

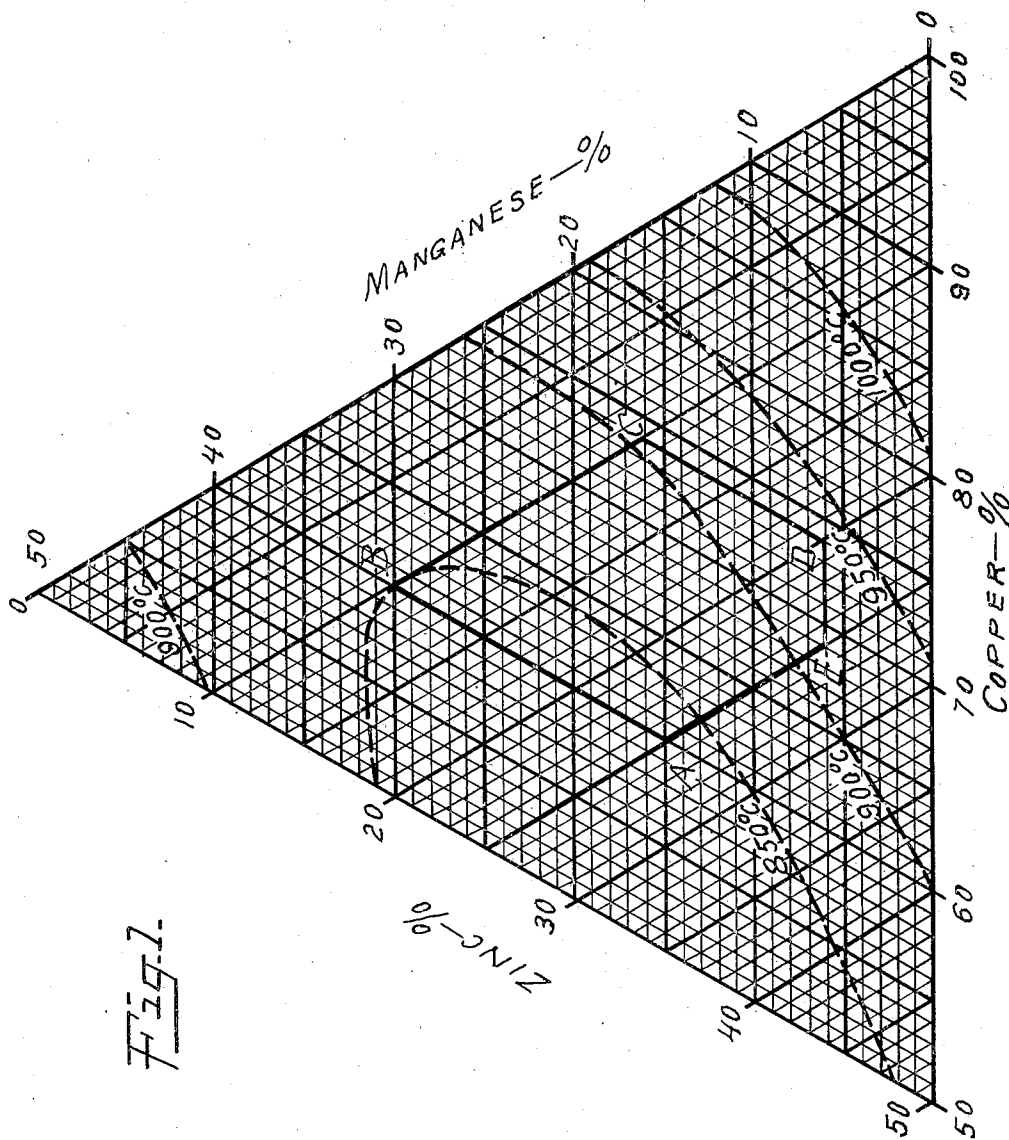
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HIGH MANGANESE BRASS ALLOYS

