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BORON CARBIDE COMPOUND

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1 Claim. (Cl. 75—136)

1

This invention relates generally to the class of metallurgy and is directed particularly to a compound, and method of using the same, whereby certain characteristics of iron base alloys are desirably changed.

The present invention has to do with the mixing in iron base alloys, of boron carbide in proportions greater than can be obtained by present generally known and followed methods, whereby there may be produced, as a principal object of the present invention, an iron base alloy having greater wear and acid resistance.

Another object of the invention is to provide a novel compound or mixture which makes possible the introduction of boron carbide into iron base alloys in quantities ranging from ½% to 10% of the total iron alloy mix.

A further object of the invention is to provide an improved method of mixing boron carbide in iron base alloys whereby, by the diffusion of the boron carbide through the mixture in greater proportions than can be accomplished according to known metallurgical processes, it is possible to reduce to a considerable extent the quantity of such scarce elements as chromium and tungsten in the alloy and at the same time produce an alloy having greater wear resisting qualities than alloys using large percentages of chromium and tungsten.

In accordance with the present invention the improved iron base alloy is produced by the introduction into the furnace melt at the proper moment, of the desired quantity of boron carbide, hydrogen reduced iron and nickel. These ingredients are thoroughly mixed together and introduced into the melt in any desirable manner or form depending largely upon the process by which the melt is produced, that is, whether it is produced in an electric furnace or in a furnace of another type. The hydrogen reduced iron and boron carbide are for all usual or ordinary alloy melts used in equal proportions in the compound regardless of the proportion of compound used to the entire melt and in the majority of cases also the nickel is used in the same quantity as the hydrogen reduced iron and the boron carbide, but the quantity of this latter ingredient may be varied in accordance with the quantity of nickel present in the alloy mixture.

The preferred form of the boron carbide compound consists of equal parts by weight of hydrogen reduced iron which is carbon free, commercially pure or approximately 99% pure nickel, and boron carbide containing not less than 70% of boron. These ingredients of the compound

2

are in powder form and the particle size must not be larger than sixty mesh or smaller than two hundred mesh.

The ingredients are mixed thoroughly dry and stored for use for introduction into the molten alloyed iron or steel, in suitable metal containers or in compressed pellets.

The following composition is illustrative of an alloy having as a part thereof the boron carbide compound of the present invention, together with the range of percentages of the different ingredients which may be employed for producing various grades of alloys for use as weld rods, castings or in any other desired manner.

The various grades of iron base alloys produced within the ranges set forth are not exceeded in alloy content with the successful introduction of the selected quantity of the herein described boron carbide compound.

The iron base alloy and percentage range of the constituents is as follows:

	Per cent
Chromium	.20 to 30
Molybdenum	.20 to 15
Tungsten	1.00 to 15
Nickel	.50 to 8
Titanium	.10 to 1
Manganese	.20 to 2
Silicon	.20 to 2
Boron carbide	½ to 10
Carbon	2 to 4

Balance, iron.

In the majority of cases use may be made of the boron carbide compound with the three ingredients thereof, that is, the hydrogen reduced iron, nickel and boron carbide in equal proportions or equal parts by weight as above outlined.

However there are times when nickel is already a major part of the molten alloy before the boron carbide compound is introduced into the melt. Since 8% of nickel is the maximum which can be employed in the entire melt without causing embrittlement of the produced matrix, the quantity of nickel in the boron carbide compound may be reduced as necessary in order to maintain the allowable maximum quantity of nickel in the final product.

In some instances it may be necessary to employ the hydrogen reduced iron in about half the weight of the boron carbide, in the mixture. This is for the reason that in sluggish mixtures of some steels and irons the boron carbide compound would not spread or mix in the molten mass quickly enough to make it uniform through-

out. The hydrogen reduced iron would, however, never be reduced to less than half the boron carbide content by weight.

While different proportions of the ingredients may be employed, the proportion of iron is never less than half of the boron carbide and the nickel is not less than 2% of the total mixture introduced into the iron base alloy melt.

Until the development of the present invention great difficulty has always been experienced in mixing boron carbide in iron base alloys. The maximum amount which it has been possible to diffuse through the alloy, especially in the electric furnace, has been about 2%.

Under the present invention it is possible to thoroughly diffuse through the alloy mass as much as 10% of boron carbide, substantially instantly after its introduction into the melt, in the compound.

