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CAST-IRONS AND THEIR MANUFACTURE

Leonce Reygagne, Decazeville, France; vested in the Alien Property Custodian

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Blast-furnace mouldable cast-irons such as produced in accordance with iron metallurgy processes, i. e. in apparatus supplied with coke and a blast of hot wind, have a total carbon content which is generally from 3.50 per cent to 4.00 per cent or even more, 0.60 to 1 per cent being in the form of combined carbon. When a cast-iron of the above type is examined with a microscope, free carbon is seen as graphite flakes which are generally voluminous, of variable although always relatively large length, and irregularly distributed.

Up to a recent time, these raw cast-irons were satisfactory as regards the requirements of remelting founders: the mechanical stresses imposed on cast-iron mouldings were but very small, as the metal was considered as a second rate and imperfectible material. But since twenty odd years, it has been found that, contrary to previously admitted theory, it is possible to obtain remelted cast-irons having mechanical characteristics far better than those previously accepted; the considerable improvement in mechanical properties is substantially attributable to the realization of particular structures and, to a minor extent, to that of a determined chemical composition. In case of strong cast-irons, so called steeled or pearlitic cast-irons, which is the most common type, the required structure admittedly consists in permite with free carbon in form of short and thin flakes, as regular as possible in respect of dimensions and distribution; excess ferrite should be prohibited, and the amount of free cementite should be as low as possible. To sum up, according to present conceptions the material should be given a pearlitic steel structure, and the strength towards mechanical stresses should be lowered as little as possible by those components which specifically characterize cast-iron, to wit, free graphite and free cementite. On the contrary the form of the latter components should be such as to highly increase friction strength and to result in the production of defectless mouldings.

It is particularly advisable to remove ferritic stains which are frequently found in cracked pigs. As a matter of fact when such pigs are melted, the mouldings produced therefrom exhibit like stains and many difficulties are experienced in their employment (lowered mechanical strength, liability to seizing under friction, rapid wear and so on).

The remelted, pearlitic, strong cast-irons generally have the following chemical composition:

Total carbon	2.80 to 3.20 per cent
Combined carbon	0.7 to 0.9 per cent
Silicon	much variable according to the dimensions of the piece and the cooling process
Sulphur	as little as possible
Phosphorous	maximum 0.20 per cent, preferably 0.12 per cent

Various methods are known for producing cast-iron shapes having the required micrographic structural characteristics and hence the required mechanical qualities. Amongst these methods, one of them is more and more preferred by founders by reason of its advantages such as its being easily carried out and the value and regularity of the results obtained therefrom. It is the method which consists in melting in a cupola or any other suitable apparatus, charges containing a predetermined proportion of a special fine-grained, raw cast-iron which has a low carbon content; furthermore they generally contain scraps arising from the manufacture of strong moulded pieces. Therefore experienced founders have regularly required such blast-furnace cast-irons with close grains and a low carbon content.

Up to this time, the said cast-irons could be manufactured only in a few blast-furnaces producing haematite mouldable cast-iron and the process differs from the usual process for producing mouldable cast-iron in the following respects:

A particular manner of working in the blast-furnace,

The use of suitable charges,

Or a combination of both.

By reason of the particular operation of the blast-furnace, it is possible to obtain:

1. A relatively low carbon content,

2. A graphite the development of which is controlled.

3. No structural anomalies.

I have now found that the manufacture in the just described conditions may be completed with full success by an after-treatment of cast-iron.

The latter treatment has for an object, in addition, to adjusting, as is always desirable, the proportions of chemical elements (carbon, silicon and so on), to act on the non-metallic inclusions suspended in cast-iron, which according to an improved theory, determine by reason of their manner of production and their distribution in the metal, the shape and dimensions of graphite as well as the structural anomalies above referred to.

According to this invention, the after-treatment comprises pouring the metal from the blast-furnace into a mixture of iron or steel shavings and hammer-scale. Any other divided scraps may be substituted for shavings; likewise the hammer-scales may be replaced by ferrosoferric oxide Fe_3O_4 from other sources. Instead of the said mixture of shavings and hammer-scales, I may also use any other granular or powdery material substantially consisting of iron and iron oxides.

A portion of the oxygen in the oxides will burn a part of the carbon in the cast-iron, thereby producing CO and CO_2; another portion, by combining with silicon, will yield an amount of heat larger than necessary for decomposing oxides. Such heat, together with the sensible heat in cast-iron above solidification temperature, will be available to melt ferrous metallic materials after reduction of any oxides present therein. Finally a part of the addition is converted into slag together with the oxidation products from cast-iron (MnO_2, SiO_2 and the like). Thus with a properly calculated addition of a mixture of shavings or iron scraps and hammer scales, the carbon and silicon contents are lowered and a slag is obtained, the properties of which control the graphitisation form of cast-iron. The production of this slag as a result of addition of iron oxide is one of the characteristic features in this invention.

According as the case may be, the respective proportions of iron or steel and iron oxide may vary within broad limits.

The above mentioned additions may be made either in the runner or in a suitable vessel, either stationary or movable, either heated or not, and into which cast-iron is poured. They may be made continuously in the runner or the vessel or by one or more batches.

Where a vessel is used, the addition is found to be more efficient. Furthermore, this process enables of checking results by cursory chemical analysis and by means of test-pieces, well known in the art, wherefrom the carbon and silicon content can be appreciated with sufficient precision. Thereby, it is possible to produce a cast-iron having a predetermined composition, and possessing the advantages of a "controlled" structure. It is also possible to produce very homogeneous metal by mechanically stirring for instance by rotating the furnace, by creating a rotating field with polyphased currents, by a pneumatic process and so on.

Good results were secured by placing in a ladle suitably alternating layers of shavings and hammer-scales, and pouring cast-iron at first at one point to enable cast-iron of running to the bottom of the ladle, then moving the ladle or the jet to sprinkle the whole mass of non-melted metallic materials, finally introducing dry wood poles into the molten mass to stir it as a result of gas evolution.

As an example, in a batch of 7,030 kg. of cast-iron the original contents of C=3.50 per cent and Si=3.08 per cent (with manganese=0.90 per cent; phosphorus+sulphur less than 1.10 per cent) were lowered to C=3.31 per cent and Si=1.98 per cent by adding 205 kg. of shavings and 400 kg. of hammer-scales. In a batch of 8,600 kg. of cast-iron, the carbon content was brought from 3.27 per cent to 2.97 per cent by adding 790 kg. of shavings. In a batch of 6,920 kg. of cast-iron, the carbon and silicon content were brought from 3.25 per cent and 4.66 per cent respectively to 3.05 per cent and 3.52 per cent respectively by adding 234 kg. of shavings and 575 kg. of hammer-scales. Finally, in a batch of 6,530 kg. of cast-iron, the carbon and silicon content were brought from 3.09 per cent and 3.68 per cent respectively to 2.76 per cent and 2.33 per cent respectively by pouring it upon 310 kg. of shavings, 905 kg. of hammer-scales and 202 kg. of pyrite ashes.

When oxygen containing materials are added an exothermic reaction takes place, whereby the amount of shavings or divided iron scraps may be increased.

On the other hand, the carbon and silicon contents may be adjusted and the cast-iron structure may be altered in such a way as to produce a homogeneous structure.

The invention allows of producing new types of cast-irons (more particularly as soon as they leave the blast-furnace) the carbon content of which may vary from 3.40 to 2.40 per cent and the silicon content may be lowered to 1.5 per cent with a homogeneous structure and no ferrite stains; no similar cast irons have ever been produced up to this time even in a special furnace.

LÉONCE REYGAGNE.