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2 Sheets-Sheet 1



INVENTORS
EDMUND A. ANDERSON
DAVID C. JILLSON
BY

Reimer, Edwards, Weston and Barron
ATTORNEYS

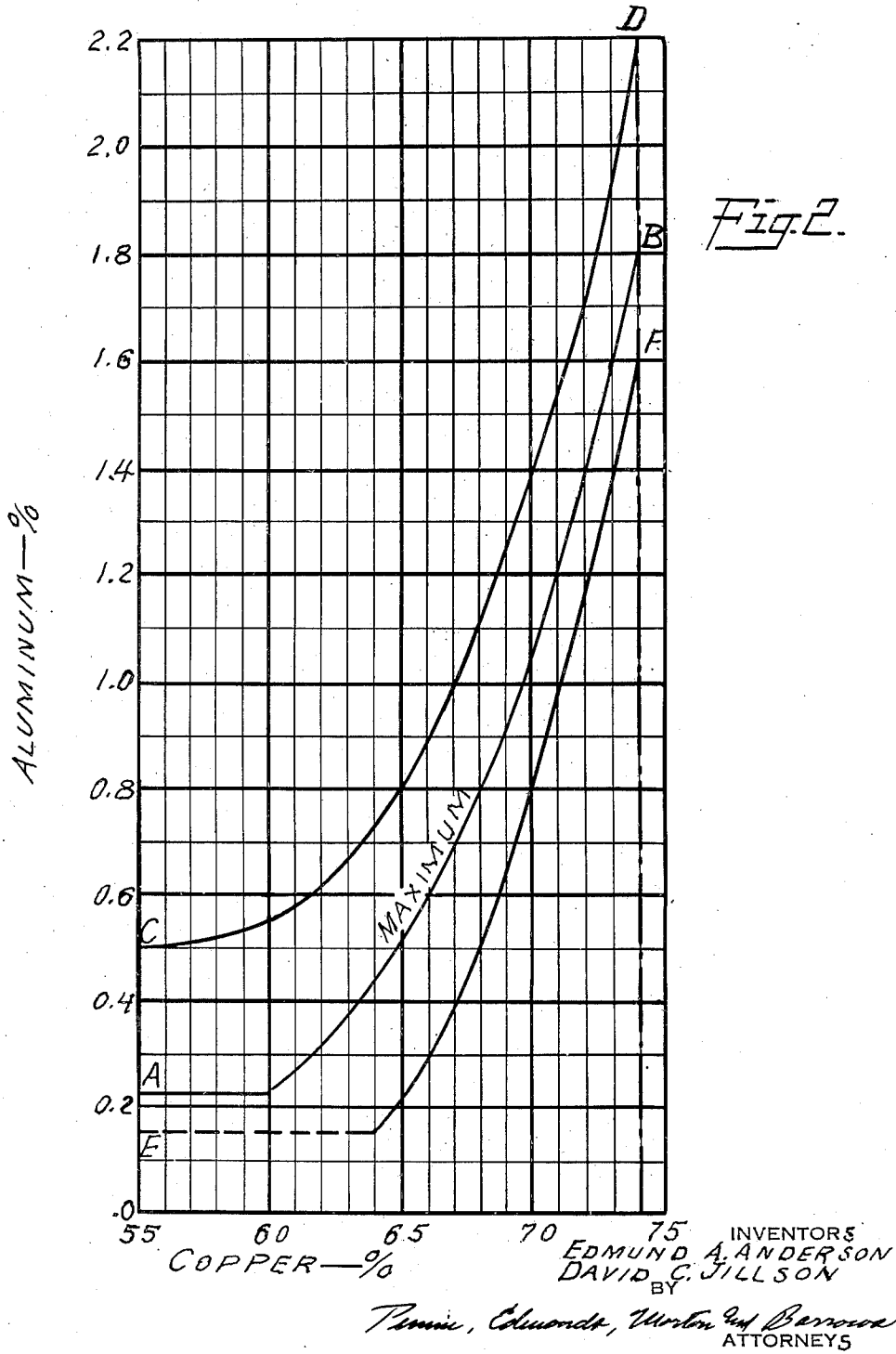
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UNITED STATES PATENT OFFICE

