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NONFERROUS ALLOY.

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To all whom it may concern:

Be it known that I, WILLIAM B. PRICE, a citizen of the United States, residing at Waterbury, county of New Haven, and State of Connecticut, have invented certain new and useful Improvements in Nonferrous Alloys, fully described and represented in the following specification.

This invention relates to an improvement in nonferrous alloys, and particularly to alloys comprising chiefly copper, nickel, and tin.

The chief object of the invention is to provide a series of alloys some of which will have a very high resistance to fatigue when hard rolled, which will be very malleable, have a very high ductility, and at the same time a high resistance to atmospheric corrosion, as well as a better resistance to the action of acids and alkalis, and a higher electrical resistivity than has heretofore been obtained with cupro-nickel alloys employed where ductility, malleability, resistance to fatigue and resistance to the electric current were requisites.

As a result of a series of experiments, I have discovered that an alloy composed chiefly of copper, nickel and tin in which the weight of each of those three metals relative to the sum of the weights of all three is kept within the limits given by the formulæ hereinafter set forth has the desired valuable properties hereinbefore recited. In discussing the percentage composition of the alloy, the percentage of each ingredient or element is figured on the basis that the sum of the percentages of the three elements, viz, copper, nickel and tin, constitutes 100 per cent. This is for the reason that small amounts of other metals and elements may be incorporated so as to appear in a finished product while still retaining in a high degree the valuable properties of the true ternary alloy.

I have found that if the percentage of the three metals is kept within certain limits hereinafter set forth, the alloy obtained will be a true ternary alloy forming a solid solution. If other ingredients are added they should be kept within small limits, for example, 1 to 5% of the total.

The limits of the percentages of the three metals, copper, nickel and tin, may be found from the following formulæ:

Let Ni represent the percentage of nickel, Cu the percentage of copper, and Sn the percentage of tin, where Ni+Cu+Sn =100%. Then, as Sn=100−(Ni+Cu), we need only determine the limiting percentages for Ni and Cu.

Let x=% of nickel and y=% of copper. Then $x+y+\%\mathrm{Sn}=100\%$

For any given value of nickel (x) the maximum and minimum limits for copper (y) are to be determined by the following formula:

$$y=93.75-0.9x\pm(5.75-0.1x)$$

In all cases the percentages of the three elements copper, nickel, and tin will not vary outside the following limits:

Cu—61.6% to 99.0%
Ni—0.5% to 33.0%
Sn—0.5% to 11.9%

While some of the alloys having copper, nickel and tin in any proportions falling within the limits fixed by the formulæ just given will be highly advantageous for all purposes requiring high ductility and malleability together with good resistance to corrosion, I have found that for some purposes, such, for example, as the manufacture of sheet metal diaphragms for diaphragm valves and the like, and for high electrical resistance, the best results are attained where the proportions of copper, nickel, and tin are so selected that the nickel and the copper considered alone have the ratio of about three to seven, that is, $\frac{\mathrm{Ni}}{\mathrm{Cu}}=\frac{3}{7}=.4285$.

For example, with the minimum amount of tin, viz, about one-half per cent, the copper would be 69.65 and nickel 29.85. The maximum amount of tin which should be used for an alloy of this specific ratio of nickel to copper would be slightly more than 6 per cent, in which alloy the copper will be about 66 per cent and the nickel about 28 per cent. Therefore, for an alloy having the special properties suitable for such diaphragms or the like, the copper will vary from 69.65 to about 66 per cent, the nickel from 29.85 to about 28, and the tin from ½ to about 6 per cent, but at all times the nickel and copper have substantially the ratio 3/7. A slight downward variation from this ratio of .4285 is not only permissible but will give improved results, as shown, for example,

by an alloy having the following composition, viz, Cu 70, Ni 29, Sn 1. In this alloy the ratio of nickel to copper is .4142.

As heretofore pointed out, an alloy comprising copper, nickel and tin proportioned relative to each other within the limits fixed by the formulæ may also contain small amounts of other ingredients, such as suitable metalloids or other metals. Usually, the sum of the ingredients other than the copper, nickel and tin should not exceed 5 per cent of the combined total. That is to say, as much as 5 per cent by weight of lead may be combined with 95% by weight of a mixture of copper, nickel and tin, to produce an alloy which will have the desirable characteristics hereinbefore recited, although not to as great an extent at the limit.

I have found that a slight amount of phosphorus added to the alloy has a beneficial effect. For example, an alloy containing Cu 69.97, Ni 29.15, Sn 1.05 and P 0.02 is more easily prepared and worked than if the phosphorus were not employed.

In making an alloy in accordance with the invention, I have found it advantageous to heat the alloy to a somewhat higher temperature than is necessary for merely melting. This tends to keep down the porosity of the resultant metal. For example, in melting the alloy above mentioned, and containing 0.02 per cent phosphorus, it was found that when poured at 1365° C., and cast in bars, the metal was porous, but when poured at 1405° C., and cast in bars, the product was satisfactory.

An alloy having a composition such as hereinbefore described is readily worked by those skilled in the art, to produce bars and sheets of rolled material, the rolling or pressing and drawing of the metal hardening it. Annealing may be resorted to during the process of working the metal to its smaller sizes, and the final rolling, pressing or drawing may be relied upon to give the proper hardness to the finished product.

What is claimed is:

1. An alloy comprised chiefly of copper, nickel and tin, and containing said copper, nickel and tin in proportions falling within the limits fixed by the formulæ, substantially as described, viz—

$$\text{Copper}=y=93.75-0.9x\pm(5.75-0.1x)$$

in which x=% of nickel and can vary between 0.5% and 33.0%

$$\%\ \text{Sn}=100\%-(\%\ \text{Cu}+\%\ \text{Ni}).$$

2. An alloy comprising not less than 98 per cent of a mixture of copper, nickel and tin, in which the said three metals are in proportions relative to their total, limited by the following formulæ, substantially as described, viz—

$$\text{Copper}=y=93.75-0.9x\pm(5.75-0.1x)$$

in which x=% of nickel and can vary between 0.5% and 33.0% and Sn=100%—(% Cu+% Ni).

3. An alloy comprising not less than 98 per cent, of a mixture of copper, nickel and tin, in which the said three metals are in such proportions to each other that the copper is not less than 61.6 per cent of the total of said three metals, the tin is not less than 0.5 per cent of the said total and the ratio of the nickel to the copper does not exceed 3/7.

4. An alloy consisting of at least 98 per cent of a mixture of copper, nickel and tin, in which the percentage of tin figured on the total of the three constituents is not less than ½ per cent and not more than about 6 per cent, while the ratio of the nickel to the copper does not exceed 3/7.

5. A metal for diaphragms and electrical resistance wire, comprising not less than 95% of a mixture of copper, nickel, tin and phosphorus the mixture being proportioned substantially as follows:

Cu=69.97
Ni=29.15
Sn=1.05
P=0.02

In testimony whereof, I have hereunto set my hand.

WILLIAM B. PRICE.