

UNITED STATES PATENT OFFICE

2,339,673

TREATMENT OF CAST IRON

Alfred L. Boegehold, Detroit, Mich., assignor to
General Motors Corporation, Detroit, Mich., a
corporation of Delaware

No Drawing. Application August 25, 1941,
Serial No. 408,208

17 Claims. (Cl. 75—45)

This invention relates generally to ferrous metallurgy and more particularly to the treatment of cast iron with compounds containing nitrogen.

I have found that cast irons can be treated while in the molten or fused condition with compounds containing nitrogen, to produce cast iron articles having properties especially useful for particular applications. Cast irons when treated in accordance with the invention contain iron carbide which is extremely stable under the influence of high temperatures. This property is valuable in irons used for many purposes where exposure to heat is involved. A few examples of articles in which this property is of advantage are: grate bars, ingot molds, annealing boxes, chilled iron articles for many purposes, etc. The invention herein resides both in the treated cast iron and in the method of treating the iron.

In carrying out the method in accordance with the invention the cast iron is melted in any suitable melting furnace and while in the molten state is treated with a relatively small amount of a compound containing nitrogen. The nitrogen compound conveniently may be a nitrided iron powder which is added to the molten cast iron. The molten cast iron also may be treated by bubbling ammonia gas therethrough. Other nitrides and other compounds containing nitrogen may also be used within the scope of the invention. For example, small amounts of such compounds as ammonium carbonate and ammonium chloride may be used to treat the molten iron. If desired, two or more of the nitrogen containing compounds may be used in combination in treating the molten iron.

The nitrogen containing compound may be added to the molten cast iron in many different ways. The preferred method in any particular application will depend on a number of factors and ordinarily will vary with the apparatus or method used in melting the iron. Where an electric furnace using induction heating is used to melt the cast iron it is convenient to add nitrided iron powder or other solid nitrogen compound to the molten cast iron therein. If desired to use ammonia gas as the nitrogen compound it may be passed or bubbled through the molten cast iron in the electric furnace. For this purpose, a quartz tube may have one end immersed below the surface of the molten iron and ammonia gas under slight pressure may be passed through the quartz tube and discharged into the molten iron below the surface thereof. Where a cupola is used to melt the iron, ammonia gas conveniently

may be introduced in the cupola blast. The nitrogen containing compound may be added to the molten cast iron, also, in the ladle prior to casting. Any other suitable method of adding the nitrogen compound may be used.

After the molten cast iron has been treated with the nitrogen compound it is thereafter cast into molds in the same way that iron castings are now made.

The composition of the cast iron to be treated with nitrogen containing compounds to produce heat resistant castings or articles will vary depending on the particular usage thereof. The amount of the nitrogen containing compound also may be varied somewhat depending on the composition of the fused cast iron and on the properties desired in the final article. In all cases a relatively small amount of the nitrogen containing compound is used. In many cases the total nitrogen in the nitrogen compound is about 0.05 to 0.1% by weight of the cast iron treated thereby.

A typical composition for a heat resistant white cast iron article in accordance with the invention is: carbon 2.50-3.00%, silicon 1.00-1.20%, manganese 0.30-0.45%, sulphur 0.15% maximum, phosphorus 0.20% maximum, nitrogen in amount resulting from addition of 1.00% nitrided iron, or by passing NH_3 gas through about 17 pounds of molten metal for about 4 to 12 minutes at a rate of 12 cubic feet per hour, and the balance iron.

In the above example the nitrided iron conveniently may be a nitrided iron powder composed largely of Fe_2N .

As a specific example of the effect of the addition of a nitrogen compound to a molten cast iron in stabilizing iron carbide, the following is given:

To a fused iron melted in an induction furnace and composed of 2.68% carbon, 1.07% silicon, .37% manganese, low sulphur and phosphorus and the balance iron, was added .5% nitrided iron powder. The resulting product was cast in the usual manner and after solidification the bar was heated for 10 hours at 1700° F. Practically no decomposition of iron carbide resulted. Similar cast iron without the nitrogen treatment when similarly heat-treated has substantially all of the massive iron carbide decomposed.

The nitrogen treatment may be used to stabilize and increase the depth of the chilled zone in a grey iron article which has been cast against a chill.

