

Jan. 6, 1970

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3,488,044

APPARATUS FOR REFINING METAL

Original Filed May 3, 1965

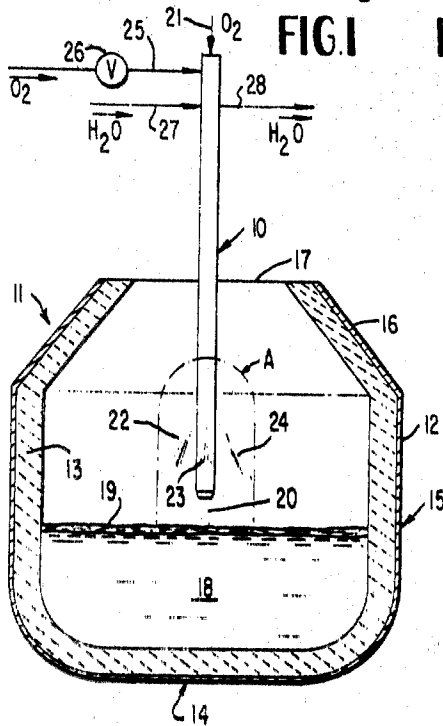


FIG. 1

FIG. 2

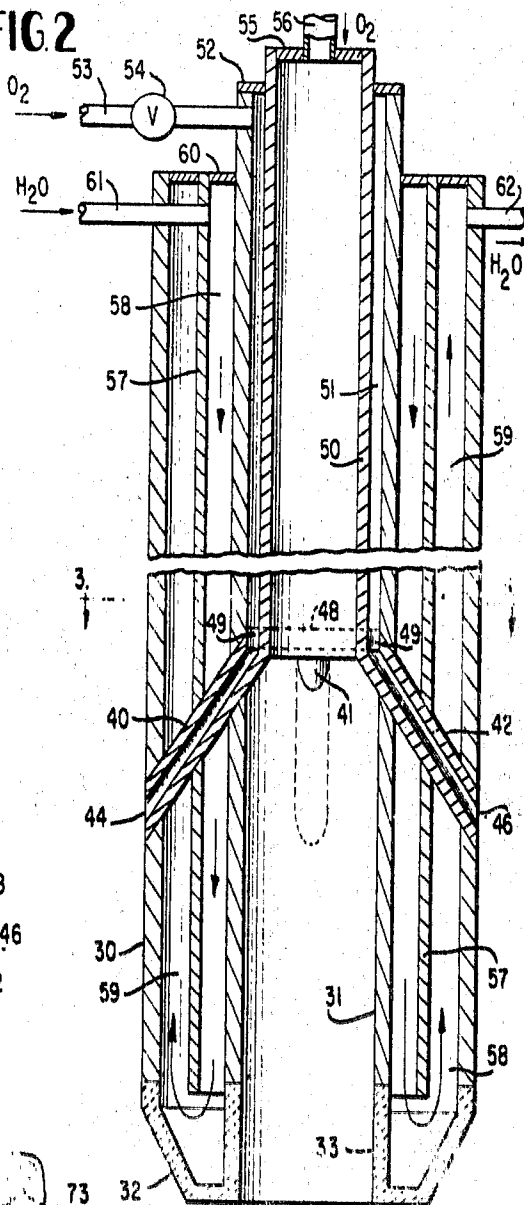


FIG. 3

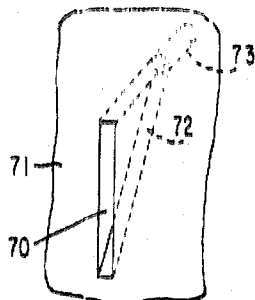
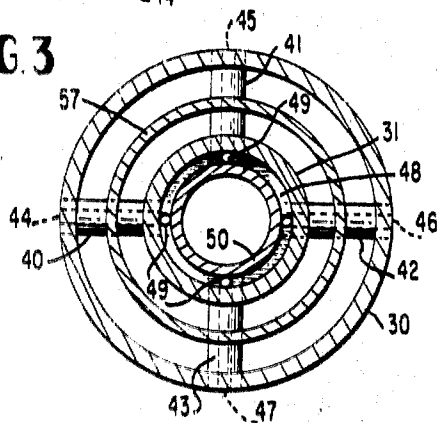


FIG. 4

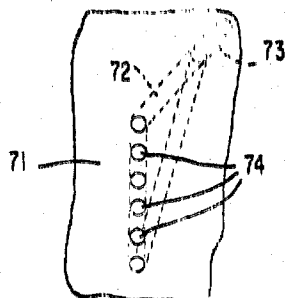


FIG. 5

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APPARATUS FOR REFINING METAL

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Continuation of application Ser. No. 452,573, May 3, 1965. This application May 1, 1967, Ser. No. 636,241
Int. Cl. C21c 7/00; F27d 7/02
U.S. Cl. 266—34

1 Claim

ABSTRACT OF THE DISCLOSURE

Method and apparatus for refining a bath of molten metal such as pig iron contained in the bottom of a chamber defined by a vessel having an open nose portion by gaseous oxygen jetted onto the bath by a lance device extending through the open nose portion of the vessel, in which auxiliary jets of gaseous oxygen are emanated from the lance device and introduced into the chamber below the nose portion of the vessel to effect oxidation of carbon monoxide.

