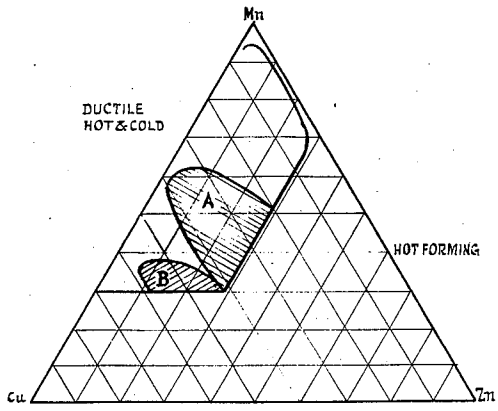
Feb. 4, 1941. R. S. DEAN 2,230,236

MANGANESE ALLOY

Filed April 1, 1938



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Patented Feb. 4, 1941 2,230,236

UNITED STATES PATENT OFFICE

2,230,236

MANGANESE ALLOY

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Application April 1, 1938, Serial No. 199,329

5 Claims. (Cl. 75—134)

My invention relates to alloys of manganese, and in particular to ductile alloys containing copper, zinc and a relatively high percentage of manganese and having desirable color, mechanical properties, corrosion resistance and other properties which make them useful in many industries.

The principal object of my invention is to produce ductile alloys high in manganese.

Another object is to utilize manganese in relatively high proportions in alloys having the general properties of and capable of being employed in place of other alloys heretofore known which do not have manganese as a constituent thereof.

A further object is to produce a series of alloys of manganese having many of the properties of non-manganese alloys heretofore known, but with advantages and properties not possessed by such alloys.

A still further object is to produce manganese alloys of good working properties, alloys which are resistant to corrosion, and alloys which are capable of being hardened by appropriate treatment.

Other objects and features of my invention will be apparent from the following detailed description, taken with the accompanying drawing, wherein the figure is a ternary diagram showing the working properties of manganese, copper-zinc alloys.

In the practice of my invention, I use pure manganese, preferably that prepared by the electrolytic process as described in U. S. Bureau of Mines Report of Investigations 3322. This manganese has the following typical composition: S, total, 0.276%; S, as sulphide, .17%; Fe, .007%; Si, .001%; Pb, .002%; Zn, .001%; Mo, .001%; Sn, .0005%; Cu, .0005%; Ni, .0005%; Co, .0005%; Ag, .0001%; As+Sb, .0001%; total Ti, Al, Zr, Cr, V, U, Be, Ta, Cb, P, and rare earths, .001%; Mn, 99.7088%.

Manganese purified by vacuum distillation may also be used in the practice of my invention; but commercial grades made by reduction with carbon, aluminum, or silicon are in general unsatisfactory, since the ductility of the alloys is seriously impaired. I have not determined the exact amounts of these elements which, when present in manganese, completely prevent obtaining the properties which my invention contemplates, but it is less than 2% of silicon and/or aluminum and .2% carbon.

By the use of suitable proportions of copper and zinc added to pure manganese, I have been able to produce ductile, useful alloys with remarkable characteristics as will be pointed out. Properties are exhibited by these alloys which have never been associated with alloys containing appreciably large proportions of manganese.

I have found that by the use of pure manganese I can make ductile alloys of manganese, copper and zinc, containing more than 30% manganese. With regard to their working qualities these alloys fall into two classes: Those which work both hot and cold, and those which are brittle cold but are excellent for pressing or rolling at a red heat. In the figure, I have indicated by means of a ternary diagram the composition ranges where these two kinds of working properties are shown.

The corrosion-resistance properties of these alloys are very valuable. I have found that they fall into three classes.

1. Alloys the corrosion resistance of which is very high, and the surface of which remains bright on alternate immersion in salt water for long periods.

