

UNITED STATES PATENT OFFICE.

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PROCESS OF MANUFACTURING STEEL.

No. 906,757.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, WILLIAM R. WALKER, of Chicago, Illinois, have invented certain new and useful Improvements in the Processes of Manufacturing Steel; and I do declare the following to be a full, clear, and exact description of my invention, sufficient to enable others skilled in the art to which my invention pertains to practice the same.

10 In the manufacture of steel by the Bessemer and open hearth processes it is customary at the close of the refining operation by which the impurities are removed from the metal, to add to the more or less completely
15 decarbonized and purified metal within the converter or refining chamber, a quantity of metallic alloy, the purpose of which is primarily to recarburize the refined metal and as well also to serve as a vehicle for such
20 agents (as manganese, silicon, aluminum or the like) as shall impart to the steel the desired character or qualities resulting from the use of such agents. Thus, for example, in the Bessemer process as now commonly practiced it is customary to add, at the end of the
25 "blow," to the more or less decarbonized molten metal within the converter a quantity of spiegel containing sufficient carbon and manganese to supply the desired per-
30 centages of these agents to the converter charge, and containing sufficient silicon to supplement any deficiency that may exist in the silicon content.

35 The method at present generally practiced for the production of spiegel consists in charging a smelting furnace with a highly mangani-ferous ore and from time to time the furnace is tapped and the metal run out into pigs, as in ordinary blast furnace operation.
40 The pigs of spiegel thus produced are often found to vary to a considerable extent especially in their manganese content throughout the furnace casts, and this variation sometimes occurs not only in different casts from
45 the same furnace but in pigs formed from different portions of the same cast. Hence, it is customary to sort the pigs of spiegel, more especially with reference to their man-ganese content, and these pigs are after-
50 wards charged into a cupola together with suitable quantities of pig-iron necessary to give to the cupola product the required per-centages of carbon, manganese and silicon. This common method of producing spiegel is
55 very expensive not only because of the cost incident to the labor of casting the spiegel

into pigs, transporting and handling the pigs and the cost incident to re-melting the metal in a cupola, but it is found that a most serious and wasteful loss of manganese occurs by
60 reason of its oxidation in the cupola. A further objection to this common method of producing spiegel is that it is frequently desired to change the grade or character of the spiegel to be used as a re-carburizing addi-
65 tion in the Bessemer converter or open hearth furnace upon very short notice, yet a change in the character of the spiegel delivered from a cupola cannot be effected with certainty inside of several hours. With this
70 common method of producing spiegel it is obvious also that in the re-melting of the pigs of spiegel within the cupola, the addition of pig-iron therein reduces to a material extent the manganese content of the spiegel. Hence
75 it is that, in order to obtain from the blast furnace pigs of spiegel sufficiently high in manganese to permit of re-melting with pig-iron in a cupola, it is necessary to use high
80 grade mangani-ferous ores, which, being found only in certain localities, are comparatively scarce and expensive. On the other hand, a lower grade of mangani-ferous ores, suitable for producing a lower grade of
85 spiegel can be obtained in many localities and at comparatively much less cost.

My present invention has for its object (so far as it relates particularly to the production of spiegel), to provide a process whereby a
90 spiegel having especially its manganese and as well also its carbon and silicon contents more thoroughly and more uniformly distributed therethrough can be obtained without the necessity of remelting the spiegel
95 within a cupola, and has for its object also to provide a process that will enable spiegel, suitable as a recarburizing addition to the charge of a Bessemer converter or like refin-
100 ing chamber, to be produced from low grade and inexpensive ores, such as are to be found in many parts of this country.

While my invention has primarily for its object to provide an improved process of producing spiegel, it will be found applicable
105 also to the production of other metallic alloys suitable as additions to the charges of a Bessemer converter or open hearth furnace, the precise character of which alloys will depend upon the particular agents for the de-livery of which to the converter or refining
110 chamber the said addition serves as a vehicle.

My invention will first be described in con-

nection with the production of spiegel and the application of the invention to the production of other metallic alloys suitable as converter additions will thereafter be more fully pointed out.

