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ALLOY

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This invention relates to alloys and more particularly to a copper base alloy and to a process of producing the same.

A feature of the present invention is the production of a copper-base alloy which has increased corrosion resistance, hardness and strength as compared to copper, which can be either hot worked or cold worked, which is more tough and ductile and which has other physical characteristics superior to known copper alloys.

Another feature of the invention consists in the addition to a copper-base alloy containing silicon, of sufficient nickel to enhance the toughness and elasticity, without reducing the increased tensile strength and hardness resulting from the presence of silicon.

Still another feature of the invention resides in the forming of a copper-base alloy having desirable strength and hardness characteristics obtained without the necessity of employing any special heat treatment in the manufacture or fabrication of the alloy.

The invention further consists in the new and useful features of operation and the new and original arrangements and combinations of steps in the process hereinafter described and more particularly set forth in the claims.

In accordance with an illustrative embodiment of the invention an alloy having desirable characteristics can be prepared as follows:

Copper, silicon and manganese-copper in amounts which will produce in the finished alloy from around 90% to 98% copper, from around 1% to 7% silicon and from around .10% to .75% manganese are charged in a crucible or furnace, melted and suitably mixed.

When the above materials have been melted and mixed, sufficient nickel is added which will produce in the finished alloy a nickel content of from .25% to 10%. Preferably, the nickel is introduced in such amounts as will go into solution quickly and with no increase in temperature of the molten bath. The introduction of the manganese before the nickel, reduces the melting point of the mix and permits the nickel to be added at a lower temperature than if the nickel were introduced first.

At the same time that the nickel is added to the melt, iron is added in an amount sufficient to give a residual iron content in the finished alloy of up to from .50% to .75%.

In certain instances it is desirable to add to the melt, a short time before pouring, a small additional amount of manganese-copper. Where this is done, a correspondingly lesser amount of

manganese-copper is added to the first mix, so that the total manganese content of the finished alloy is from .10 to .75%. Addition of the small additional manganese-copper insures that the resulting casting will be sound and free of inclusions of oxides or gases.

It is desirable that the mix be melted at a temperature of above 1150° C. Before pouring, the melt preferably is allowed to cool to a temperature between 1120° C. minimum and 1140° C. maximum in order to obtain a sound casting without pipe and which does not spew when freezing. In pouring the melt, it is desirable to use a pouring cup for filling the mould in order to distribute the metal evenly as it flows into the mould and to assist in "shrinking" the bar, that is, teeming or filling the mould from time to time with additional metal as shrinking occurs, in order to prevent piping.

Where it is desirable that the finished alloy be readily machinable, lead is added in small amounts sufficient to give a lead content in the finished alloy of approximately .10 to .50%. However, it is desirable only to add lead where machinability is an important requirement. Where lead is added, is preferably is added to the mix only a short time before pouring, in order to prevent loss of lead by oxidation.

We have found that by the addition of nickel to the copper-silicon alloy and by the cleansing effect obtained by the additions of manganese-copper, it is possible to obtain in soft material a tensile strength in excess of 70,000 pounds per square inch with a yield point of 30,000 pounds per square inch and an elongation of 50% in two inches, with the necessity of any particular heat treatment in the fabrication of the material other than ordinary process anneals.

This alloy can be hot rolled or forged at a temperature of at least 100° F. higher than the temperature at which many other copper-silicon alloys can be rolled. For example, this alloy can be rolled at a temperature of around 1600° F. which permits greater reductions between heats than heretofore possible.

We have also found that at the critical temperature of annealing this alloy, namely, 1500° F., without quenching, the material is sufficiently softened to permit stretching, or patent leveling and flattening when cold. The material, however, retains a Rockwell B scale $\frac{1}{16}$ " ball hardness of 60 to 70 with an elongation of the order of 50% and a tensile strength of around 70,000 pounds per square inch. This alloy will permit

a greater amount of economical cold work than many of the usual copper-silicon alloys.

We have found further, that when this alloy is cold worked after annealing a tensile strength in excess of 120,000 pounds per square inch can be obtained with a yield point of at least 60,000 pounds per square inch and an elongation of not less than 3% in two inches. The modulus of elasticity of the material is 18.8×10^6 .

The alloy is inherently resistant to corrosion and is at least equal to or, in some cases, superior to usual copper-silicon alloys in this regard. By reason of the great hardness of this alloy, which is obtained without special heat treatment, the alloy has a very high resistance to abrasion. The material produced in accordance with the invention has a relatively low electrical conductivity, namely, around 6%.

Some of the commercial uses for this alloy are: tanks or boilers for water or chemicals; paper print rollers on which designs are etched; paper mill equipment, such as paper pulp chests, screen, plates, Jordan or beater bars; leaf springs for electrical contacts and for mechanical uses; thrust bearings for taking shocks; sanitation equipment; textile equipment; turbine blading; pump liners and rods, etc. The alloy can be readily welded electrically and the weld or seam has exceptionally high strength and resistance to corrosion.

Although the percentage composition of the alloy set forth above has been found preferable, nevertheless, it is possible to produce a desirable alloy in accordance with the invention by departing from the ranges set forth above. In general, the alloy should contain a sufficient proportion of silicon to render the alloy resistant to corrosion and to produce a tensile strength substantially greater than that of copper. In order to obtain maximum hardness it is necessary that the alloy contain a minimum of 3% silicon. It is also desirable that the alloy contain at least .5% each of iron and manganese. The alloy also should contain a sufficient proportion of nickel to render it workable and tough. The alloy should contain

.25-10% nickel and preferably approximately 5%.

From the foregoing it will be seen that we have produced a copper-base alloy which has high corrosion resistance, hardness, tensile strength, toughness, ductility, and elasticity, which can be either hot worked or cold worked and which has a low electrical conductivity.

While certain novel features of the invention have been disclosed herein, and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. An alloy composed of from 1-5% silicon, approximately one-half of one per cent each of nickel, iron and manganese, and the balance substantially all copper, which is corrosion and abrasion resistant.

2. An alloy containing substantially 95½% of copper, 3% of silicon, the remainder being one-half of one per cent each of nickel, manganese, and iron, which is more than ordinarily ductile and elastic as compared to its strength and hardness, and which is corrosion and abrasion resistant.

3. An alloy composed of .25-10% nickel, 1.0-7.0% silicon, approximately one-half of one per cent of manganese and approximately one-half of one per cent of iron, and the remainder substantially all copper, which can be annealed at 1500° F., and without quenching produce a material which can be easily cold rolled, stretched, or patent leveled and flattened and still retain a Rockwell B scale, ¼" ball hardness of 60 with an elongation of 50% and a tensile strength of 70,000 pounds per square inch.

4. A copper base alloy composed of from about 1.0-7.0% silicon, from about 0.25-10.0% nickel, from about 0.5-0.75% iron, from about 0.1-0.75% manganese and the remainder substantially all copper.

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