2. Alloys resistant to atmospheric corrosion but showing a surface etch on alternate immersion in salt water.

3. Alloys resistant to atmospheric corrosion but forming a black coating of MnO_2 on alternate immersion in salt water.

The ternary diagram in the figure indicates the composition ranges in which these alloys have the several types of corrosion resistance. I have found that relatively small percentages of nickel may be added to these alloys with some improvement in mechanical properties and corrosion resistance. In the figure, the shaded portion marked "A" identifies alloys of Class 1 hereinabove referred to, while the shaded portion "B" identifies alloys of Class 2 hereinabove referred to. Those alloys falling within the composition range of the manganese-copper-zinc system herein identified and claimed falling outside of the shaded portions A and B come within the third class of alloys identified immediately hereinabove.

These manganese-copper-zinc alloys have many uses in the arts, being suitable in general for the purposes for which such alloys as brass, nickel-silver, and Monel metal are conventionally used. Alloys of Class A are particularly suitable for condenser tubes, hot water heaters, and similar uses where resistance to corrosion by salts in solution is important.

The mechanical properties of manganese-copper-zinc alloys made in accordance with my in-

vention vary with the composition. The following illustrative examples will serve to show the order of the range of tensile strength.

Number	Manganese	Zinc	Copper	Nickel	Tensile strength, lbs./sq. in.	
					Annealed	Cold worked
1	80	2	18	0	70,000	80,000
2	70	10	20	0	42,000	125,000
3	65	27	8	0	41,000	125,000
4	55	10	35	0	51,000	90,000
5	30	13	50	7	70,000	112,000

As a general rule, within the cold working range the increase of manganese to copper ratio produces a softer and more ductile alloy, while the increase of copper and the addition of nickel produce a tougher alloy and one which work hardens to a greater degree. For purposes of comparison it may be noted that alloys 2 and 3 in the above table have practically the same tensile strength as yellow brass in the annealed state; but these alloys are more ductile and with 50% reduction have a tensile strength of 125,000 lbs./sq. in. as compared to 100,000 lbs./sq. in. for brass. On the other hand, alloy 4 in the above table has a tensile strength approximately that of annealed nickel-silver, but on cold working reaches 90,000 lbs./sq. in. as compared to 65,000 lbs./sq. in. for nickel silver. On the other hand, alloy 5 has much the same tensile strength in the cold worked and annealed states, respectively, as Monel metal. All of these alloys are much more ductile than brass or nickel silver.

The alloys of the hot forming class are not generally sufficiently ductile for satisfactory cold working; on hot pressing, however, they have the necessary strength and ductility for all practical purposes. Two alloys typical of the hot forming range are the following:

Manganese, per cent	Zinc, percent	Copper, percent	Tensile strength hot pressed, lbs./sq. in.
35	40	25	73,000
40	50	10	87,000

In the specification and claims it is clear that, where I refer to manganese, I mean pure manganese, except where the context clearly indicates otherwise. The specification in general identifies what I mean by pure manganese, but, for the further assistance of those skilled in the art, I may add that the manganese employed should be at least about 99.5 percent pure and preferably about 99.7% pure; it being obvious that those impurities which are identical with certain of the alloying constituents employed, for example, copper, zinc, and nickel, will not deleteriously affect the final result, and in general in an otherwise pure manganese may be disregarded.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. A ductile and corrosion-resisting alloy comprising 2 to 30% zinc, 5 to 40% copper, and the balance pure manganese.

2. A corrosion-resisting alloy suitable for hot working, comprising 30 to 60% zinc, 10 to 40% copper, and the balance pure manganese, said manganese comprising at least 30% of the alloy.

3. An alloy resisting corrosion by alternate immersion in salt solution, consisting of pure manganese alloyed with zinc and copper in such proportions that the final alloy has a composition within the range cross-hatched in the figure.

4. A ductile alloy of copper, zinc and manganese, containing from 8% to 35% copper, from 2% to 50% zinc, and substantially all of the remainder being a highly purified manganese, said manganese containing not more than 0.1% by weight of any one of the elements iron, carbon, silicon and aluminum, the total amount of copper and zinc not being greater than 70%.

5. A ductile alloy comprising copper from 8% to 57%, zinc from 2% to 50%, and substantially all of the remainder a highly purified manganese containing not more than 0.3% by weight of the elements iron, carbon, silicon and aluminum, the total amount of copper and zinc not being greater than 70%.

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