2,479,596

HIGH MANGANESE BRASS ALLOYS

Edmund A. Anderson and David C. Jillson, Palmerton, Pa., assignors to The New Jersey Zinc Company, New York, N. Y., a corporation of New Jersey

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4 Claims. (Cl. 75-157.5)

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This invention relates to alloys and, more particularly, to high manganese brass alloys characterized by high ductility and excellent retention of composition during remelting.

Manganese brasses, that is, copper-zinc-manganese alloys have been known for decades. In general, the tensile strength of these manganese brasses increases with their manganese content, and, as in the case of most metals and alloys, an increase in tensile strength is accompanied by a decrease in ductility. The high manganese content of these alloys has a further disadvantage in that the alloys exhibit a pronounced tendency to form a scum of manganese oxide while the alloy is in the molten state. This scum forms rapidly during the pouring of castings and results in the formation of occlusions of manganese oxide within the castings. These occlusions, or flaws, like lowered ductility, preclude the use of such alloys in the fabrication of many articles wherein their exceptional properties would otherwise be advantageous.

In the pending application of John L. Rodda, Serial No. 541,900, filed June 24, 1944, now abandoned, there are described high manganese brasses containing from 15 to 37.5% zinc, from 7.5 to 30% manganese, from 0.1 to 2% aluminum, and the balance copper. As described in said application, the presence of aluminum in such high manganese brasses serves to inhibit oxidation of the manganese while the alloys are in the molten state. The tensile strength of the alloys varies from about 40,000 to about 70,000 pounds per square inch, and the tensile elongation of the alloys varies from about 20% to about 45%. It is pointed out in said application that the aluminum improves the tensile strength and hardness but decreases the tensile elongation. Thus, the aluminum tends to decrease the ductility of the alloys although it serves a particularly useful effect in its capacity as an anti-oxidant for the manganese content of the alloy.

We have now found that aluminum is capable of producing exceptionally high ductility in high manganese brasses, this capability depending upon a definite relationship between the amount of aluminum used and the copper content of the alloys. The aluminum also serves to produce alloys of excellent tensile strength and further serves to inhibit oxidation of manganese when the alloy is in the molten state.

The manganese brasses which we have found susceptible to improved ductility by the addition of aluminum are those having copper, zinc and manganese contents coming within the area

ABCDEA in Fig. 1 of the drawings. This figure comprises a trilinear chart based on the percentage which each of the elements copper, zinc and manganese bears to the total amount of copper, zinc and manganese. As a result of extensive investigation, we have found that manganese brasses having compositions within the area ABCDEA are capable of having their tensile elongation increased to at least about 45% by the addition of the proper amount of aluminum as hereinafter explained. Alloys lying outside of said area show marked reduction of tensile elongation without a commensurate improvement in tensile strength. Within the area ABCDEA, we have found that compositions consisting of about 68% copper, from 10 to 25% zinc, from 7 to 22% manganese, and the balance aluminum in the optimum amount, are characterized by maximum ductility in addition to their high tensile strength. These preferred alloys are characterized by tensile elongation of at least about 48-50% and generally of at least 60% in two inches.

The manganese brasses in the following table are illustrative of those which we have found susceptible to improvement in ductility by the addition of aluminum. Each of the alloys reported in the table nominally contained approximately the same amount of aluminum (0.4-0.5%). The table shows the effect of varying copper-zinc-manganese content on the tensile elongation of the alloy.