In accordance with the present invention, about three or four minutes, not less than three, after the furnace melt is ready for pouring into ladles or molds, and after the molten mass has been thoroughly degasified causing oxygen, nitrogen and other harmful gases or impurities to be removed, the herein described boron carbide compound is introduced in the percentage of from 10% to 30% by weight of the entire melt and the melt is thoroughly stirred or agitated for approximately thirty seconds, after which it is ready to pour.

It is understood, of course, that the proportion of the herein described compound will be governed by the wear and corrosive conditions to be met by the bodies produced from the alloy.

The boron carbide compound may be submerged in the melt by means of tongs or like tools, in the form of pellets or in the usual metal containers.

In cases where the alloy is not produced in an electric furnace of the agitating type the compound introduction may be accomplished by ladle induction as in those processes where the smelter pours directly from the furnace into a ladle, deoxydizing there and then pouring from the ladle into the molds. In such processes, as soon as pouring commences into the ladle and the bottom is well covered with molten metal, the containers of the boron carbide compound, or the pellets thereof, are dropped in and the ladle filled to capacity. No stirring is required as the mixing is thoroughly accomplished by the pouring action.

It will, of course, be obvious that in following the method of mixing the compound with the metal in the ladle it is necessary, in order that the desired result may be obtained, to use extreme care in measuring correctly both the amount in the ladle and the amount of the compound. In effecting the introduction of the compound into the alloy in the furnace, this is easily accomplished but in mixing in the ladle much is left to guess work and therefore extreme care must be used as stated.

By employing the powders of the compound within the range of the particle size hereinbefore stated, the time of distribution of the compound through the mass is reduced to a minimum. If larger particle sizes are employed there would be danger of the compound not being evenly distributed.

It is a desirable feature to have the boron carbide retain its identity in the alloy at all times through to the finished product, which may be in the form of a casting. This it does. It does not melt but appears as a very dense hard substance in minute form, increasing the hardness of the mass considerably and, due to this increased hardness, it is also found that such castings are far less subject to corrosive attack because of the fact that the boron carbide compound gives a hard surface to the product.

As previously stated there are conditions under which it may become necessary or desirable to reduce the amount of nickel in the boron carbide compound, but this is never reduced to less than 2% of the total compound mixture. The amount of hydrogen reduced iron preferably is balanced with the amount of boron carbide, but may be reduced under certain conditions to not less than half the amount of boron carbide.

Prior to the development of the present invention the average of the ingredients for an iron base alloy used for the making of weld rods, castings and the like was as set forth in the following formula;

Formula "A"

	Per cent
Chromium	30
Tungsten	22
Molybdenum	15
Nickel	10
Manganese	2
Silicon	1

Total alloy 80%, balance iron.

Use of the present boron carbide composition in any alloy of the character above set forth makes possible the reduction to a very considerable extent of the amounts of the scarce elements, chromium and tungsten, as shown in the following Formula "B," and produces an alloy which outwears one made according to Formula "A," by a ratio of 2 to 1.

Formula "B"

	Per cent	
Chromium	15	maximum
Tungsten	8	maximum
Molybdenum	4	maximum
Nickel	8	maximum
Silicon	2	maximum
Manganese	2	maximum
Titanium	.10	maximum
Boron carbide	2	maximum

Balance iron.

It is to be noted that formula "B" contains much smaller amounts of chromium and tungsten and of certain other ingredients, but because of the inclusion of the present boron carbide composition the alloy produced is of superior quality particularly as regards its wear and acid resisting properties.

Tests made upon boron carbide containing alloys produced according to the single Formula "B" here given, give a Brinell hardness reading of #670–680; very uniform and proving the metal to be very dense and highly resistant to wear.

The hardness number for an alloy made according to Formula "A" was never greater than #514 and often as low as #461, not at all uniform.

In spite of the fact that the alloy of Formula "A" has high chromium, molybdenum, nickel and tungsten, all field or service tests have proven that a boron carbide containing alloy such as set forth in Formula "B," has at least 50% more resistance to corrosive wear in all its forms than Formula "A." This is believed to be due to the inertness of boron carbide to all acids, concentrated and dilute and the high degree of hard-

ness which the boron carbide alloy has, gives a surface which is dense and of uniform hardness, with no porous effects and when subjected to frictional wear develops a mirror-like finish which is not characteristic of metals not containing the boron carbide composition of the present invention.

I claim:

The herein described mixture for addition to an iron base alloy melt consisting solely of a physical mixture of powdered boron carbide, powdered hydrogen-reduced iron and powdered nickel in which the quantities of the ingrediants range from equal proportions to proportions in which the iron is not less than half that of the boron carbide and the nickel is not less than 2% of the total mixture.

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