UNITED STATES PATENT OFFICE.

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PROCESS OF MANUFACTURING STEEL, &c.

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To all whom it may concern:

Be it known that I, CHARLES H. FOOTE, residing at Chicago, Cook county, Illinois, have invented certain new and useful Improvements in the Process of Manufacturing Steel and in the Process of Producing Spiegel or Ferromanganese for Use in Steel Manufacture, of which I do declare the following to be a full, clear, and exact description, sufficient to enable others skilled in the art to which my invention relates to practice the same.

In the Bessemer process of manufacturing steel it is customary after the metal has been sufficiently refined to add to the charge of metal within the converter spiegel containing carbon, manganese, and silicon in definite percentages in order to give the desired character to the converter product. The present method of producing this spiegel consists in charging a blast-furnace with a manganiferous ore from which the spiegel is to be made, and from time to time the furnace is tapped and the melted spiegel run into pigs. These pigs of spiegel are then analyzed and sorted and stacked in separate piles with reference more particularly to their manganese content. A cupola is afterward charged with the pigs of spiegel, together with a desired proportion of pig-iron and fuel, in order to give to the product of the cupola the desired percentages of manganese, silicon, and carbon. This cupola product is used in molten condition in making the additions to the charges of the Bessemer converter at the end of the refining operation.

The charging of the blast-furnace with manganiferous ore necessary to produce the spiegel has commonly been effected with only about the same degree of care that is exercised in the charging of blast-furnaces used in the production of pig-iron, and it has been found that a very material variation exists in the pigs of spiegel from the furnace, and this variation exists not only in pigs obtained from different casts of the same furnace, but in pigs obtained from different portions of the same cast or heat. The variations in the spiegel pigs from the blast-furnace have been due largely to the fact that the manganiferous ore from which the pigs are made varies materially in its character and grade, the variations being much greater than are found in ores used in the manufacture of pig-iron. Manganiferous ore such as is suitable for the manufacture of spiegel is usually found in pockets, so that such ore, even from the same locality and from the same mines, is apt to vary to a very considerable extent, particularly as to its manganese content. These variations in the character and grade of the pigs obtained from a spiegel-furnace have been looked upon in great measure as unavoidable, and this has constituted one reason why it has been heretofore deemed impossible to use spiegel direct from the blast-furnace as a recarburizing addition to the charge of a Bessemer converter or open-hearth furnace, because in modern steel-making the specifications for carbon, silicon, and manganese are so rigid and exact and the limits of variation allowed are so slight that if the spiegel vary considerably either in manganese or silicon, or both, it cannot be used, and variations in the manganese content of the spiegel are found particularly objectionable.

Another reason why it has been heretofore thought impossible to use spiegel direct from the blast-furnace as an addition to the charge of a Bessemer converter is that it was supposed that the molten spiegel would chill in the ladles before it could be delivered to the converter, and this supposedly fatal objection to the use of spiegel direct from the furnace has arisen because of the rapidity with which the pigs of spiegel set and harden within the casting-beds.

I have found that if the manganiferous ore delivered to the spiegel-furnace be carefully selected and graded before it is charged into the furnace, and if the furnace be carefully burdened, a much more uniform grade or character of spiegel can be obtained than has been heretofore deemed possible, and that by thus exercising extreme care in the proper charging and burdening of the furnace, particularly with respect to the precise grade and character of the manganiferous ore used therein, a spiegel suitable for direct additions to the charges of a Bessemer converter or open-hearth furnace may be obtained. I have discovered also that notwithstanding the fact that molten spiegel sets and hardens so rapidly when cast into pigs it may, nevertheless, be transported in ladles from the blast-fur-

nace to the Bessemer converter or open-hearth furnace without danger of becoming chilled in transit.

In the practical operation of my invention I prefer to use two or more blast-furnaces for producing the spiegel, and I prefer that these furnaces shall be of comparatively small capacity, the reason for employing two furnaces being that if any accident, such as a leaky bosh-plate or twyer or a "scaffold," in one furnace should occur the other furnace may be relied upon to give the desired grade and character of spiegel.

My object in using furnaces of smaller capacity than are commonly employed in the manufacture of spiegel is that with such small furnaces a more careful charging and more uniform and exact operation can be relied upon.

In the preferred manner of practicing my invention the spiegel will be drawn from the blast-furnace either into a large ladle adapted to hold one or more casts of the furnace and thereby serve as a mixing-chamber wherein a more uniform distribution of the manganese, silicon, and carbon contents of the spiegel may be effected, or the metal from the spiegel-furnace may be transported in suitable smaller ladles to a mixing-chamber of a capacity adapted to receive one or several heats or casts of the spiegel-furnace. This mixing-chamber may be of that kind commonly employed at those steel works at which the direct process of manufacturing steel (without the intermediary of a cupola for remelting the pig-iron) is practiced and at which the casts of molten pig-iron from the blast-furnaces are delivered into a large mixing-chamber in order to secure a more uniform grade or character of the iron. The spiegel thus delivered direct from the spiegel-furnace to the large ladle or by means of smaller ladles to a mixing-chamber of large capacity will be tapped or poured from such large ladle or from such mixing-chamber in suitable quantities for addition to the charges of a Bessemer converter at the end of the refining operation. When such large ladle or separate mixing-chamber is thus employed, the mass of spiegel therein will be replenished from time to time by successive casts from the spiegel furnace or furnaces.

By the use of spiegel "direct" from the blast-furnace (by which term I mean without casting the spiegel into pigs and remelting it in a cupola) a very great saving in the cost of manufacture is effected, since obviously the time and labor required to cast the smelted spiegel into pigs, in transporting and handling these pigs, the fuel, labor, and repairs incident to remelting the pigs in a cupola, and more particularly the loss of manganese and silicon by oxidation in the remelting of the pigs within the cupola are avoided.

While I have described my invention especially with reference to the production and use of spiegel, it is manifestly applicable to the production of ferromanganese, since ferromanganese may be regarded as merely a richer spiegel.

Having thus described the invention, what I claim as new, and desire to secure by Letters Patent, is—

1. That improvement in the process of manufacturing steel in a Bessemer converter or open-hearth furnace that consists in first producing spiegel or ferromanganese in a smelting-furnace and thereafter, without remelting said spiegel or ferromanganese, adding the same to the charge of a Bessemer converter or open-hearth furnace.

2. That improvement in the process of manufacturing steel in a Bessemer converter or open-hearth furnace that consists in first producing spiegel or ferromanganese in a smelting-furnace and thereafter, without remelting said spiegel or ferromanganese, charging different casts thereof into a suitable mixing-chamber and successively removing portions of the molten mass from the mixing-chamber while replenishing the contents of said chamber by new portions or casts direct from the smelting-furnace.

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