Analyzed Composition			Mechanical Properties			
Per cent Cu	Per cent Zn	Per cent Mn	Tensile Strength, P. S. I.	Per cent Elong. in 2"	Red. of Area, Per cent	Brinell Hardness Number
60.2	21.6	17.7	59,000	43	33	86
66.0	19.2	14.7	50,000	61	38	60
71.0	16.2	12.6	45,000	50	31	54
70.2	20.5	9.1	45,200	63	42	58
63.5	25.0	11.1	51,000	50	34.5	68
67.9	14.9	16.8	46,500	65	40	59
63.4	17.0	19.2	50,000	60	35	66
65.5	13.2	21.2	49,000	58	36	63
61.1	15.8	23.1	56,000	53	34.5	73

Although each of the alloys in the foregoing table is characterized by a high tensile elongation, it will be understood from the following discussion that this is not necessarily the maximum ductility which each specific alloy is capable of attaining.

We have found that for any given copper content within the range of about 60% to about 74% copper, the ductility of the above-described man-

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manganese brasses increases to a maximum and then decreases as the aluminum content is progressively increased. The amount of aluminum which will produce the maximum ductility varies with the copper content of the alloys. Based upon extensive investigation, the curve AB in Fig. 2 of the drawings shows the amount of aluminum plotted against copper content which will produce maximum ductility in these high manganese brasses. Commercially satisfactory alloys may have somewhat less, say 5% less, than the high maximum tensile elongation obtainable in accordance with the invention. In Fig. 2, accordingly, there are plotted two curves CD and EF which represent the upper and lower limits in the amount of aluminum which can be used with varying copper content to produce manganese brasses having a percentage tensile elongation not more than about 5 less than the maximum percentage tensile elongation obtainable in accordance with the invention. A minimum of 0.15% aluminum is required to impart to the alloys their characteristic ability to retain their composition in the molten state. Thus, aluminum to copper proportions defined by the area between lines CD and EF in Fig. 2 represent particularly useful proportions capable of producing high ductility manganese brasses which are also characterized by excellent retention of composition during remelting.

The ability of aluminum to improve the ductility of manganese brasses having compositions coming within the area ABCDEA in Fig. 1 is exhibited only in the substantial absence of silicon or of iron plus silicon in the alloys. For example, we have found that as much as 0.05% silicon in such a manganese brass prevents the attainment of the characteristic ductility of the alloys of the invention even when using an amount of aluminum which produces the maximum improvement in ductility. Small amounts of iron alone may be tolerated but amounts of iron and silicon together totalling 0.25% or more of the alloy effect an embrittlement of the alloy which cannot be overcome by the presence of the aluminum. Accordingly, the high manganese brass alloys of the invention consist of copper, zinc, manganese and aluminum, the amount of copper, zinc and manganese coming within the area ABCDEA in Fig. 1 of the drawings, the amount of aluminum with respect to the copper being such as to come within the range of proportions defined by the area between lines CD and EF in Fig. 2 of the drawings, and the alloy being free of the common presence of iron and silicon totalling in excess of 0.25.

The limitation on the amount of silicon alone, or silicon plus iron, which can be tolerated in the alloys of the invention dictates the use of substantially pure manganese in making up the alloys. Commercial manganese of the highest quality available for the production of alloys generally contains at least 1.5% and usually several per cent of iron and silicon. Accordingly, the alloys of the present invention should be produced either with electrolytic manganese or aluminothermic manganese of substantially equivalent purity in practicing the invention. Electrolytic copper cathode sheet, or any other good commercial grade of copper, may be used in the manufacture of the alloys. The zinc is preferably high grade metal containing 99.99% zinc.

The alloys of the invention are preferably manufactured and handled in clay-silicon carbide and

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carbon-silicon carbide crucibles. Steel crucibles may be used for remelting purposes without excessive iron contamination provided the component elements of the alloys are substantially free of silicon. However, steel crucibles should be avoided entirely in the manufacture of the alloy. Crucibles made of refractory oxides, such as alumina and magnesia, may also be used with advantage.