This is a continuation of application Ser. No. 452,573, filed May 3, 1965, now abandoned.

The invention relates to the refining of metal and more particularly to a novel steelmaking process employing oxygen and to a novel apparatus for performing the process.

While the present invention has application in the refining of all metals in which an oxidizing gas may be used to remove impurities of the metal, it has particular application to steelmaking by an oxygen top blowing or basic oxygen process in which gaseous oxygen is blown on to the surface of molten pig iron contained within an open top refractory lined vessel. In such a process a lance device is generally vertically disposed and introduced through the open top to within the vessel with its discharge end spaced above the central area of the bath of molten metal. Gaseous oxygen is emitted from the discharge end of the lance device as a high velocity jet which impinges upon the molten pig iron centrally of the bath to effect refining of the metal by partial oxidation of the carbon to carbon monoxide. The partial oxidation of carbon is an exothermic reaction and permits the initial charge to include metal scrap and it has been appreciated the initial charge could contain a greater percentage of metal scrap if it were possible to obtain and utilize in the process heat resulting from complete oxidation of carbon.

It is an object of the present invention to provide a novel process and apparatus for refining molten metal by an oxidizing gas.

Another object is to provide an improved oxygen blowing process and apparatus for refining pig iron.

A further object is to provide an improved process and apparatus for refining pig iron by oxygen blowing in which carbon monoxide resulting from the refining of a bath of molten pig iron is oxidized completely in such a manner as to increase the heat content of the bath.

Other objects and features of the present invention will appear more fully from the following detailed description considered in connection with the accompanying drawing which discloses several embodiments of the invention. It is to be expressly understood, however, that the drawing is designed for purposes of illustration only and not as a definition of the limits of the invention, reference for the latter purpose being had to the appended claim.

In the drawing, in which similar reference characters denote similar elements throughout the several views:

FIGURE 1 is a diagrammatic view of a basic oxygen furnace and lance apparatus for performing the novel

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steelmaking process according to the present invention;

FIGURE 2 is a view in cross section of a lance apparatus provided by the present invention;

FIGURE 3 is a view in section taken along the line 3—3 of FIGURE 2;

FIGURE 4 is a fragmentary view showing another embodiment of the present invention, and

FIGURE 5 is a fragmentary view showing a further embodiment of the present invention.

Apparatus for performing the novel steelmaking process provided by the present invention is shown in FIGURE 1, including a lance apparatus 10 and a basic oxygen furnace 11. The furnace 11 comprises a vessel including an outer steel shell and an inner lining 13 of refractory material having a bottom portion 14, a barrel portion 15 and a nose portion 16 converging upwardly and inwardly with respect to the central axis of the vessel and terminating in an opening 17. As illustrated, the vessel contains a bath 18 of molten metal covered by slag layer 19; it is understood, of course, that during initial phases of the steelmaking process, the vessel is ordinarily charged with solid scrap and hot metal.

The lance apparatus 10 is provided at its discharge end with nozzle discharge means which may comprise a single discharge nozzle or a multiplicity of discharge nozzles from which is emitted gaseous oxygen in the form of a jet 20 directed downwardly onto the surface of the bath of molten metal to effect partial oxidation of the carbon in the molten metal. Gaseous oxygen forming the jet 20 is introduced into the lance apparatus by conduit 21 under conditions which may correspond to conventional basic oxygen furnace practices. The lance apparatus 10 also includes a plurality of supplemental discharge nozzles located above its discharge end from which are emitted auxiliary jets of oxygen symmetrically about the longitudinal axis of the lance apparatus, in a direction downwardly toward its discharge end and outwardly with respect to its longitudinal axis. The lance apparatus disclosed includes four supplemental nozzles located in a common plane parallel to and spaced equally from each other about the longitudinal axis of the lance apparatus; it is to be understood, however, that three or more than four supplemental discharge nozzles may be employed. In FIGURE 1, auxiliary oxygen jets 22, 23, 24, are shown emitted from three of such supplemental discharge nozzles. The supplemental discharge nozzles are supplied with gaseous oxygen from a separate source by conduit 25 having a control valve 26. The lance apparatus is of the fluid-cooled type and includes a fluid cooling inlet conduit 27 and a fluid cooling exit conduit 28. Also, the lance apparatus is mounted for vertical movement with its longitudinal axis substantially coincident with a vertical axis passing through the center of the vessel 11 by equipment, not shown, which may be of conventional construction. With such apparatus, the lance apparatus may be moved downwardly relative to the vessel 11 to adjust the position of its discharge end above the surface of the bath 18, and also may be moved upwardly to space its discharge end heightwise above the upper end of the vessel to allow the vessel to be tilted for receiving a charge and for discharging refined metal therefrom.

