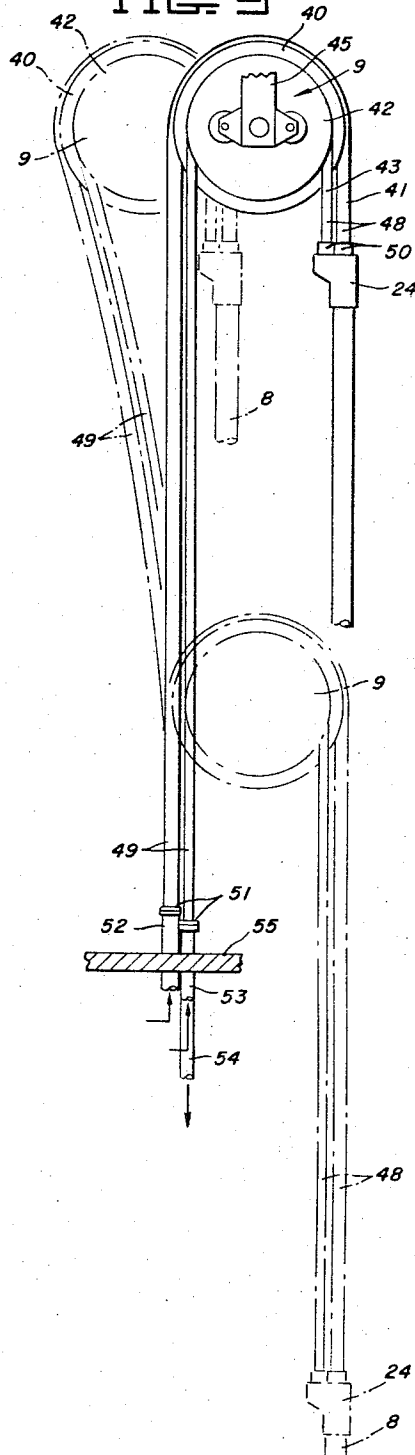


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OXYGEN INJECTION APPARATUS FOR STEELMAKING CONVERTERS

4 Sheets-Sheet 1



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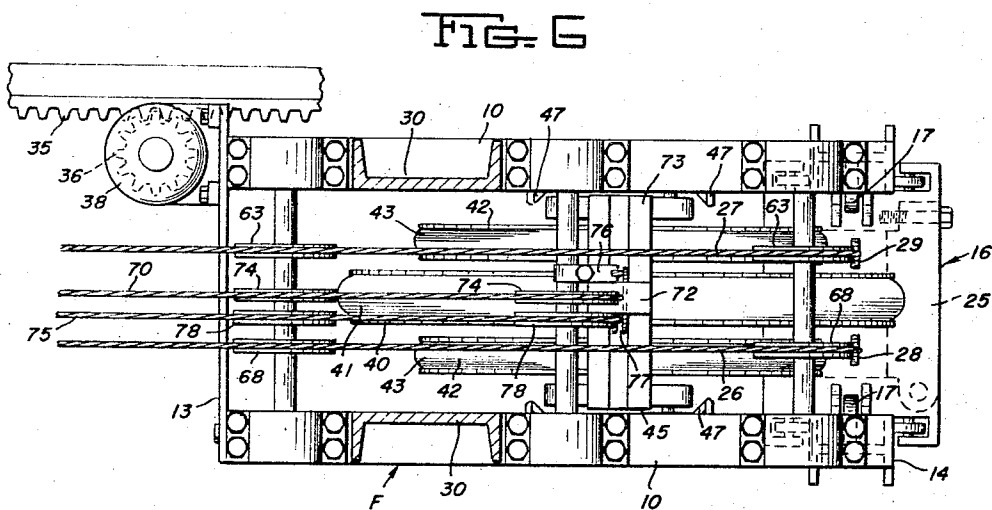
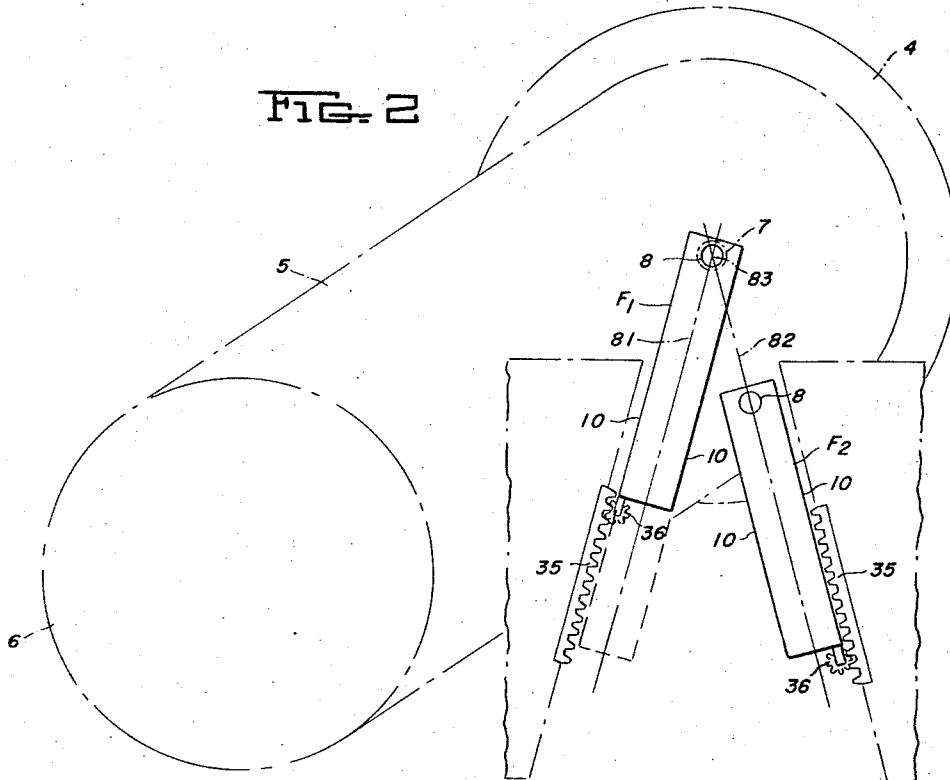
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OXYGEN INJECTION APPARATUS FOR STEELMAKING CONVERTERS

