Patented July 27, 1948

2,445,868

UNITED STATES PATENT OFFICE

2,445,868

COPPER BASE ALLOYS

John D. Berwick, Alton, Ill., assignor to Olin Industries, Inc., a corporation of Delaware

No Drawing. Application August 28, 1944, Serial No. 551,620

8 Claims. (Cl. 75—157.5)

1

This invention relates to certain new and useful alloys of copper, zinc, nickel, and manganese having materially improved physical properties. More specifically, this invention relates to copper-zinc-nickel alloys containing sufficient manganese to provide advantages hitherto unattained with copper-zinc-nickel alloys.

An object of this invention is to provide a copper-zinc-nickel-manganese alloy having improved tensile strength, ductility, and resistance to fatigue.

Another object of this invention is to provide a copper-zinc-nickel-manganese alloy having improved physical properties and workability.

Another object is to provide an alloy having the desirable properties of copper-zinc-nickel alloys but having improved characteristics permitting greater utility with lower working costs.

In accordance with this invention it has been found that such objects and advantages are obtained by providing an alloy composed of about 53% to 75% copper, a minimum of 5% manganese, a minimum of 5% nickel, with the sum of the manganese and nickel being equal to about 12% to 20%, and with the balance substantially zinc. For instance, the alloy may have a minimum content of about 5% manganese and 7% nickel or of about 5% nickel and 7% manganese. Alloys of copper-zinc-nickel-manganese have been known heretofore, but such alloys have contained amounts of the constituents differing from those discovered in accordance with this invention and such prior alloys have not had the improved characteristics provided by the alloys of this invention. Further, in such prior alloys, the manganeses employed contained impurities such as silicon, aluminum, or iron. Such impurities resulted from the method of manufacture and appeared in the alloy in amounts influencing the physical characteristics thereof.

In accordance with this invention, it has been discovered that, if highly purified manganese is employed, an alloy having novel properties is obtained. The manganese employed has a purity of at least about 99% and preferably of at least about 99.9%, which manganese is substantially free from iron, silicon and the like. Such manganese has been prepared recently by an electrolytic process and when produced by such method is commonly designated electrolytic manganese. The alloys of this invention thus contain only traces, if any, of such impurities as iron, aluminum, silicon and the like, and have physical characteristics greatly improved over prior quaternary alloys and the copper-zinc-nickel alloys.

2

One of the chief advantages of the alloy of this invention is its tendency to react favorably to hot working as well as cold working and it thereby permits low cost fabrication of strip, formed parts, and the like.

Microscopic examination has shown the alloy to be an alpha solid solution and it has been found that a copper content substantially less than about 53% results in the inclusion of an undesirable beta phase, which makes the composition harder and much more difficult to work. Likewise, it has been found that, with a copper content of only about 53%, the sum of the manganese and nickel must be maintained at about 12% or more to avoid inclusion of a beta phase. It has likewise been found that a minimum of about 5% manganese is necessary in order to render the alloy hot workable. The nickel, in addition to providing strength and color characteristics, has been found to serve as a stabilizer for the manganese and a minimum of about 5% is required for this purpose. Increasing the copper content of the composition substantially above about 75% results in an alloy having undesirable softness and loss of the relatively white color characteristic of the alloy of this invention. The sum of manganese and nickel in the alloy is maintained at about 20% or less, since the inclusion of more than about 15% manganese makes casting of the alloy difficult unless the casting is carried out in an inert or reducing atmosphere and the inclusion of more than about 15% of either nickel or manganese renders the alloy harder making it much more difficult to work. For optimum properties of color and the like it is preferred to maintain the zinc content in the range of about 7% to 35%.

Variations in composition within the specified range effect changes in the physical characteristics, which changes, for most purposes are only of minor character. For instance, the color may vary slightly from a white to a yellowish or reddish tint. Likewise, other differences may be found in physical characteristics, such as melting point, tensile strength, and the like.

A preferred composition within the range contains about 53% to 57% copper. This composition ordinarily has a slightly yellowish tint, with a melting point around 910° C. to 950° C. and is especially suited for flat spring electrical contacts and the like. Another preferred composition within the range contains about 63% to 67% copper. This composition is white in color, is readily hot or cold rolled, has a melting point of around 930° C. to 970° C., has high electrical resistance,

and is particularly suitable for use in cutlery, formed weather and terrazzo strip and the like. Still another preferred composition within the range contains about 70% to 74% copper. This composition has a slightly reddish tint, a high electrical resistance, a melting point around 980° C. to 1020° C., is readily hot or cold rolled and is especially adapted to the manufacture of ornamental hardware and the like.

