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AUSTENITIC NODULAR IRON

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The present invention relates to cast irons having an austenitic structure and in which the free carbon is in the spheroidal form.

It is known that cast irons having an austenitic structure are generally advantageous owing to their particularly high resistance to the corrosive action of chemical agents. When the free carbon is in the spheroidal form, they also possess high mechanical properties and great deformability before rupture, which renders these irons particularly suitable for the manufacture of, notably, tanks for acid solutions and other like reservoirs which must also resist pressure. But heretofore, these free spheroidal carbon austenitic irons have been obtained only with a very high nickel content generally between 20 and 25%.

On the other hand, grey lamellar graphite cast irons having an austenitic structure and including about 5 to 7% copper and 13 to 15% nickel are known. But when magnesium is added to the constituents of these grey cast irons for the purpose of rendering the graphite spheroidal, which considerably enhances the mechanical properties of the iron, it is observed that the high proportion of copper prevents the crystallization of the graphite in the spheroidal form, the carbon being in the form of lamellar graphite after solidification of the iron.

The object of the invention is to provide a process of manufacturing austenitic spheroidal graphite cast irons having only a moderate nickel content, resulting in low cost price, said process comprising the steps of adding to the molten iron, in the form of pure metal, ferro-alloys or other combinations of nickel, copper, manganese, so as to obtain the austenitic structure after solidification and cooling to room temperature, the amount of manganese added being such that the cast iron obtained contains at least 2.5% thereof, and then adding magnesium to the molten iron in the known manner.

The applicant has discovered that notwithstanding the small nickel content, an austenitic spheroidal graphite cast iron is obtained.

If desired, an inoculation with ferrosilicon or other graphitizing agent could be effected, this inoculation being carried out after addition of the magnesium and before casting.

Another object of the invention is to provide austenitic cast irons obtained by means of the foregoing process, the free carbon of which is present wholly or partly in the spheroidal form, these irons, which are of the type comprising 2.2 to 3.3% of total carbon, 1 to 3.3% silicon, less than 0.5% of phosphorus, less than 0.10% sulphur and 0.02 to 0.10% magnesium, being characterized in that they contain 10 to 17% nickel, 2.5 to 7% manganese and 0.8 to 3% copper.

As will be seen hereinunder, the higher the nickel content the lesser the need to add copper and manganese. On the other hand, the lower the nickel content the greater the need to add copper and manganese.

The interest of the invention resides in the fact that even with moderate nickel contents, for example between

10 and 14%, spheroidal graphite irons are obtained, provided there are combined additions of copper and manganese. In this case, the applicant has observed that the sum of the copper and manganese contents must be between 4.5 and 7% without, however, the respective copper and manganese contents exceeding the maximum amounts indicated above, this being particularly so in the case of the copper content which must not exceed 3%.

Preferably, the respective nickel, copper and manganese contents range between the following values:

	Percent
Nickel	12 to 13
Copper	1.8 to 2.2
Manganese	2.9 to 3.4

in which case the cast iron would have the following composition by weight in addition to the iron:

	Percent
Total carbon	2.8 to 3.2
Silicon	2.5 to 3
Phosphorus	<0.15
Sulphur	<0.05
Nickel	12 to 13
Copper	1.8 to 2.2
Manganese	2.9 to 3.4
Magnesium	0.04 to 0.08

Some examples of cast irons will now be given, it being understood that the scope of the invention is not intended to be limited thereto.

Example 1

500 kg. of iron having the following approximate analysis by weight in addition to the iron is melted in an electric furnace:

	Percent
Total carbon	3
Silicon	2.75
Phosphorus	0.08
Sulphur	0.04
Manganese	0.5

Added to the molten iron are 80 kg. of commercial quality 99.5% pure nickel, 31 kg. of ferromanganese, containing 80% manganese, and 5 kg. of electrolytic copper scrap.

