%; nickel about ¾%; phosphorus about 0.15%; from 0.3% to 2½% of material from the group consisting of lead, tellurium and selenium; and the balance substantially of zinc and at least 7½%, the total of the copper and zinc being at least 96%; the alloy being characterized by a red-bronze color, and by being relatively free from fissuring.

4. A copper-base alloy consisting substantially of: copper from 85% to 90%; nickel from ½% to 1¼%; phosphorus from 0.06% to 0.3%; from 0.2% to 2½% of material from the group consisting of lead, tellurium and selenium; and the balance substantially of zinc and at least 7%, and the total of the copper and zinc being at least 95%; the alloy being characterized by a red-bronze color, and by being relatively free from fissuring, and said alloy having been given a solution treatment by having been suitably cooled from temperature in the range from about 1200° F. to about 1600° F. and having been hardened by having been given a precipitation treatment at temperature in the range from about 700° F. to about 1000° F.

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