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HEAT TREATMENT OF ALLOYS

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8 Claims. (Cl. 148—21.2)

This application is a division of my copending application Serial No. 143,017, filed October 20, 1926, and patented January 10, 1933, Number 1,893,984.

5 This invention relates to a method of heat treating alloys which contain copper as their principal constituent and which contain minor amounts of nickel and beryllium. These alloys may also contain nickel and the amount of nickel may be as high as 40%.

10 A principal object of my invention is to impart to such alloys by a suitable heat treatment hardness and strength far in excess of that possessed by metallic copper, thus forming a material having properties which permit of its use for many purposes for which copper is used at the present time as well as for other uses to which copper is not adapted.

15 In my Patent 1,658,186, dated February 7, 1928, I have disclosed that copper and copper alloys containing regulated minor amounts of one or more of certain silicides, among them nickel silicide, Ni_2Si , will assume a remarkably hard and strong condition if subjected to certain heat treatment of the kind to which the term "age hardening" is usually applied in the art. I have now discovered that a copper alloy containing, in place of nickel silicide, minor amounts of nickel and beryllium may be worked and heat treated in a more or less similar manner.

20 For example, an alloy containing 95.7% copper, 4% nickel and .3% beryllium can be hot or cold rolled, or otherwise worked, and after the rolling operation subjected to a softening treatment comprising quenching from above 900° C. In this state the alloy is very soft and ductile, and shows a tensile strength of 48,000 pounds per square inch with 60% elongation in two inches. It also possesses a Brinell hardness (500 kg. load, 10 mm. ball) of 52. The quenched alloy can be hardened by subjecting it to a second heat treatment which comprises heating at a temperature within the range of about 350° C. to 700° C. and holding it for a time, depending upon the temperature used and the hardness desired. Heating for a period of approximately 48 hours will secure maximum hardness when a temperature of 350° C. is used, while at a temperature of 700° C. heating for 2 hours will suffice. Alloys of the composition above-mentioned have, when subjected to a hardening heat treatment, attained a Brinell hardness of 110 and a tensile strength of 90,000 pounds per square inch with 15% elongation in two inches. The alloy, when in a hardened state

produced either by heat treatment or by cold work, shows substantially no diminution in hardness under the influence of heat until a temperature of 700° C. or upwards is reached.

The alloy in the unquenched state is further characterized by the property of self-hardening if air cooled or furnace cooled from 900° C. If cooled in a slow way as compared with air cooling, for instance, when the temperature drops from 900° C. to 700° C. in the course of one and one-half hours, the alloy acquires a hardness of 86 Brinell and a tensile strength of 72,000 pounds per square inch with 25% elongation in two inches.

Copper alloys containing from 0.1% to 2% of beryllium and as high as 40% nickel are considered to be within the scope of the present invention. However, it is preferred that nickel should be present in the proportion of about 13 parts nickel to 1 part beryllium by weight.

The electrical resistivity of the alloys coming within the present invention can be lowered by heat treatment. For example, the alloy of 95.7% copper, 4% nickel and .3% beryllium above-described has an electrical resistivity of 9.3 microhms per centimeter cube when quenched. By subjecting the alloy to a prolonged heat treatment,—i. e., heating at 700° C. for 1 hour and then gradually reducing the temperature over a period of 6 hours to 350° C.—the electrical resistivity of the alloy is brought down to 3.4 microhms or about three times that of copper. The unquenched alloy will show approximately the same electrical resistivity if air or furnace cooled from 900° C.

I claim:

1. The method of improving the properties of copper, which comprises alloying the copper with about 0.1% to 2% beryllium and with about 0.1% to 40% nickel, heating the alloy at temperatures above about 900° C. and below its melting point, whereby the alloy is softened, and subsequently heating the alloy at temperatures between about 350° C. and 900° C., whereby the alloy is hardened.
2. Process of treating an alloy containing copper as its principal ingredient, about 0.1% to 40% nickel, and about 0.1% to about 2% beryllium, which comprises heating the alloy at temperatures above about 900° C. and below its melting point, quenching the alloy, and then heating the alloy at temperatures between about 350° C. and 700° C.
3. Process of treating an alloy consisting predominantly of copper and containing about 0.1% to 40% nickel and about 0.1% to 2% beryllium

which comprises working the alloy, heating the alloy to above 900° C. and below its melting point, and then allowing the alloy to cool slowly.

4. Process of treating an alloy consisting pre-
5 dominately of copper and containing about 0.1%
to 40% nickel and about 0.1% to 2% beryllium
which comprises working the alloy, heating the
alloy to above 900° C. and below its melting point,
and then allowing the alloy to cool in air.
- 10 5. Process of treating an alloy containing cop-
per as its principal constituent and about 0.1%
to 40% nickel and about 0.1% to 2% beryllium
which comprises working the alloy; heating the
worked alloy to a temperature above 900° C. and
15 below its melting point, quenching; and then
heating the alloy at a temperature above 350° C.
and below about 700° for a sufficient time to
impart the desired degree of hardness thereto.
- 20 6. Process of treating an alloy containing cop-
per as its principal constituent and about 0.1%
to 40% nickel and about 0.1% to 2% beryllium,

which comprises heating the alloy at tempera-
tures above about 900° C. and below its melting
point, quenching the alloy, and then heating the
alloy at temperatures between about 350° C. and
700° C.

7. Process of treating alloys consisting pre-
dominately of copper and containing about 0.1%
to 40% nickel and about 0.1% to 2% beryllium,
which comprises heating the alloy to tempera-
tures above about 900° C. and below its melting
point, and then allowing the alloy to cool slowly.

8. An article comprising an alloy having cop-
per as its principal constituent and containing
nickel and beryllium, the beryllium being not in
excess of about 2% and the nickel being not in
excess of about 40%, which alloy has been soft-
15 ened by heating at temperatures above about
900° C. and below its melting point, and sub-
sequently hardened by heating the alloy above
about 350° C. and below about 900° C.

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