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PROCESS AND ALLOY FOR ADDING RARE EARTH ELEMENTS AND BORON TO MOLTEN METAL BATHS

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This invention relates to alloys and particularly to an addition alloy for imparting toughness and hardenability to metals. It is frequently desirable to add one or more of the rare earth metals and boron to a metal in order to increase its toughness and hardenability. In order to accomplish this it has been the general practice to add boron as ferroboron, boron silicon alloys and other boron combinations and the rare earth metals either in the form of the pure metals or in the form of rare earth metal salts to the molten metal to be treated either in the ladle or in the ingot. In the case of the rare earth metals this has resulted in a substantial loss of metal through vaporization and failure of the metal to sink into the molten mass of metal being treated. In the case of boron, a large percentage of the boron reacts with nitrogen to form nitrides and the alloying effect of the boron itself is substantially lost.

We have discovered an alloy by means of which the rare earth metals and boron may be incorporated into molten metals without the substantial loss of rare earth metals by vaporization common to the materials heretofore used and without the substantial loss of boron by the formation of nitrides. Our alloy, moreover, has the advantage of being much more dense than the forms of rare earth metals heretofore used as additions and as a result sinks into the molten metal being treated. At the same time, the melting point of our alloy is lower than the melting point of the usual addition alloys ordinarily added to iron and steel so that danger of segregation of undissolved or partially dissolved additions is avoided.

The alloy of our invention, in general, has the following broad range of compositions:

About 10% to 95% manganese
About 0% to 75% nickel
About 5% to 60% rare earth metals
About 1% to 10% boron

Preferably, however, we limit the range within the following composition:

About 25% to 65% manganese
About 5% to 65% nickel
About 10% to 30% rare earth metals
About 1% to 10% boron

The single preferred alloy composition is:

About 40% manganese
About 25% nickel
About 25% rare earth metals
About 5% boron
Balance iron with residual impurities in ordinary amounts

In the manufacture of our alloy the boron may be added by the use of ferroboron which carries into the alloy considerable amounts of iron. This iron is not detrimental for most purposes and particularly for addition to iron and steel. Large percentages of iron, however, do tend to raise the melting point of our alloy and the iron content of the alloy should for that reason be kept as low as possible. However, iron up to about 20% is generally not objectionable. In addition, our alloy ordinarily contains small amounts of impurities which result from the manufacturing process and are carried in with the raw materials. For example, a certain amount of carbon, silicon, sulphur, and phosphorus are found in the ordinarily raw materials used in the production of our alloy and these, as well as small amounts of other impurities, remain as residual impurities in our alloy. These usual residual impurities in ordinary amounts are not objectonable.

The action of the boron in our alloy is greatly intensified over the same amount of boron in the ordinary alloy used for boron additions. This may be the result of a greater affinity for nitrogen inherent in the rare earth metals which thereby protect the boron against the nitrogen. At the same time, the rare earth recovery in the molten metal is extremely good and is much higher percentagewise than the recovers resulting from the addition of the pure rare earth metals or the salts to the molten metal. The use of our alloy substantially eliminates what is commonly termed "fading" in the steel industry, i. e., the decrease in the boron from the first poured to the last poured ingot. The alloy of our invention is particularly useful in electric furnace practice where, because of the presence of large amounts of nitrogen, the usual boron additions must be doubled or trebled in order to get a given boron residual as compared with the open hearth furnace.

While we have described a particular embodiment of our invention it will be understood that it may be otherwise embodied within the scope of the following claims.

We claim:

1. An addition alloy for imparting toughness and hardenability comprising about 10% to 95% manganese, up to about 75% nickel, about 5% to 60% of rare earth metals, about 1% to 10% boron, the balance iron with residual impurities in ordinary amounts.

2. An addition alloy for imparting toughness and hardenability comprising about 25% to 65% manganese, about 5% to 65% nickel, about 10% to 30% rare earth metals, about 1% to 10% boron, the balance iron with residual impurities in ordinary amounts.

3. An addition alloy for imparting toughness and hardenability comprising about 10% to 95% manganese, up to about 75% nickel, about 5% to 60% rare earth metals, about 1% to 10% boron, up to 20% iron, and the balance usual impurities in ordinary amounts.

4. An addition alloy comprising about 40% manganese, about 25% nickel, about 25% rare earth metals, about 5% boron, and the balance iron with residual impurities in ordinary amounts.

5. The method of simultaneously adding rare earth elements and boron to metals comprising forming a molten bath of the metal to which the rare earth element is to be added, adding to said molten bath an alloy comprising about 10% to 95% manganese, up to about 75% nickel, about 5% to 60% of rare earth metals, about 1% to 10% boron, the balance being usual impurities in ordinary amounts, permitting the alloy to melt in said molten bath and solidifying the resulting molten mass.

6. The method of simultaneously adding rare earth elements and boron to metals comprising forming a molten bath of the metal to which the rare earth element is to be added, adding to said molten bath an alloy comprising about 25% to 65% manganese, about 5% to 65% nickel, about 10% to 30% rare earth metals, about 1% to 10% boron, the balance iron with residual im-

purities in ordinary amounts, permitting the alloy to melt in said molten bath and solidifying the resulting molten mass.

7. The method of simultaneously adding rare earth elements and boron to metals comprising forming a molten bath of the metal to which the rare earth element is to be added, adding to said molten bath an alloy comprising about 10% to 95% manganese, up to about 75% nickel, about 5% to 60% rare earth metals, about 1% to 10% boron, up to about 20% iron and the balance usual impurities in ordinary amounts, permitting the alloy to melt in said molten bath and solidifying the resulting molten mass.

8. The method of simultaneously adding rare earth elements and boron to metals comprising forming a molten bath of the metal to which the rare earth element is to be added, adding to said molten bath an alloy comprising about 40% manganese, about 25% nickel, about 25% rare earth metals, about 5% boron and the balance iron with residual impurities in ordinary amounts, permitting the alloy to melt in said molten bath and solidifying the resulting molten mass.

References Cited in the file of this patent

UNITED STATES PATENTS

1,869,497	Osborg	Aug. 2, 1932
1,986,585	Kroll	Jan. 1, 1935
2,144,200	Rohn et al.	Jan. 17, 1939
2,339,252	Dean	Jan. 18, 1944
2,360,717	Phelps	Oct. 17, 1944
2,622,022	Crome	Dec. 16, 1952
2,642,358	Kent	June 16, 1953
2,683,661	Tisdale et al.	July 13, 1954

FOREIGN PATENTS

375,792	Great Britain	June 20, 1932

OTHER REFERENCES

Udy: "Boron in Steel," Metal Progress, August 1947, pages 257–264. (Copy in Div. 3, 75–B.) Pages 258 and 259 particularly pertinent.

Corbett et al.: "Effects of Boron in Steel," Bureau of Mines Report of Investigations 3816, June 1945, 21 pages. (Copy in Sci. Libr.) Pages 5 and 12 particularly pertinent.