

UNITED STATES PATENT OFFICE.

HENRY M. HOWE, OF BOSTON, MASSACHUSETTS.

PROCESS OF MAKING MOLTEN IRON FOR MALLEABLE CASTINGS.

SPECIFICATION forming part of Letters Patent No. 584,781, dated June 22, 1897.

Application filed February 20, 1895. Serial No. 539,111. (No specimens.)

To all whom it may concern:

Be it known that I, HENRY M. HOWE, of Boston, county of Suffolk, Commonwealth of Massachusetts, have invented an Improvement in Processes of Making Molten Iron for Malleable Castings, of which the following is a specification.

The usual way of making what are technically called "malleable castings" is to melt cast-iron and maintain it molten in a reverberatory or air furnace until it becomes "refined"—that is to say, until by the removal of its carbon and silicon by the oxidizing action of the atmosphere it reaches a certain suitable composition. This metal is then poured into suitable molds, yielding castings. The metal so produced is cast-iron, and of a composition which gives such extreme brittleness that it is useless in that condition, but which confers the power to be converted from cast-iron into malleable iron by a special annealing. This annealing consists of a long and high heating in contact with iron oxid, whereby the carbon of the cast-iron is removed, so that the composition of the metal approaches that of other highly-malleable forms of iron, such as wrought-iron and extra-soft steel.

My invention has for its object an improved way of making molten cast-iron of a composition suitable for making cast-iron castings, which are later to be converted into malleable-iron castings, and does not relate directly to such conversion of cast-iron into malleable iron, nor does it relate to the manufacture of steel or of wrought-iron or any malleable form of iron other than malleable castings. Therefore, though it is a step in the manufacture of malleable castings, my invention itself is an improved way of making a special form of cast-iron, which, though capable of being later made malleable, is at the point where my invention ends an extremely brittle form of cast-iron, containing usually between 2.8 and 3.10 per cent. of carbon and between 0.60 and 0.80 per cent. of silicon. Such molten cast-iron of the special composition suitable for later conversion into malleable castings has no suitable distinctive name, though it is sometimes called "sprue." I shall hereinafter designate it as "cast-iron

suitable for conversion into malleable castings."

When I speak in this specification and in the accompanying claims of "malleable castings," I refer solely to castings which have been made essentially in the way which I have just described—that is to say, by pouring into suitable molds cast-iron, which when thus cast is too brittle for use, and is subsequently made malleable by decarburizing it by cementation with iron oxid or by other equivalent means. The term "malleable castings" is in trade applied exclusively to this product. It is true that certain cast-iron castings not so toughened by such decarburizing process are slightly malleable, but they are not technically known as "malleable castings," and I do not include them here under this name. Cast-iron is generally used as the sole or almost the sole material for making this special cast-iron suitable for conversion into malleable castings, but the use of cast-iron alone or nearly alone has two serious disadvantages: first, because it usually contains so much silicon that a long expensive fusion and refining in the air-furnace is necessary to remove such silicon; second, in many cases the cast-iron is very much more expensive than other forms of iron—as, for instance, scrap wrought-iron or steel, which for brevity I will hereinafter call "malleable scrap-iron."

In present methods of procedure only a small proportion of wrought-iron or steel can be mixed with the cast-iron, because otherwise it would unduly dilute the carbon of the cast-iron.

The molten metal when ready for casting should contain between 2.8 and 3.10 per cent. of carbon and 0.6 to 0.80 per cent. of silicon. By retaining the cast-iron of commerce in the air-furnace long enough to reduce its silicon to within these limits its carbon also will usually have fallen to its proper limits.

While it may be possible to add a little scrap malleable iron to some classes of cast-iron, if much is added the carbon of the cast-iron is diluted too greatly, so that the molten metal has less than the 2.8 per cent. of carbon needed to give it proper fluidity.

My invention has for its object the production of a process whereby the use of a large

proportion of malleable scrap-iron is permissible and to shorten or altogether do away with the costly air-furnace refining.

In carrying out my process I melt the cast-iron with a large amount of scrap wrought-iron or scrap-steel or other cheap form of relatively carbonless iron in such proportion that when melted the charge as a whole shall contain about 0.8 per cent. to one per cent. of silicon. I then mix with the metal enough carbonaceous matter, such as charcoal, gas-carbon, coke, anthracite, &c., to give it altogether about three per cent. of carbon. If the metal be at the proper temperature, it can be cast at once into molds, and then converted into malleable iron by annealing in the usual way.

It may be necessary to retain the molten metal in the furnace in which it has been melted or in another suitable furnace till it reaches the temperature suitable for casting, which temperature is well known to those versed in the art, and also to bring it to the proper composition. For instance, if the metal when molten still has a little excess of silicon it may be necessary to maintain it molten till it refines—that is, until its excess of silicon is removed.