In the preferred and most economic practice of my invention the smelting furnace will be charged in usual or suitable manner with a low grade manganiferous ore, such, for example, as will give to the product of the smelter a manganese content of say from 8 to 12 per cent. The metal from the smelter will be delivered by a suitable runner into ladles and by preference will be transported by these ladles to a suitable mixing chamber having a capacity sufficient to receive one or preferably several casts from the spiegel furnace. This mixing chamber may be of the character commonly employed at those plants at which the direct process of steel-making is practiced and in which the casts from various blast-furnaces producing pig-iron are delivered into a common mixing chamber in order to give a more uniform character to the converter charges. As the low grade spiegel is thus delivered from the smelting furnace I gradually add to the metal while in the runner or at the discharge end of the runner or while in the receiving ladle, a quantity of richer spiegel, or ferro-manganese, (and if desired, also ferro-silicon or similar iron alloys) necessary to raise the manganese content and as well also the silicon and carbon or the like of the low grade spiegel to the required percentages. These additions of richer spiegel or ferro-manganese or the like may be made in molten condition, although I prefer to make such additions in comminuted or lump form, the richer spiegel or ferro-manganese being broken to about the size of hickory nuts and brought to a red-heat and then gradually delivered into the mass of metal from the blast furnace. I prefer to make these additions while the metal from the blast furnace is passing down the runner since thereby a more gradual and uniform distribution of the additions can be effected and the intimacy of the mixture can be increased by the agitation incident to the passage of the metal down the runner and its delivery into the receiving ladle. The charge of metal within the ladle may then be delivered to the mixing chamber (if a mixing chamber be employed) and there mixed with pre-delivered charges, and from this mixing chamber portions of the metal will be tapped from time to time for additions to the charges of the Bessemer converter or refining chamber. By thus adding the richer spiegel or ferro-manganese or the like to the low grade before the delivery of the metal to the mixing chamber, I insure a far more intimate mixture of the additions with the mass of metal than would be possible if the additions of richer spiegel or ferro-manganese or the like

were made in the mixing chamber, and consequently a much more uniform distribution of the manganese, silicon and carbon or the like throughout all parts of the mass of metal within the mixing chamber is obtained. The thorough mixture of the additions of richer spiegel or ferro-manganese or the like with the blast-furnace casts results not merely from the mechanical agitation of the smelted metal and the additions made thereto during the delivery into and discharge from the receiving ladle but the agitation of the metal within the ladle incident to the generation of the gases therein during the time that the metal is within the ladle also contributes materially to the more uniform mixture of the content of manganese, silicon and carbon or the like throughout the entire mass.

When a richer spiegel or ferro-manganese is added to a lower grade spiegel it has been found that there is a tendency of the metal to stratify, but by making the additions to the low grade spiegel before it is discharged from the receiving ladle (and preferably before its delivery thereto) all danger of this stratifying of the metal is avoided. Preferably the ladle that receives the charge of spiegel from the smelter will be covered and will be provided with a gas or oil burner or may have an addition of charcoal, or coke dust in order to keep the metal hot in transit from the blast furnace to the mixing chamber (when a mixing chamber is used), and in order to secure a more intimate mixture within the ladle, I prefer to insert a bar of wood into the molten metal contained therein, the result being a violent ebullition of the mass. When the smelted spiegel from the blast furnace is delivered to the mixing chamber a further intimacy of the mixture is secured by reason of the mechanical agitation incident to the discharge of the metal from the receiving ladle into the mixing chamber and the agitation therein resulting from the repeated additions of metal to such chamber.

That feature of my invention which consists in delivering to the metal from a smelter while such metal is running into the ladle or while contained in the ladle such additions as will adapt such metal as a recarburizing addition to a converter charge will be found of advantage not merely in the production of spiegel from low grade ores in manner herein described, but will be found applicable also in other connections in which it is desired to change the character or grade of the recarburizing metal from the smelting furnace. Therefore, I do not wish this feature of my invention to be understood as restricted either to the production of spiegel or to the enrichment of a low grade spiegel, since so far as the broad feature of making the desired additions to the product of a smelting furnace before it is discharged from the receiving ladle, can be practiced with advantage

irrespective of the precise character or grade of the metal delivered from the smelter or of the precise grade or character of chemical composition of the additions, that are made to the furnace product.

In the practice of my invention, so far as the same relates to the addition of richer spiegel or ferro-manganese to a low grade spiegel in manner above defined, I prefer to make the required additions at a red-heat since the necessity of melting spiegel or ferro-manganese in a cupola or furnace for this purpose is thereby avoided, this use of solid additions being rendered possible by reason of the uniform distribution of the additions throughout the mass owing to the additions being made prior to the discharge of the metal from the ladles.

Instead of transporting the spiegel from a blast-furnace to a mixing chamber by small ladles as above described, the mixing chamber might be dispensed with and a single ladle employed of suitable construction and capacity to receive the entire cast from the smelting furnace or to receive several successive casts therefrom. Or, without departing from the spirit of the invention the metal from the smelting furnace having received suitable additions of richer spiegel or ferro-manganese or the like, necessary to adapt the metal for use as a recarburizing addition to the charge of a Bessemer converter or open hearth furnace, might be transferred directly from the smelting furnace to the converter or open hearth furnace.