The details of the lance apparatus provided by the present invention is illustrated in FIGURES 2 and 3 of the drawings. As shown, with particular reference to FIGURE 2, the lance apparatus includes an outer tubular member 30 and an inner tubular member 31 in spaced concentric relation within the outer tubular member 30. The tubular members 30 and 31 extend substantially throughout the length of the lance apparatus and their ends adjacent the discharge end of the lance apparatus, the lower end of the lance apparatus as viewed in FIGURE 2,

are joined in fluid sealing relation to a closed annular member 32, which may be formed of ceramic material, having an internal cylindrical wall surface 33 concentric with the internal surface of the tubular member 31 and together therewith forming the main discharge nozzle of the lance apparatus. While such discharge nozzle is illustrated as a single smooth bore type, it is to be understood that it may be of the converging-straight or the converging-diverging types and that a plurality of such nozzles may be employed.

In accordance with the principles of the present invention the lance apparatus includes supplemental discharge nozzles 40, 41, 42 and 43 terminating in orifices 44, 45, 46 and 47 respectively, located in the outer surface of the tubular member 30. The supplemental nozzles preferably are spaced equally about the longitudinal axis of the lance apparatus and are inclined downwardly toward its discharge end and outwardly from its longitudinal axis. As shown more clearly in FIGURE 2, the supplemental discharge nozzles traverse the space between the tubular members 30 and 31 and are received by openings in such tubular members to which they are sealably joined. The inner ends of the discharge nozzles are sealably joined to an angular plate 48 each in fluid communication with a separate opening 49 therein as shown in FIGURE 3. The annular plate 48 is joined between the inner surface of the tubular member 31 and the outer surface of the tubular member 50 located within the tubular member 31 in spaced concentric relation therewith to provide an annular space 51. The plate 48 closes the lower end of the annular space 51, as viewed in the drawing, and its upper end is closed by an annular plate 52 and gaseous oxygen is fed to the annular space 51 by a conduit 53 provided with a control valve 54. The tubular member 50 provides a passageway communicating with the passageway of the tubular member 30 leading to the main discharge nozzle and the tubular member 50 is closed at its upper end by a plate 55 through which passes an oxygen supply conduit 56.

The lance apparatus is of the fluid cooled type and for this purpose the annular space between the tubular members 30 and 31 is divided by a tubular partitioning member 57 forming annular chambers 58 and 59. The tubular member 57 is joined at its upper end to annular end plate 60 sealed between the tubular members 30 and 31 and at its lower end the tubular member 57 is terminated in spaced relation with the internal surface of the annular member 32. Cooling fluid, such as water, is introduced by conduit 61 to the annular chamber 58 and cooling fluid leaves the lance apparatus through conduit 62 connected to the annular chamber 59; the cooling fluid flows through the annular chamber 58 downwardly to the discharge end of the lance apparatus, around the terminating edge of the tubular partitioning member 51, and then through the annular chamber 59 for discharge through the conduit 62.

Modified forms of supplemental discharge nozzles are shown in FIGURES 4 and 5. In FIGURE 4, the discharge nozzle has an orifice in the form of elongated, narrow slot 70 formed in the outer surface 71 of the tubular member 30 with the long dimension of the slot lying in a plane parallel to the longitudinal axis of the lance apparatus. The slot 70 communicates with an inwardly converging passageway 72 which in turn merges with a conduit 73 in fluid communication with the annular passageway 51 through an opening 49 in the annular plate 48. In FIGURE 5, the discharge orifice comprises a plurality of openings 74 formed in the tubular member 30, the openings 74 lying in a plane parallel to the longitudinal axis of the lance apparatus.