In manufacturing the alloy, the copper is first melted and brought to a sufficiently high temperature so as not to freeze when the other alloying constituents are later added. The manganese is then added in small lots until all of the addition has dissolved in the copper. At this stage, it is expedient to add a small amount of borax to clear up the oxide on the surface of the melt. The amount of borax is preferably less than that required to form a continuous molten cover, the ideal condition being to have beads of molten borax which dissolve or flux the surface oxide and then gather near the crucible wall leaving a clear center portion through which other additions may be made. After the borax has thus cleared up the oxide on the surface of the melt, the zinc is added and the entire melt is stirred to produce a uniform composition. Aluminum is next added in small pieces placed on the surface of the melt and allowed to dissolve quietly without stirring. This procedure gives a higher recovery of aluminum in the final melt than is otherwise obtained by plunging the aluminum below the melt surface. The final operations are to stir thoroughly, allow the melt to stand for a few minutes to permit entrained oxides to reach the surface, and then skim and pour.

The alloys of the invention melt at temperatures between about 800 and 950° C., as shown by the dotted line contours of melting points appearing in Fig. 1, and can be cast without difficulty. The molten metal should be superheated for casting, and the alloys of the invention are all characterized by the fact that they can be cast at temperatures not substantially in excess of 1000° C. This casting temperature is well below the temperature at which the aluminum tends to burn off and thus expose the manganese of the alloy to oxidation.

The alloys of the invention can be sand cast in the standard green sand mold common to the foundry industry, using casting and molding practices common in the industry. The alloys have a high shrinkage during solidification, as have many sand casting alloys, and means for handling such alloys are well understood and available in commercial foundry practice. A notable advantage of the alloys in sand casting is that the sand does not adhere to the casting and can be removed easily by shaking or by blowing as distinguished from most commercial foundry alloys which must be sand blasted to remove the sand burned into their surfaces during the casting operation. In addition to sand casting, the alloys of the invention may be chill cast or die cast.

The machinability of the manganese brasses of the invention may be improved by the common expedient of adding lead thereto. For this purpose, up to about 3% lead, and preferably about 2% lead, may be incorporated in the alloys.

We claim:

1. A high manganese brass alloy characterized by high ductility and by retention of composition during remelting consisting of copper, zinc, manganese and aluminum, the amount of copper,

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zinc and manganese being such as to come within the area ABCDEA in Fig. 1 of the drawings, the aluminum being present in amount with respect to the copper such as to come within the ranges of proportions defined by the area between lines CD and EF in Fig. 2 of the drawings, said alloy being free of silicon in excess of 0.05% and being free of the common presence of both silicon and iron totalling in excess of 0.25%.

2. A high manganese brass alloy characterized by high ductility and by retention of composition during remelting consisting of about 68% copper, 10-25% zinc, 7-22% manganese, and the balance aluminum, the aluminum being present in amount with respect to the copper such as to come within the range of proportions defined by the area between lines CD and EF in Fig. 2 of the drawings, said alloy being free of silicon in excess of 0.05% and being free of the common presence of both silicon and iron totalling in excess of 0.25%.

3. A high manganese brass alloy characterized by high ductility and by retention of composition during remelting consisting of copper, zinc, manganese and aluminum, the amount of copper, zinc and manganese being such as to come within the area ABCDEA in Fig. 1 of the drawings, the ratio of aluminum to copper in said alloy being defined by the line AB in Fig. 2 of the drawings, said

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alloy being free of silicon in excess of 0.05% and being free of the common presence of both silicon and iron totalling in excess of 0.25%.

4. A high manganese brass alloy characterized by high ductility and by retention of composition during remelting consisting of about 68% copper, 10-25% zinc, 7-22% manganese, and about 0.8% aluminum, said alloy being free of silicon in excess of 0.05% and being free of the common presence of both silicon and iron totalling in excess of 0.25%.

EDMUND A. ANDERSON.
DAVID C. JILLSON.

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

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