The progress of the removal of the silicon is readily followed by watching the fracture of test samples taken out from time to time in usual manner. So long as the fracture of these samples has any excess of black spots there is still an excess of silicon present. Should there be a slight deficit of silicon, this may be remedied by adding a little ferrosilicon. So, too, if there be an excess of carbon it may be removed either by diluting the charge by the addition of more malleable scrap-iron or by maintaining the charge molten while the carbon gradually oxidizes. If there be not enough carbon, a little may be added in the form of charcoal, coke-dust, &c. The charge may be melted in the usual air-furnace or in an open-hearth furnace. In either case the carbonaceous matter may be mixed with the initial charge, which will absorb it in melting, or it may be incorporated with the charge after fusion; but I prefer to melt the charge in a cupola-furnace and to run it thence into an air-furnace or other reverberatory furnace, passing it through or over the carbonaceous substance on its way from the cupola to the reverberatory furnace.

When malleable scrap-iron is much cheaper than cast-iron, the cast-iron most suitable for my process is one extremely rich in silicon, because such iron will carry a very large proportion of scrap-iron. Thus a pig-iron with five per cent. of silicon may have as much as five or six times its weight of malleable scrap-iron mixed with it. A pig-iron with three per cent. of silicon will carry three times its weight of malleable scrap-iron.

When malleable scrap-iron is very much cheaper than cast-iron and when ferrosilicon

is not too expensive, I may add ferrosilicon to the initial charge, so as to enable it to carry a still larger proportion of malleable scrap-iron.

The composition of the molten iron ready for casting when prepared in accordance with my process is substantially the same as that made in the usual way. It should not contain much more than 0.40 per cent. of manganese and not over 0.20 per cent. of phosphorus or 0.15 per cent. of sulfur, the less of the last two elements the better.

The quantity of scrap malleable iron which any pig-iron will carry may be readily calculated from its percentage of silicon, which will simply be diluted by such scrap-iron, bearing in mind that about 0.30 per cent. of silicon will be incidentally removed if the metal be melted in a cupola-furnace and from 0.5 per cent. to one per cent. if the metal be melted in a reverberatory furnace.

The quantity of carbonaceous matter which must be added to carburize the molten metal sufficiently also can be calculated from the percentage of carbon in the pig and in the scrap, respectively, remembering that a little carbon will be removed in fusion and that from seventy per cent. to ninety per cent. of the carbon of the carbonaceous matter will be absorbed by the molten metal, according to the intimacy of contact afforded.

In practicing my herein-described process until thoroughly familiar therewith it is better to use rather less scrap than the cast-iron is capable of carrying and to add to the molten metal rather more carbon than is needed, so that the charge when first melted shall have a little more silicon and a little more carbon than it should have when ready for casting. The excess of silicon and of carbon will then be removed spontaneously as the metal lies molten and is refined by the oxidizing action of the air, and any deficit of carbon when the silicon reaches the right point will be made up by slight additions of carbonaceous matter to the molten metal. To the experienced eye the fracture of the metal, its shrinkage, and its fluidity give sufficient indication as to whether there be an excess or a deficit of carbon and silicon, respectively.

In general, black spots in the fracture indicate an excess of either silicon or carbon; but if the eye be unpracticed it is best to determine the carbon and silicon as soon as the metal is melted by the rapid analytical methods used in connection with the open-hearth steel process. Charcoal and coke-dust in canvas bags or sheet-iron canisters are convenient forms for such additions.

With further experience the pig or cast iron may be so proportioned to the scrap that the charge as soon as it is molten will have very nearly the composition and temperature suitable for casting, thus shortening the time needed for adjusting the composition and

temperature in the reverberatory furnace. Indeed, skilful operatives can melt in a cupola-furnace a charge of such initial composition and with such quantity of fuel that the
5 molten metal as it reaches the bottom of that furnace will be almost exactly at the temperature and composition fit for casting, save that it lacks carbon. This can then be added to it in a ladle into which the metal runs direct from the cupola without any reverberatory-furnace treatment. The molten metal
10 will quickly absorb the carbon and be ready for casting.

For carburizing, coke is cheaper than charcoal; but it usually contains much sulfur, which the molten metal absorbs; but such absorption will do no serious harm unless the charge initially is rather rich in sulfur.

I do not confine myself to any particular
20 method of causing the carbonaceous matter to unite with the molten metal nor to any special form of furnace.

I claim—

1. The herein-described process of making
25 molten cast-iron suitable for conversion into malleable iron, which consists in melting cast

and malleable iron, and ferrosilicon, and then adding carbon thereto, substantially as described.

2. The herein-described process of making
30 molten cast-iron suitable for conversion into malleable iron, which consists in melting cast and malleable iron, and ferrosilicon, and then carburizing the molten metal by the addition of non-metallic carbonaceous matter, substantially as described. 35

3. The herein-described process of making
molten cast-iron suitable for conversion into malleable iron, which consists in melting cast
40 and malleable iron, carburizing the molten metal by the addition of non-metallic carbonaceous matter, and bringing the carburized metal to temperature and composition suitable for pouring by adding thereto scrap-iron, substantially as described. 45

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRY M. HOWE.

Witnesses:

FREDERICK L. EMERY,
AUGUSTA E. DEAN.