In the refinement of pig iron with gaseous oxygen, such as in a basic oxygen converter as shown in FIGURE 1, while the reactions that occur within the converter are numerous and complicated, it is known that the jet 20 of oxygen impinging upon the molten pig iron effects refining of pig iron by incomplete oxidation of

the carbon producing carbon monoxide. Due to the actions that occur within the converter, the partial oxidation of carbon takes place throughout the bath and carbon monoxide emanates from the bath throughout its surface. Due to the direct contact of the oxygen jet 20 with the molten pig iron, below the lance apparatus centrally of the bath, the quantity of carbon monoxide contained in a zone about the center of the bath and extending upwardly about the lance apparatus beyond its discharge end, such as zone A indicated by dotted lines in FIGURE 1, contains a greater quantity of carbon monoxide as compared to the remaining portions of the space within the vessel above the bath. In accordance with the principles of the present invention, the supplemental discharge nozzles 40, 41, 42 and 43 are located with respect to the discharge end of the lance apparatus so that the auxiliary jets of oxygen emitting therefrom, such as jets 22, 23 and 24 shown in FIGURE 1, flow into the zone A to effect oxidation of carbon monoxide concentrated therein. The feature of introducing auxiliary jets of oxygen into the zone A of high carbon monoxide concentration results in oxidation within the zone of a large quantity of carbon monoxide for a given quantity of auxiliary oxygen notwithstanding the high turbulence of the atmosphere within the vessel above the bath and the rapid flow of gas from the vessel through the opening 17. The feature of injecting oxygen into the zone A of high carbon monoxide concentration downwardly in overlying relation with the hot external surfaces of the lower end portion of the lance apparatus is believed to aid in effecting concentrated oxidation of carbon monoxide by contact catalyst effect. The concentration of carbon monoxide oxidation within a zone immediately above the bath results in a large quantity of heat produced by the reaction being transferred to the bath and the confining of the complete oxidation reaction within a centrally located zone prevents damage to the refractory lining of the vessel.

The size of the supplemental discharge nozzles, their angle of inclination and their location with respect to discharge end of the lance apparatus as well as the rate of oxygen flow thereto and the velocity and extent of the oxygen jet emitted therefrom will depend upon varying factors including the capacity and shape of the vessel. In some installations it may be desirable to introduce a relatively large flow of auxiliary oxygen under relatively low velocity and in such instances the discharge nozzles shown in FIGURES 4 and 5 may be employed. It is to be understood that the number of supplemental discharge nozzles may be varied and three or more than four discharge nozzles may be disposed about the longitudinal axis of the lance apparatus preferably in symmetrical relationship.

The flow of oxygen to the supplemental discharge nozzles is preferably controlled independently of the flow of refining oxygen to the main discharge nozzle means as the flow of oxygen through the supplemental discharge nozzles ordinarily will be of a lower quantity and at a lower velocity and need not be employed at all times when refining oxygen is flowed through the main oxygen discharge nozzle means. In general, it is desirable only to flow oxygen through the supplemental discharge nozzles when the quantity of carbon monoxide in the zone A surrounding the lower end of the lance apparatus is of sufficiently high concentration to permit efficient use of auxiliary oxygen in effecting concentrated oxidation of carbon monoxide. Accordingly, during the initial phase of the refining operation before partial oxidation of carbon reaches a high order and during terminal phases when the carbon content of a bath is low or when the temperature of a bath is being controlled, the flow of oxygen to the supplemental discharge nozzles may not be employed.

The novel process and apparatus disclosed herein is capable of increasing the heat available to an oxygen

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top blowing process to permit the addition of at least up to 4-5% of metal scrap to the charge.

What is claimed is:

1. Lance apparatus comprising a first elongated tubular member,
- a second elongated tubular member is spaced overlying relationship with the first tubular member to provide a first annular space located between the first and second tubular members,
- an annular member including inside wall means joined to one end of the first tubular member and outside wall means joined to a corresponding end of the second tubular member,
- a third tubular member located within the first tubular member in spaced relationship therewith to provide a second annular space located between the first and third tubular members,
- the third tubular member terminating in an open end within the first tubular member in fluid communication with the passageway of the first tubular member and spaced from the annular member a substantial distance along the longitudinal axis of the tubular members,
- means adjacent the open end of the third tubular member for sealing the second annular space from the passageway of the first tubular member,
- a plurality of passageways communicating with the

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second annular space and terminating in discharge openings formed in the outer surface of the second tubular member,

the plurality of passageways being located symmetrically about the longitudinal axis of the tubular members and being inclined downwardly toward the annular member and outwardly from the longitudinal axis,

means for circulating coolant fluid in the first annular space, and

means for separately feeding pressurized gas to the passageway of the third tubular member and to the second annular space.

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RICHARD O. DEAN, Primary Examiner

U.S. Cl. X.R.

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