The color of these compositions will vary somewhat with the total manganese and nickel content, that is, the higher the total content the whiter the alloy. The strength and hardness of the compositions are equal to and in some instances greater than prior copper-zinc-nickel alloys having a nickel content equal to the total content of nickel and manganese in the composition.

The alloy may be made by any suitable means from new materials or scrap of suitable purity. For instance, when using new stock, the nickel and manganese may be placed in the bottom of the furnace with copper, then zinc on top of the nickel and manganese. As the material in the furnace melts, the remainder of the copper and zinc may be intermittently added until the complete charge is made up. It is preferred to melt the charge in an electric induction furnace in which thorough circulation and uniform mixing of molten ingredients is accomplished. To avoid oxidation of the constituents, a cover of charcoal may be maintained over the charge during the entire melting procedure. The molten metal may then be cast in a chill or water cooled mold in accordance with customary practice, and may be formed into strip by either hot or cold rolling, or by a combination thereof.

The following Table 1 lists physical properties of alloys of the present invention along with those of nickel-silver containing 55% copper, 18% nickel and 27% zinc. The cold ductility given is the percent reduction in height of a cast rod 0.356 inch in diameter compressed at 150,000 pounds per square inch. The elongation is given as the percent in a 2 inch length. The resistance is given in ohms per circular mil foot. The strength characteristics of the alloy were measured on strip 0.020 inch thick, which was prepared by hot rolling an ingot about 3.0 inches thick to a strip thickness of about 0.5 inch, cold rolling in three steps followed by annealing to a thickness of 0.04 inch, and then cold rolling to a thickness of 0.020 inch. The nickel-silver test pieces were formed by cold rolling the ingot in the usual manner.

TABLE 1

Composition

Copper, per cent	55	54.74	55.68	56.88	57.45
Zinc, per cent	27	33.68	24.00	25.95	22.49
Nickel, per cent	18	6.58	8.55	11.33	8.07
Manganese, per cent		5.00	11.76	5.76	11.93

Properties

Cold Ductility, per cent	39.4	40.7	41.3	41.2	42.1
Resistance Ohms	183	229	318	201	328
Tensile Strength (1,000 lbs./sq. in.)	109	115.2	115.4	108.4	112.9
Elongation, per cent	2	1	1	1	1
Hardness (Rockwell B)	96.5	95.5	97	92	95

These copper-zinc-nickel-manganese compositions after annealing at 350° C. have a tensile strength in the range from about 93,000 to 113,000 lbs./sq. in., a percent elongation in the range from 4 to 8, and a Rockwell B hardness in the range from 93 to 99, and after annealing at 750° C. have a tensile strength in the range from 49,000 to 62,000 lbs./sq. in., a percent elongation in the range from 42 to 50, and a Rockwell B hardness in the range from 31 to 47.

The following Table 2 lists physical properties of the alloy along with those of nickel-silver containing about 65% copper, 17% zinc and 18% nickel.

TABLE 2

Composition

Copper, per cent	65	62.4	63.31	65.54	65.57
Zinc, per cent	17	21.7	14.56	16.75	22.50
Nickel, per cent	18	7.5	6.34	9.19	6.87
Manganese, per cent		8.4	15.75	8.46	5.00

Properties

Cold Ductility, percent	47.7	46.0	41.6	44.2	49.6
Resistance Ohms	175	246	379	270	189
Tensile Strength (1,000 lbs./sq. in.)	97	100.8	116.3	109.5	106
Elongation, per cent	2	2	1	1	1
Hardness (Rockwell B)	92	93	97	93	93

These copper-zinc-nickel-manganese compositions after annealing at 350° C. have a tensile strength in the range of about 91,000 to 101,000 lbs./sq. in., a percent elongation in the range from about 5 to 7, and a Rockwell B hardness in the range from 92 to 96, and after annealing at 750° C. have a tensile strength in the range from 53,000 to 62,000 lbs./sq. in., a percent elongation in the range from 35 to 42, and a Rockwell B hardness in the range from 32 to 48.

The following Table 3 lists the physical properties of the alloy along with those of nickel-silver containing 72% copper, 10% zinc and 18% nickel.

