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WALTER MACHIN AND WILLIAM BOUCH O'BRIEN GOUDIELOCK, OF BARROW-IN-FURNESS, ENGLAND, ASSIGNORS TO P-M-G METAL TRUST LIMITED, OF LONDON, ENGLAND

METHOD OF IMPROVING COPPER OR COPPER ALLOYS AND HARDENER FOR USE THEREIN

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This invention relates to the manufacture of copper alloys and has for its object to provide an improved method of manufacture whereby alloys are produced of the character of bronzes or brasses for example but having improved properties and capable of use in conditions which will not normally admit of the employment of the copper alloys referred to.

According to the present invention a method is provided for the improvement of copper alloys which consists in the addition during manufacture of a hardener or pre-alloy, which contains silicon, iron, preferably cast iron or iron prepared from a mixture of steel and cast iron; and copper; with or without the inclusion of phosphorus. The iron constituent of the new hardener is preferably pearlitic in structure and may be obtained by the mixture of steel, preferably wrought steel and cast iron, and the steel employed in making the mixture may include one or more of the metals, nickel, chromium, molybdenum, tungsten or vanadium. The phosphorus acts as a deoxidizer, and also confers better metallurgical properties on the final alloy. Some manganese may also be added if desired.

Some copper alloys containing iron and silicon have previously been made, and for this purpose iron or steel containing only small amounts of carbon and ferro-silicon have been used; the melting points of these substances are much higher than that of copper and overheating of the alloys is therefore difficult to avoid, and porous alloys are liable to be produced with irregular casting properties and non-uniform mechanical values. Pre-alloys made according to the present invention have lower melting points than those of iron or steel or ferro-silicon and when they are alloyed with copper or copper alloys overheating is avoided and the alloys show very regular casting properties and uniform good mechanical values.

In carrying the invention into effect according to the preferred form the hardener or pre-alloy is prepared as a separate alloy by first preparing the iron constituent which consists preferably of cast iron, or of semi-steel formed by alloying wrought steel which may contain nickel, chromium, molybdenum, tungsten or vanadium with cast iron. The cast iron is brought to a molten condition and phosphor-copper added. To the molten mixture thus obtained silicon is added in small quantities at a time until the whole of the required amount of silicon has been incorporated into the melt. To this melt ferro-manganese may be added, the whole molten mass so prepared being then mixed with the requisite quantity of copper. Subsequently the entire homogeneous molten mixture containing all the desired ingredients is heated to the required extent to bring it to a sufficiently liquid condition or without further heating if it is already sufficiently liquid it is finally cast.

The composition of this hardener alloy varies in accordance with the particular characteristics which it is desired to give to the final copper content alloy but usually the hardener is made with the proportions of its constituents maintained within about the following limits:

Iron	5 to 30 per cent
Silicon	10 to 70 per cent
Copper	not less than 20 per cent

Phosphorus and manganese may be added if desired in amounts not exceeding 10% phosphorus and 15% manganese.

The hardener above described can be applied, for example, to the production of a copper alloy which will fulfill the functions of gun-metal but at the same time possess increased mechanical properties. In applying the hardener or pre-alloy for this purpose the tin content of a normal gun metal of the approximate constitution 88% copper, 10% tin, and 2% zinc would be replaced by a propor-

tion of a hardener or pre-alloy manufactured as above described and for this particular purpose the hardener or pre-alloy has been employed with its constituents in the following proportions:—

	Per cent
Iron	16
Silicon	40
Ferro-manganese (commercial quality containing about 80% manganese)	7
Copper	31
Phosphor-copper (comprising an alloy of about 85 parts copper and 15 parts phosphorus)	6

Applying the hardener to copper or a copper alloy the final alloy is prepared in a similar manner to that usually employed in the manufacture of ordinary bronze.

For some purposes it is not necessary to use zinc but if desired, the zinc or a large part thereof may also be included in the hardener and any further quantity of zinc which may be required to give to the final alloy obtained the precise composition desired may be added to the melted copper. The hardener may be used to replace the tin content wholly or in part according to the requirements to be met by the finished alloy. The hardener may also be used in varying proportions to replace wholly or in part the content of zinc or other metals in brasses or special brasses.