The following table indicates the effect on the depth of the chill on two cast irons with and without addition of iron nitride to the molten

iron. The several irons were fused in an induction furnace and chill bars 4" x 4" x 1/2" were poured in green sand molds with a steel chill 1" x 1" x 4" along the edge of the bar opposite the gate.

Bar No.	Percentage of constituents other than iron						Depth of chill in inches (at center of bar and perpendicular to chilled edges)
	C	Si	Mn	P	S	Nitrided iron	
1.....	3.44	2.06	.56	.15	.074	None	1/8
2.....	3.39	2.06	.57	.14	.062	1.00	1/8
3.....	3.49	1.48	.48	.18	.085	None	1/4
4.....	3.45	1.47	.57	.18	.072	1.00	1/8

All of the bars numbered 1 to 4 were poured at a temperature of 2620° F. The maximum temperature before pouring bars 1 to 4 were 2832° F., 2823° F., 2787° F. and 2794° F., respectively.

In general it is contemplated that the composition for grey iron articles having a chilled zone will be composed about as follows: carbon 3.00-3.75%, silicon 0.50-2.50%, manganese 0.30-1.00%, sulphur 0.15% maximum, phosphorus 0.10-0.50%, nitrogen in amount resulting from the addition of about .5 to 1.00% nitrided iron powder, or by passing NH₃ gas through about 17 pounds of molten metal for about 4 to 12 minutes at a rate of about 12 cubic feet per hour, balance iron.

A composition that may be used for valve taps is composed about as follows: carbon 3.40%, silicon 2.00%, manganese 0.40%, sulphur 0.12%, phosphorus 0.15%, nitrogen as above, balance iron.

A car wheel having a chilled surface may be composed about as follows: carbon 3.40%, silicon 0.65%, manganese 0.60%, sulphur 0.10%, phosphorus 0.15%, nitrogen as above, balance iron.

It has been found that cast iron produced by the addition to the molten metal of nitrided iron powder is more resistant to carbide decomposition at high temperatures than similar cast irons treated by bubbling ammonia gas therethrough.

Advantage may be taken of the method of the invention to produce heat resistant white cast irons from compositions that without the treatment with nitrogen containing compounds would produce grey or mottled fractures. For example, the proportions of carbon and/or silicon are limited in usual practice by the fact that the cast iron will be mottled or grey if either or both are above a certain amount. The limit depends on the rate of cooling of the molten iron in solidifying and this is related to the size of section cast and on the type of molds used. By bubbling a small amount of ammonia through a molten cast iron of a composition that under usual cooling conditions will produce a grey or mottled cast iron, an iron having a white fracture may be produced that is resistant to carbide decomposition at high temperatures.

As an example, a cast iron composition containing about 2.68% carbon, 1.07% silicon, 0.37% manganese, when melted in an electric furnace, and cast into a green sand mold will produce a grey or mottled iron in sections equivalent in size to a two inch round. A similar composition through which a small amount of ammonia has been bubbled while the iron is molten, will produce a white iron when cast under similar conditions. In place of bubbling ammonia gas through the molten iron, other compounds containing nitrogen may be added to the molten

iron to produce white iron from compositions that would otherwise form grey or mottled irons.

Various changes in the modifications of the invention described herein may be made without departing from the principles of the invention and I do not intend to limit the patent granted thereon except as necessitated by the prior art.

I claim:

1. The method of treating a cast iron to increase its resistance to heat which includes melting the cast iron, adding to the molten cast iron a small amount of a compound containing nitrogen, and casting the thus treated cast iron into a mold, said cast iron when solidified containing iron carbide characterized by its stability under high temperature as compared with that in similar cast irons not treated with the nitrogen compound.

2. The method of treating a cast iron to increase its resistance to heat which includes melting the cast iron, adding to the molten cast iron a small amount of iron nitride, and casting the cast iron as thus treated into a mold, said cast iron when solidified containing iron carbide characterized by its stability under high temperature as compared with that in similar cast irons not treated with iron nitride.

3. The method of treating a cast iron to increase its resistance to heat which includes melting the cast iron, adding to the molten cast iron a small amount up to about 1.00% of iron nitride, and casting the cast iron as thus treated into a mold, said cast iron when solidified containing iron carbide characterized by its stability under high temperature as compared with that in similar cast irons not treated with iron nitride.

