APPARATUS FOR PRODUCING A FORM OF PIG IRON OF LOW CARBON CONTENT

Amos Denison Williams, Philadelphia, Pa.

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The principal object of this invention is to provide an improved apparatus for producing slag-free low carbon pig iron suitable, for example, for use in material advantage in the manufacture of steel and for foundry purposes.

In the conventional iron smelting blast furnace, the ore or iron bearing materials are reduced to sponge iron in the shaft of the furnace and in the bosh above the fusion zone. This material is charged in the furnace in a solid condition because the solid solution of carbon by the cementation process is very slow and the time during which this sponge iron is in contact with the fuel carbon or deposited carbon at temperatures sufficiently high for cementation or the solid solution of carbon to occur is so short that only a very slight and extremely superficial impregnation of the sponge iron can take place. This low carbon metal is melted in the fusion zone and frequently freezes and accumulates on the water cooled wall at the top of the hearth and the lower portion of the bosh. It is this intermediate low carbon product of the blast furnace which by use of my invention becomes the end or final product. In the conventional blast furnace this low carbon metal is melted in contact with fuel carbon and remains in contact with the carbon, dissolving it, until withdrawn from the furnace. In accordance with my invention, the contact of the molten iron is limited entirely to that which occurs in the fusion zone, and immediately after leaving this zone the molten metal is segregated from contact with carbon until withdrawn from the furnace. This procedure results in a new blast furnace metal which has hitherto been unattainable.

In conventional iron smelting blast furnace operation, a mass of unburned fuel carbon accumulates in the hearth below the tuyères. This mass is continuously built up by accretions from the descending column of stock, and the lower portion of the mass is immersed in and permeated by the molten iron accumulating in the bottom of the crucible or hearth between the castra. At the castra, this mass or raft probably rests on the bottom of the hearth, while for a part of the time before a cast it is probably floating on the molten iron in a condition proportional to the unbalanced weight of the superimposed stock column. This fuel carbon is gradually passing into solution in the iron and in the conventional practice the iron carries a carbon content when cast that is rarely below 3.5% and in the larger castra frequently higher than 4%.

In accordance with my invention, the blast furnace is provided with a built-in combustion and melting zone hearth located immediately below and between the tuyères and above the decanter crucible of the furnace from which the cast is made. Upon this hearth practically all of the fuel carbon is consumed, and the hearth is formed so that the molten iron and slag may drain freely into the crucible where the iron is segregated from the fuel carbon and where gravity separation of the iron and slag takes place. Any fuel carbon that may be carried into the crucible will be supported on the molten slag above the level of the molten iron and will remain in this position until consumed. By this prompt separation of the molten iron from the fuel carbon solution of carbon in the iron is kept to a minimum as the contact of the molten iron with the fuel carbon is limited to the relatively short distance from the point where it melts to the combustion and melting zone hearth and thereon to the point where it falls into the decanter crucible.

The invention will be more readily understood by reference to the attached drawings, wherein,

Fig. 1 is a vertical sectional view of the lower portion of an iron smelting blast furnace equipped with a combustion and melting zone hearth in accordance with my invention;

Fig. 2 is a sectional view on the line 2—2, Fig. 1;

Fig. 3 is a fragmentary view in perspective showing details of the combustion and melting zone hearth, and,

Fig. 4 is a view in sectional perspective of an element of the hearth structure.

With reference to the drawings, the iron smelting blast furnace therein illustrated is circular in horizontal cross-section, but it will be understood that the invention is readily adaptable to blast furnaces of rectangular or other cross-section. For purposes of clarity, structural supports the means for water cooling, and the means which provides for renewal and replacement of the parts which are subject to wear and erosion, are in the drawings since these details are not immediately pertinent to the invention and will be apparent to those skilled in the art. To this extent, therefore, the drawings may be considered diagrammatic.

The conventional decanter crucible in the bottom of the furnace in which the molten iron and slag accumulate for gravity separation and from which the iron is cast and the slag flushed is indicated by the reference character A. B designates the iron notch through which the iron is cast at suitable intervals; and C designates the cinder notch through which the slag is flushed, also at suitable intervals, both in accordance
with the conventional practice. It should be understood that the terms indicating the "molten iron level" and "molten slag level" are for purposes of illustration only, and the actual and relative elevations of these levels may vary widely from those shown during the periods between the casts and flushes.

The combustion and melting zone hearth consists generally of an annular structure S, the upper surface of which is formed so as to provide an annular series of interspersed ridges G and troughs H radiating from the lip L of a central opening E. From this opening the troughs and ridges extend outwardly and upwardly to the enclosing wall M of the furnace. The inclination of the bottoms of the troughs is such as to insure a free flow of molten iron and slag from the hearth to the crucible by way of the opening E. Projecting through the wall M into the upper and outer end of each of the troughs H is a tuyère J through which the blast is forced into the furnace to form an intensely hot combustion zone above the hearth structure S. K designates the lower portion of the hearth within which the walls M of the furnace are drawn into the tuyère circle. In the outer portion of the structure S and extending upwardly from the top of the crucible chamber A to the outer and upper end of each of the troughs H is a passage D, these passages having a dual function hereinafter described. Supported at the top of the hearth structure S upon the upper edges of the ridges G is a deflecting cone F. This cone covering the central opening E but leaving the lower ends of the troughs H unobstructed.