TABLE 3

Composition

Copper, per cent	72.0	68.90	71.36	73.74	75.23
Zinc, per cent	10.0	16.15	10.34	7.50	13.31
Nickel, per cent	18.0	6.45	7.64	9.56	6.02
Manganese, per cent		8.50	10.63	9.20	5.40

Properties

Cold Ductility, per cent	52.6	47.5	45.7	45.8	47.8
Resistance Ohms	163	231	275	252	196
Tensile Strength (1,000 lbs./sq. in.)	85	98.8	105.5	100.5	93.8
Elongation, per cent	3	2	1	1	2
Hardness (Rockwell B)	87	93	93.5	91	87

These copper-zinc-nickel-manganese compositions after annealing at 350° C. have a tensile strength in the range from 86,000 to 93,000 lbs./sq. in., a percent elongation in the range from 4 to 8, and a Rockwell B hardness in the range from 91 to 94, and after annealing at 750° C. have a tensile strength in the range from about 53,000 to 60,000 lbs./sq. in., a percent elongation in the range from 35 to 46 and a Rockwell B hardness in the range from 33 to 44.

The data in the above tables give a clear indication of the similarity and superiority of the alloys of this invention to nickel-silver alloys.

It may be seen that minor changes in physical properties occur with variations in composition of the alloy of this invention, and it has been found in general that a composition containing about 53% to 57% copper, 8% to 12% manganese, and 7% to 11% nickel, with the balance zinc, has a color and other characteristics giving it great utility in those applications in which nickel-silver containing 55% copper, 27% zinc and 18% nickel has heretofore been employed. Similarly, a composition containing about 63% to 67% copper, 8% to 12% manganese and 7% to 11% nickel, with the balance zinc, has over-all characteristics qualifying it for applications in which nickel-silver containing 65% copper, 17% zinc, and 18% nickel has been heretofore employed. Likewise, a composition containing about 70% to 74% copper, 8% to 12% manganese, and 7% to 11% nickel, with the balance zinc, is well suited for those applications in which nickel-silver containing about

72% copper, 10% zinc and 18% nickel has heretofore been employed.

Alloy compositions in accordance with this invention may be produced in a variety of forms such as sheet, coil, strip, wire, rod and tube by either, or both, hot and cold working. The sheets are readily adapted for forming by the various fabrication methods, for example they may be drawn, spun, formed and bent. Also the alloy is suitable for treatment by the known plating, tinning, welding, soldering and brazing methods.

This invention accordingly provides a novel alloy of copper, zinc, nickel, and manganese having improved physical properties, and characterized for one thing by its hot working properties and consequent low cost fabrication. While the invention has been described in the foregoing with particular reference to specific examples, it is to be understood that these are illustrative and that variations may be made within the spirit and scope of the invention, as expressed in the appended claims.

Having now described the invention, what is claimed and is desired to be secured by Letters Patent is:

1. An alloy comprising 53% to 75% copper, a minimum of 5% manganese and a minimum of 5% nickel, with the sum of the manganese and nickel being in the range of about 12% to 20%, and with the balance zinc.

2. An alloy as set forth in claim 1 in which the copper content is in the range of about 53% to 57%.

3. An alloy as set forth in claim 1 in which the copper content is in the range of about 63% to 67%.

4. An alloy as set forth in claim 1 in which the copper content is in the range of about 70% to 74%.

5. A copper base alloy comprising 53% to 57% copper, 8% to 12% manganese, and 7% to 11% nickel, with the balance zinc.

6. A copper base alloy comprising 63% to 67% copper, 8% to 12% manganese, and 7% to 11% nickel, with the balance zinc.

7. A copper base alloy comprising 70% to 74% copper, 8% to 12% manganese, and 7% to 11% nickel, with the balance zinc.

8. A copper base alloy comprising 53% to 75% copper, 8% to 12% manganese, and 7% to 11% nickel, with the balance zinc.

JOHN D. BERWICK.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
203,266	Hale	May 7, 1878
824,103	Driver	June 26, 1906
846,851	Hobson	Mar. 12, 1907
2,195,434	Silliman	Apr. 2, 1940
2,230,237	Dean	Feb. 4, 1941

FOREIGN PATENTS

Number	Country	Date
133,362	Great Britain	Oct. 16, 1919
768,372	France	Aug. 4, 1934

OTHER REFERENCES

Engineering Alloys, Woldman and Dornblatt, 1936 ed., page 203.