It is manifest that the precise quantity and character of the additions of richer spiegel, ferro-manganese or the like that should be made to the metal from the smelting furnace will depend upon the character of the metal at such time and upon the percentages of silicon, manganese, carbon and the like that are called for by the character or grade of the finished product of the converter or open hearth furnace. And it is obvious that changes in the precise grade and character of the spiegel to be delivered to the converter or open hearth furnace can be quickly varied by variation in the quantity or character in the additions made to the metal from the smelting furnace.

While my invention is primarily designed for the production of a spiegel in manner above defined, it is manifest that features of the invention may be employed in the production of other metallic alloys suitable as additions to the charges of the Bessemer converter or open hearth furnace, and it is plain also that features of the invention may be employed without its adoption as an entirety.

While my purpose is in the preferred practice of my invention, to obtain the desired grade or character of spiegel, (or like metallic alloy) before its delivery into the mixing

chamber (if such chamber be used), it may at times be found that for certain heats a sudden change in the carbon content of the converter product is desired. When such a change is desired the spiegel will be delivered to the converter in manner above defined, and at the end of the blow a suitable quantity of powdered charcoal, coke, dust or like carbonaceous material will be added to the metal delivered from the converter after the blow. In this way the required change of carbon content can be made without the necessity of changing the grade or character of the entire mass of metal within the mixing chamber. So also, if it be desired, say for certain heats of the converter, to vary both the silicon and carbon contents of the spiegel, a quantity of the spiegel may be carried in a ladle from the spiegel mixing chamber or from the blast furnace direct, and into this ladle a suitable addition of molten pig-iron can be delivered from a mixing chamber containing pig-iron, or from a cupola or blast-furnace in order to give the required silicon percentage to the mass within the ladle, and after this ladle charge of modified spiegel has been delivered to the converter, the requisite amount of charcoal, coke dust or like carbonaceous material can be added to bring the carbon content of the converter product to the required percentage.

I do not wish to be understood as claiming as of invention broadly the discovery that spiegel from the smelting furnace may be used without re-melting as a recarburizing addition to the charge of a Bessemer converter or open hearth furnace, nor as claiming broadly the process of producing spiegel suitable as such recarburizing addition by changing the grade or character of the spiegel by the addition of molten metal containing agents adapted to impart the desired grade or character to the spiegel, as such matters are the inventions of others.

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 producing steel that consists in running the smelted metal, that is to be used as a recarburizing addition to the charge of a Bessemer converter or steel refining chamber, from the blast furnace directly into a receiving ladle, mixing with the smelted metal after its discharge from the blast furnace and before its admission to said receiving ladle suitable metallic additions of one or more agents for which said blast furnace product serves as a vehicle, refining the body of metal to which said recarburizing addition is to be made, and thereafter while said metallic alloy is still in the molten condition in which it is received from the blast furnace, adding said alloy to the charge of a Bessemer converter or steel refining chamber after the refining operation.

2. That improvement in the process of steel manufacture that consists in charging a blast furnace from which spiegel is to be produced with ore so low in manganese as to give to the product of the furnace a manganese percentage below that desired in the spiegel that is to be charged into the Bessemer converter or open hearth furnace, afterwards tapping the smelted metal from the blast furnace and mixing with said metal after it is discharged from the blast furnace, a metallic addition containing a sufficient excess of manganese to adapt the spiegel as a recarburizing addition to the charge of a Bessemer converter or open hearth furnace and finally adding said spiegel to the charge of a Bessemer converter or steel refining chamber.

3. That improvement in the process of steel manufacture that consists in charging the blast furnace from which spiegel is to be produced with ore so low in manganese as to give to the product of the furnace a manganese percentage below that desired in the spiegel that is to be charged into the Bessemer converter or open hearth furnace, afterwards tapping the smelted metal from the blast furnace and mixing with said metal after it is

discharged from the blast furnace and before it is removed from the receiving ladle a metallic addition containing an excess of manganese and finally adding said spiegel to the charge of a Bessemer converter or steel refining chamber.

4. That improvement in the process of steel manufacture that consists in charging a blast furnace from which spiegel is to be produced with ore so low in manganese as to give to the product of the furnace a manganese percentage below that desired in the spiegel that is to be charged into the Bessemer converter or open hearth furnace, afterwards tapping the smelted metal from the blast furnace and mixing with said metal after it is discharged from the blast furnace and before it is removed from the receiving ladle a metallic addition containing an excess of manganese and finally successively delivering the charges of the metal from the ladle into the mixing chamber.

WILLIAM R. WALKER.

Witnesses:

GEO. P. FISHER, Jr.,
GEO. P. FISHER.