In operation, the descending stock column is deflected outwardly by the cone F into the tuyères region in which the iron will be melted and the slag formed and also melted. The ridges G which occupy the dead space between the tuyères serve to guide the descending stock and fuel into the active zones in front of the tuyères. Within the intensely hot combustion zones, the iron is melted, and the gangue of the ore combines with the flux and forms the molten slag in a free running condition. The stream of hot gas from the stream of molten iron and molten slag to the central opening E where they flow into the decanter crucible A. In case of any obstruction in the troughs H preventing the stream of molten iron and slag from flowing freely in the normal way into the apertures E, the troughs will act to divert the flow to the vent passages D which lead to the crucible A as previously described. These vent passages serve, therefore, as emergency drains in the event that the "quicks" and slag forming in this zone drains freely through the aperture E into the decanter crucible A wherein gravity separation occurs as indicated in the drawings. Any fuel carbon carried down with the molten stream will float at the top of the slag until it is gasified or burned. Extended contact of the molten iron with the fuel carbon is avoided and a slag free low carbon iron results.

As previously set forth, the passages D provide vents for any blast or other gases that may enter the crucible, and serve also as emergency drains in event of obstruction of the troughs. In this respect, it is to be noted that with the relative arrangement of the hearth and tuyères described above, the molten iron is maintained in a zone of high temperature until it actually leaves the hearth through the notch B so that possibility of freezing due to freezing of the low carbon metal on the surfaces of the hearth is minimized. In this manner the well known difficulties experienced in conventional blast furnace operations due to the high freezing temperature of low carbon metal are largely obviated.

I claim:

1. An iron smelting blast furnace having a combustion and melting zone hearth forming a support for the stock column, and a crucible below said hearth, said hearth comprising a central aperture and a plurality of troughs radiating outwardly and upwardly from said aperture, and having also a central member overlying the aperture and supported in non-obstructing relation to said troughs.

2. An iron smelting blast furnace having a combustion and melting zone hearth forming a support for the stock column, a crucible below said hearth, said hearth having a central aperture and a plurality of troughs radiating outwardly and upwardly from said aperture, and having also a central member overlying the aperture and supported in non-obstructing relation to said troughs, and a tuyère at the upper end of each of said troughs.

3. An iron smelting blast furnace having a combustion and melting zone hearth forming a support for the stock column, a crucible below said hearth, said hearth having a central aperture and a plurality of troughs radiating outwardly and upwardly from said aperture, and having also a central member overlying the aperture and supported in non-obstructing relation to said troughs, and a tuyère at the upper end and directed longitudinally of each of said troughs.

4. An iron smelting blast furnace having a combustion and melting zone hearth forming a support for the stock column, a crucible below said hearth, said hearth having a central aperture and a plurality of troughs radiating outwardly and upwardly from said aperture, and a cover for said central opening supported in non-obstructing relation with said troughs.

5. An iron smelting blast furnace having a combustion and melting zone hearth forming a support for the stock column, a crucible below said hearth, said hearth having a central aperture and a plurality of troughs radiating outwardly from said opening, and a cover for said central opening supported in non-obstructing relation with said troughs.

6. An iron smelting blast furnace having a combustion and melting zone hearth forming a support for the stock column, and a crucible below said hearth, said hearth having a central aperture communicating with the crucible, a trought-like depression in the upper surface of said hearth extending from each of said ports inwardly and downwardly to said central aperture, a tuyère at the center of each of said troughs and a central member overlying said
aperture and the inner terminal ends of said troughs.

7. An iron smelting blast furnace having a combustion and melting zone hearth forming a support for the stock column, and a crucible below said hearth, the upper surface of said hearth being inclined downwardly toward the center and terminating in an opening communicating with the crucible, ports in the outer peripheral area of the hearth also communicating with the crucible, and a central member overlying said central aperture and supported in spaced relation to the upper surface of the hearth.

8. An iron smelting blast furnace comprising tuyères and a crucible and an intermediate combustion and melting zone hearth supported by the wall of and bridging the crucible and on which the stock column in the bosh and shaft of the furnace is carried, said hearth being adapted to receive and to direct the molten metal and slag to the crucible for gravity separation, whereby the molten metal in the crucible is protected from contact with the fuel carbon.

9. An iron smelting blast furnace having a crucible for reception and gravity separation of the molten metal and slag, a superimposed hearth, and tuyères operatively associated with said hearth, said hearth constituting a support for the stock column in the bosh and shaft of the furnace and comprising means for guiding the stock into the active zone immediately in front of the tuyères and for passing the molten metal and slag to the crucible.

10. An iron smelting blast furnace having a crucible for reception and gravity separation of the molten metal and slag, a superimposed hearth constituting a support for the stock column in the bosh and shaft of the furnace and comprising means for gravity flow of molten metal and slag to the crucible, said means comprising a lip on the hearth from which the said molten metal and slag may pass freely and directly into the crucible, means for guiding the said molten elements to the lip, and means for establishing an active melting zone at the top of the hearth embracing said guide means.

11. An iron smelting blast furnace having a crucible for reception and gravity separation of the molten metal slag, a superimposed hearth supported by the wall of and bridging the crucible and on which the stock column in the bosh and shaft of the furnace is carried, said hearth having also a discharge area from which molten metal and slag may pass freely and directly into the crucible, means including tuyères for establishing an active melting zone at the top of the hearth, and means for guiding the stock into the active zone of said tuyères and for directing the flow of molten metal and slag to said discharge area.

AMOS DENISON WILLIAMS.