For example an alloy prepared from 88% copper 10% of the hardener and 2% zinc was found to possess excellent casting properties and sand-cast bars gave on test the following mechanical properties:—

(*a*) A yield point of approximately 12 tons per square inch.

(*b*) An ultimate tensile strength of approximately 22 tons per square inch.

(*c*) An elongation of approximately 12 per cent on 2 inches.

(*d*) A Brinell hardness of approximately 110, with a 10 millimetre ball and a load of 2,000 kilogrammes.

It has also been found that the alloy can be extruded; one sample of extruded bar was found to have the following properties:—

Yield point	28 tons/sq. inch
Ultimate tensile strength	40.4 tons/sq. inch
Elongation on 2 inches	22 per cent

The alloy can be forged hot, by which process the mechanical properties are modified and improved. The following are typical examples of tests on such forged alloy:—

(*i*) *Hot forged: Finished at a red heat*

Yield point	18 tons/sq. inch
Ultimate stress	32.2 tons/sq. inch
Elongation on 2 inches	52 per cent

(*ii*) *Hot forged: Finished at a black heat*

Yield point	36.8 tons/sq. inch
Ultimate stress	42 tons/sq. inch
Elongation on 2 inches	17 per cent

Density

Condition—as cast	8.45 density
Condition—hot forged 3 ins. round to 1.08 inches square	8.44 density

It has been found that the properties of these alloys may be modified by heat treatment, consisting in heating them to temperatures between 800° C. and the temperature at which they begin to melt, followed by cooling rapidly as by immersing in water or oil. Cast bars of the gun metal substitute alloy, for example, were found to have a tensile strength of 25 tons per square inch and an elongation of 28 per cent after heating at 900° C. for one hour and quenching in water.

The heat treatment may also consist in quenching as described from temperatures between 800° C. and the melting temperature followed by reheating to temperatures not exceeding 450° C.

It has also been found that this alloy possesses excellent properties at high temperatures. In one series of tests, the following results were obtained:—

Temperatures °C.	Yield (tons per sq. in.)	Tensile strength (tons per sq. in.)
200	11.6	19.6
350	8.2	16.0
500	7.6	9.6

We claim:—

1. The method of manufacturing copper alloys containing silicon and iron by first alloying silicon, iron and copper to constitute a hardener or pre-alloy in the proportions of 5 to 30% iron, 10 to 70% silicon and not less than 20% copper; and thereupon melting said pre-alloy with copper.

2. The method of manufacturing copper alloys containing silicon and iron by first alloying silicon, iron and copper to constitute a hardener or pre-alloy in the proportions of 5 to 30% iron, 10 to 70% silicon and not less than 20% copper; and thereupon melting said pre-alloy with a copper alloy.

3. The method of manufacturing copper alloys containing silicon and iron by first alloying silicon, iron, copper and phosphorus to constitute a hardener or pre-alloy in the proportions of 5 to 30% iron, 10 to 70% silicon and not less than 20% copper and phosphorus not more than 10%; and thereupon melting said pre-alloy with copper.

4. The method of manufacturing copper alloys containing silicon and iron by first alloying silicon, iron, copper and phosphorus to constitute a hardener or pre-alloy in the proportions of 5 to 30% iron, 10 to 70% silicon and not less than 20% copper and phosphorus not more than 10%; and there-

upon melting said pre-alloy with a copper alloy.

5. A hardener or pre-alloy for use in the manufacture of alloys consisting predominantly of copper; said pre-alloy containing 5 to 30% iron; 10 to 70% silicon; and not less than 20% copper.

6. A hardener or pre-alloy for use in the manufacture of alloys consisting predominantly of copper; said pre-alloy containing 5 to 30% iron; 10 to 70% silicon; not less than 20% copper and not more than 10% of phosphorus.

In testimony whereof we have hereunto set our hands.

WALTER MACHIN.
WILLIAM BOUCH O'BRIEN GOUDIELOCK.