4. The method of treating a cast iron to increase its resistance to heat which includes melting the cast iron, bubbling through the molten cast iron a relatively small amount of ammonia gas, and casting the cast iron as thus treated into a mold, said cast iron when solidified containing iron carbide characterized by its stability under high temperature as compared with that in similar cast irons not treated with ammonia gas.

5. The method of producing a heat resistant cast iron article which includes melting iron in a cupola, introducing a small amount of ammonia gas in the cupola blast to thereby treat the molten iron with ammonia, and casting said treated molten iron into a mold to form a heat resistant cast iron article, said cast iron being characterized by its resistance to carbide decomposition under high temperature as compared with generally similar cast irons not treated with ammonia gas.

6. The method of treating a cast iron to increase its resistance to heat which includes fusing a cast iron containing about 2.50-3.75% carbon, 0.50-2.50% silicon, and 0.30-1.00% manganese, adding to the molten cast iron a relatively small amount of a compound containing nitrogen, and casting the thus treated cast iron into a mold, said cast iron when solidified containing iron carbide characterized by its stability under high temperature as compared with that in similar cast irons not treated with the nitrogen compound.

7. The method of producing a heat resistant white iron casting which includes fusing a cast iron that would produce a grey or mottled iron casting when cooled normally and adding thereto a small but effective amount of a compound containing nitrogen thereby producing a heat resistant white iron casting.

8. A cast iron containing a small but effective

amount of nitrogen uniformly dispersed throughout the casting, said cast iron being characterized by its resistance to carbide decomposition at high temperatures as compared with similar cast irons containing no nitrogen therein.

9. A heat resistant cast-iron containing about 2.50-3.75% carbon, 0.50-2.50% silicon, 0.30-1.00% manganese, and a small but effective amount of nitrogen substantially uniformly distributed throughout the casting.

10. A cast iron containing about 2.50-3.75% carbon, 0.50-2.50% silicon, 0.30-1.00% manganese, and about 0.05-0.1% nitrogen uniformly distributed throughout the cast iron.

11. A heat resistant white iron casting containing 2.50-3.00% carbon, 1.00-1.20% silicon, 0.30-0.45% manganese and a small but effective amount of nitrogen distributed throughout the casting.

12. A casting having a grey iron core and a white iron surface zone, said casting having a small amount of nitrogen substantially uniformly distributed throughout the casting and having a thicker zone of white iron than similar compositions containing no nitrogen.

13. The method of producing a casting having a grey iron core and a white iron surface layer which comprises fusing a cast iron composition, adding a small amount of a nitrogen compound to said fused cast iron, and pouring the composition in a mold having a metal chill.

14. The method of producing a casting which comprises providing a fused composition containing about 2.50-3.75% carbon, 0.50-2.50% silicon, 0.30-1.00% manganese, balance iron and ordinary impurities, and adding to the fused composition

a small but effective amount up to about 1.00% of nitrided iron powder.

15. A heat resistant iron casting containing about 2.50-3.75% carbon, 0.50-2.50% silicon, 0.30-1.00% manganese and a small but effective amount of nitrogen equivalent in effect to that resulting from the addition of up to 1.00% of nitrided iron, or by passing NH_3 gas through about 17 pounds of molten metal for about 4 to 12 minutes at a rate of 12 cubic feet per hour.

16. The method of producing a cast iron product containing iron carbide characterized by its stability under the influence of heat which includes, fusing a cast iron containing about 2.50-3.75% carbon, 0.50-2.50% silicon, and 0.30-1.00% manganese, adding to said fused cast iron a small but effective amount up to about 1% of nitrided iron powder, and pouring the treated fused cast iron into a mold to produce a cast iron product containing iron carbide characterized by its stability under the influence of heat.

17. The method of producing an iron casting which includes providing a fused cast iron containing about 2.50-3.75% carbon, 0.50-2.50% silicon, 0.30-1.00% manganese, balance iron and ordinary impurities found in cast iron, passing ammonia gas at a rate of 12 cubic feet per hour for from 4 to 12 minutes through about 17 pounds of the fused cast iron, and casting the fused cast iron as thus treated into a mold to thereby produce a cast iron product characterized by its stability under high temperature as compared with similar products not treated with the ammonia gas.

ALFRED L. BOEGEHOLD.