Patented Dec. 12, 1944 2,364,922

UNITED STATES PATENT OFFICE

2,364,922

METHOD OF MANUFACTURING CAST IRON

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No Drawing. Application August 11, 1941, Serial No. 406,356

3 Claims. (Cl. 75—130)

This invention relates to novel methods of producing cast irons, and more specifically to all-pearlitic cast irons having a close grained structure and improved characteristics.

Objects of the present invention are to produce pearlitic cast iron from iron mixes and compositions which would normally produce ferritic structures or free ferrite in combination with pearlite; to add tellurium in regulated amounts to normally ferrite cast irons to produce pearlitic cast irons; to control the addition of tellurium to a normally gray cast iron melt so as to produce a pearlitic cast iron containing combined carbon substantially at the eutectoid value; to regulate and control the addition of tellurium to cast iron and to prevent the formation of cementite with the addition of an alkaline-earth graphitizer such as calcium silicide; to produce novel all-pearlitic cast irons by the addition of tellurium.

In the prior art, pearlitic cast irons are known and desired for their high strength values and good mechanical properties. The present invention utilizes tellurium to produce new pearlitic cast irons and from materials which would not normally produce pearlitic structures when cast in sections useful in ordinary commercial practice.

While the present invention contemplates the manufacture of all-pearlitic cast irons by the accurate addition of tellurium alone in controlled amounts to convert a soft graphitic iron which would normally be gray and ferritic to an all-pearlitic iron, with or without traces of cementite, it will be understood that if too much tellurium has been added to produce such an all-pearlitic structure, then calcium silicide can be added to graphitize back to the desired all-pearlitic condition. When used in connection with effective amounts of calcium silicide, the quantities of tellurium and calcium silicide are regulated and controlled so that a pearlitic structure results in the finished casting. Where the amount of tellurium causes the combined carbon content to be beyond the eutectoid point with the resultant presence of excessive cementite, the use of calcium silicide inhibits and/or breaks down such excess cementite, so that the final product is substantially pearlitic.

Metallic tellurium is volatile at the melting temperature of cast iron, and dense white fumes are given off when it is added or incorporated in metallic form to the ladle metal. Tellurium is quite potent in its action on cast iron, and small quantities of tellurium exert a powerful influence on the same. The matter of control of the addition of tellurium is an important one, and its addition to cast iron can be best controlled by using it alloyed with some other material, or when mixed with an inert substance such as graphite, silica flour, or clay. The tellurium may be introduced in the molten metal in the form of capsules or tablets, each tablet containing 9½ grams of inert material and ½ gram of tellurium. A glutinous substance or molasses may be used to compound the tellurium with the inert material in tablet form. Alternatively, tellurium may be introduced into cast iron in the form of a tellurium-cast iron alloy, or other pre-alloy containing iron; such pre-alloy being useful as an addition agent to prevent undue loss of tellurium and serve for more accurate control in the process. As indicated, the tellurium may be added as an iron-tellurium alloy, but it also may be added as a copper-tellurium alloy, a silver-tellurium compound alloy, a silver-copper-tellurium alloy, or as an aluminum-tellurium alloy. The tellurium may be alloyed with certain of the alkali-earth metals, such as barium or calcium, and such pre-alloy used in the control of the making of cast iron having good physical and mechanical characteristics.

In the making of all-pearlitic cast irons in accordance with the present invention, the total carbon plus silicon content should add up to from at least 5.0% and above; the total carbon content preferably exceeding 3%, and the silicon content preferably being 1.8% or over. Examples of preferred analyses within the above ranges to which tellurium is to be added are noted in the following combinations of total carbon and silicon adding up to the range of 5.2% to 6.2%, together with their physical properties on average 1½ inch sections without the addition of tellurium.

Total C plus Si	Tensile	Brinell	Base structure
T. C. 3.6 / Si 2.6 = 6.2	20,000	156	Ferrite predominates.
T. C. 3.45 / Si 2.15 = 5.6	25,000	178	Approximate—50% ferrite, 50% pearlite.
T. C. 3.4 / Si 1.8 = 5.2	30,000	187	Approximate—20% ferrite, 80% pearlite.

When tellurium is added in controlled amounts of from ½ gram per hundred pounds to the most ferritic metal it is made pearlitic. The more ferrite the metal would contain, the larger the addition of tellurium required. Where the total carbon and silicon values add up to over 5.2%

together, the addition of tellurium eliminates ferrite and gives an all-pearlitic structure.

For heavy castings of 3 inch sections or over, it may be desirable to increase the quantity of tellurium in various controlled amounts up to 100 grams, or even up to 150 grams per 100 pounds in extreme cases. For medium castings having a section of 1 inch up to 3 inches, 15 grams per 100 pounds may be used, and for light castings up to 1 inch, 5 grams per 100 pounds may be used; for these medium and light castings any quantity of tellurium up to about 90 grams per 100 pounds may be used.