After complete melting of the added elements, the molten metal is brought to the temperature of 1,450° C. and then poured into a ladle for treatment with magnesium, by addition of 8 kg. of a nickel-magnesium alloy containing 80% nickel, and finally inoculated with 2.5 kg. of granulated ferrosilicon containing 90% silicon.

Specimens were poured into baked sand moulds. The final analysis of the cast iron was the following by weight, in addition to the iron:

	Percent
Total carbon	2.94
Silicon	3.24
Phosphorus	0.08
Sulphur	0.02
Nickel	17
Copper	1
Manganese	5.40
Magnesium	0.06

Microscopic examination revealed an austenitic structure of the ferrous matrix and graphite in the spheroidal form.

The cast iron obtained is completely non-magnetic, a

characteristic of austenitic irons, and its mechanical properties were as follows:

Tensile strength	kg. per sq. mm.	52.5
Elongation before rupture	percent	23

Example 2

With a further quantity of molten grey iron the same procedure as the foregoing is repeated but less nickel, more copper and less manganese are incorporated. After solidification the cast iron has the following composition by weight, in addition to the iron:

	Percent
Total carbon	3.05
Silicon	3.30
Phosphorus	0.06
Sulphur	0.03
Nickel	14
Copper	2.20
Manganese	2.70
Magnesium	0.04

Micrographic examination revealed an austenitic structure and spheroidal graphite. The cast iron is non-magnetic. Its mechanical properties are as follows:

Tensile strength	kg. per sq. mm.	48.6
Elongation before rupture	percent	21

Example 3

With a further quantity of molten iron the foregoing procedure is repeated with incorporation of a relatively small amount of nickel and larger amounts of copper and manganese. After solidification, the cast iron has the following composition by weight, in addition to the iron:

	Percent
Total carbon	3.19
Silicon	2.63
Phosphorus	0.08
Sulphur	0.01
Nickel	10.5
Copper	2.5
Manganese	3.8
Magnesium	0.04

Micrographic examination revealed an austenitic structure and spheroidal graphite. The cast iron is non-magnetic and its mechanical properties are as follows:

Tensile strength	kg. per sq. mm.	44
Elongation before rupture	percent	20

Example 4

In proceeding in the same manner, an intermediate amount of nickel, between 12 and 13%, is added.

After solidification, the cast iron had the following composition by weight, in addition to the iron:

	Percent
Total carbon	2.88
Silicon	2.86
Phosphorus	0.04
Sulphur	0.01
Nickel	12.7
Copper	1.85
Manganese	2.9
Magnesium	0.05

Micrographic examination revealed an austenitic structure and spheroidal graphite. The cast iron is non-magnetic and its mechanical properties are as follows:

Tensile strength	kg. per sq. mm.	50
Elongation before rupture	percent	22

Although a few specific examples of the invention have been given, many modifications and changes may be made therein without departing from the scope of the invention as defined in the appended claims.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. An austenitic cast iron produced from molten iron and having a high resistance to traction, and in which the free carbon is present at least partly in the spheroidal form, said cast iron comprising 2.2% to 3.3% total carbon, 1% to 3.3% silicon, less than 0.5% phosphorus, less than 0.10% sulphur, 0.02% to 0.10% magnesium, 10% to 17% nickel, 0.8% to 3% copper and 2.5% to 7% manganese; said copper and manganese constituents being added simultaneously to said molten iron.

2. A cast iron as claimed in claim 1, wherein the nickel content is between 10 and 14%, the manganese and copper contents being such that the sum thereof is between 4.5 and 7%.

3. A cast iron as claimed in claim 2, containing 12 to 13% nickel, 1.8 to 2.2% copper and 2.9 to 3.4% manganese.

4. A cast iron as claimed in claim 3, having the following composition by weight, in addition to the iron:

	Percent
Total carbon	2.8 to 3.2
Silicon	2.5 to 3
Phosphorus	<0.15
Sulphur	<0.05
Nickel	12 to 13
Copper	1.8 to 2.2
Manganese	2.9 to 3.4
Magnesium	0.04 to 0.08

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