The tellurium addition is to be adjusted in accordance with the softness of the gray iron that is started with, and any gray cast iron for the purposes of the present invention may be defined as a cast iron in which the combined carbon does not exceed .8%. Without limiting the invention to an exact theory, it appears that the addition of tellurium not only influences the combined carbon, but also changes the graphite, reduces its length and even to nodular form and thus improves the grain structure and the mechanical properties. When starting with a gray iron which normally will not give a pearlitic structure without a tellurium addition, the incorporation of tellurium in such iron produces a pearlitic structure, provided the amount is controlled, as hereinabove indicated. The present invention seeks to control the tellurium addition to normally gray cast iron containing free ferrite to produce an all-pearlitic iron, and to take up the effect of any tellurium added in excess of such all-pearlitic structure by the use of an alkaline-earth silicide or graphitizing substance, such as calcium silicide.

In the preferred practice of the invention, a cupola is charged with a mix which would normally produce a soft gray iron containing free-ferrite. The use of steel scrap in the mix may be dispensed with, but its use does not interfere with the invention. When the metal is tapped from the cupola to the ladle, 5 up to 200 grams of calcium silicide per 100 pounds may be added to the metal in the spout, and then the silicide-treated metal further treated in the ladle with the calculated tellurium addition to throw the base structure into an all-pearlitic condition. Alternatively, tellurium may be added first, and calcium silicide added thereafter for adjustment purposes. As hereinbefore stated, the use of calcium silicide may be dispensed with entirely, and tellurium alone added to produce the desired all-pearlitic structure. The tellurium may be added to the ladle and/or to the molds. It may be added to the molten metal, or the molten metal may be poured over it.

One advantage of the present invention is the facility of changing the nature and physical properties of a soft gray cast iron as it comes from the cupola without having to charge a special or additional mixture in the cupola.

Another advantage is the cutting down of the amount of steel scrap which has been heretofore thought necessary to produce a high strength iron; another advantage is that strategic metals such as nickel, copper, vanadium, chromium and molybdenum may be eliminated in the production of close-grained irons. A further advantage of the invention resides in what appears to be the minor cumulative effect of tellurium in cast iron scrap. In the remelting of scrap cast iron, the ordinary foundry practice utilizes the overflow metal, sprues and risers as scrap for subsequent meltings. When such scrap contains nickel and/or chromium, the foundryman may be at a loss to know what the resulting melt will be in view of the chromium and/or nickel content of the scrap. For example, while some oxidation of chromium occurs in the cupola, there is a tendency for the amount of chromium to continue as the scrap is melted and remelted. This cumulative addition of elements interferes with the foundryman's production of a variety of products. It requires separate scrap piles of chromium-containing scrap which may not be used in non-chromium melts. Even when used, the foundryman must speculate on just what he is going to obtain in the finished product. The use of tellurium reduces these disadvantages since it does not "run through" into the next melt to the same extent, or, in other words, it does not cumulate in the same manner as nickel, sulphur, phosphorus or chromium. The foundryman therefore to some extent may disregard the tellurium content of the scrap, due to the apparent volatilization of some of the tellurium in the remelt down to a minute percentage. In the practice of the present invention, nickel, copper and molybdenum, either individually or in combination, may however be added to obtain greater hardness and toughness in amounts of from 0.1% to 5%.

The amount of tellurium which appears in the finished product may vary from an effective amount of a trace up to 0.2%, and the addition of the tellurium will be controlled, regulated, and adjusted in accordance with the total carbon and silicon content of the metal and the section of the casting. As a practical matter, the preferred tellurium content of the finished casting should approximate under .1% tellurium.

The all-pearlitic irons made in accordance with the present invention are not intended to be malleableized, nor heat treated by any operation which destroys the pearlitic structure or forms temper carbon in substantial amount therein. This does not exclude heat treatment for relieving stress, or for improving machineability, nor does it exclude quenching from proper temperatures to increase the hardness, strength and toughness. Local or surface hardening is also not excluded.

While a cupola is the preferred form of furnace to be used, the spirit of the invention comprehends the use of an air furnace or electric furnace in which cast iron or cast iron charges may be melted.

This application is a continuation-in-part of copending application, Ser. No. 202,133, filed April 14, 1938, entitled "Method of manufacturing cast iron and product thereof," which matured into Patent No. 2,281,460.

I claim:

1. A method of producing an all-pearlitic cast iron which comprises melting a charge of iron of such total carbon and silicon content that if cast in the absence of tellurium would result in a gray cast iron containing free-ferrite, and adding tellurium and calcium-silicide in quantity sufficient to produce an all-pearlitic structure.

2. A method of producing an all-pearlitic cast iron which comprises melting a charge of iron having a total carbon and silicon of over 5.0%, the total carbon content being in excess of 3.3% whereby if cast in the absence of tellurium would result in a gray cast iron containing free-ferrite,

and adding tellurium and calcium-silicide in quantity sufficient to produce an all-pearlitic structure.

3. A method of producing an all-pearlitic cast iron which comprises melting a charge of iron of such total carbon and silicon content that if cast in the absence of tellurium would result in a gray cast iron containing free ferrite and adding tellurium and calcium silicide in conjunction with at least one metal of the group consisting of nickel, molybdenum and copper in an amount from 0.1% up to 5%.

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