Filed Nov. 30, 1964

4 Sheets-Sheet 2



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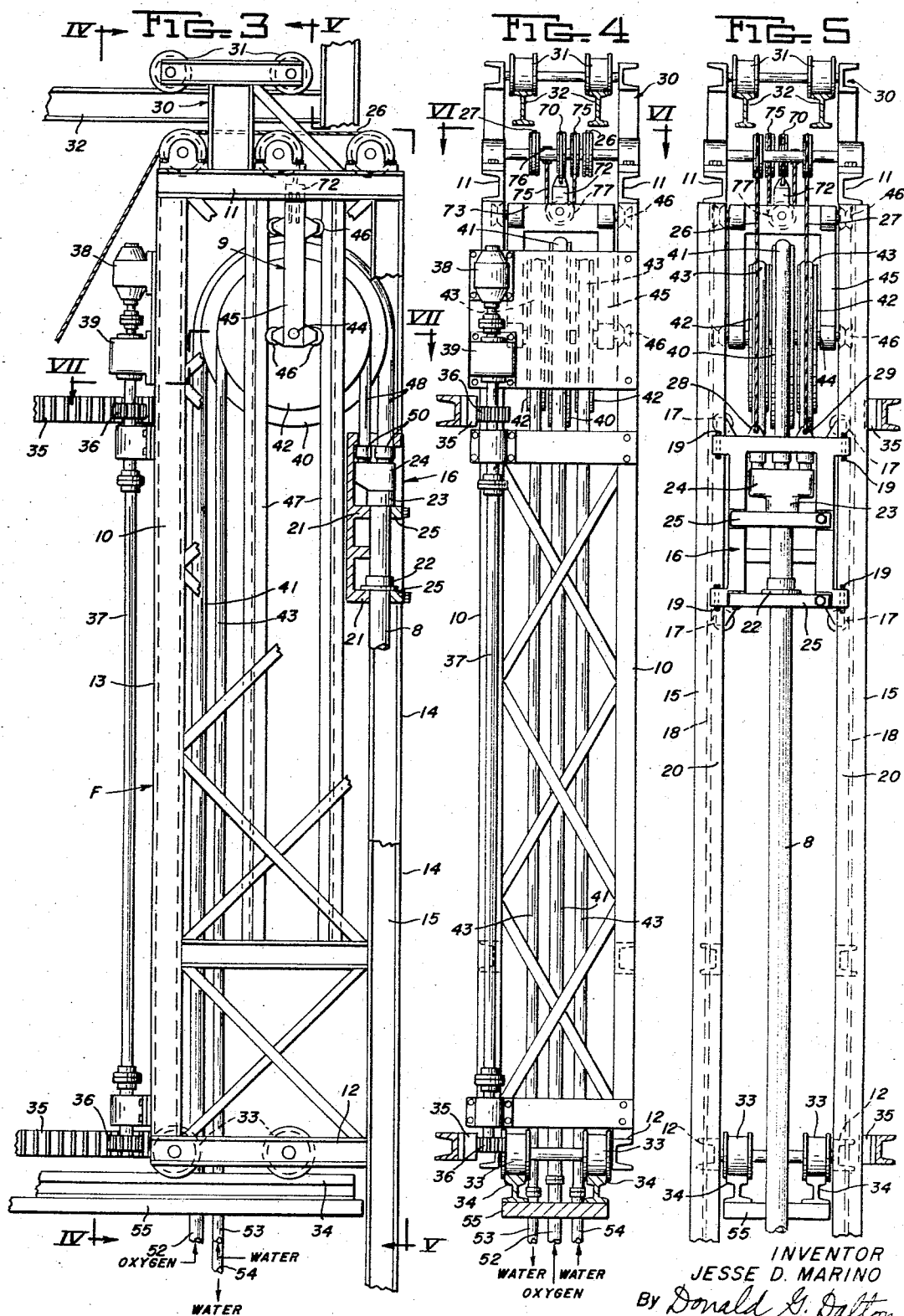
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OXYGEN INJECTION APPARATUS FOR STEELMAKING CONVERTERS

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4 Sheets-Sheet 3



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OXYGEN INJECTION APPARATUS FOR STEELMAKING CONVERTERS

Filed Nov. 30, 1964

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FIG. 7

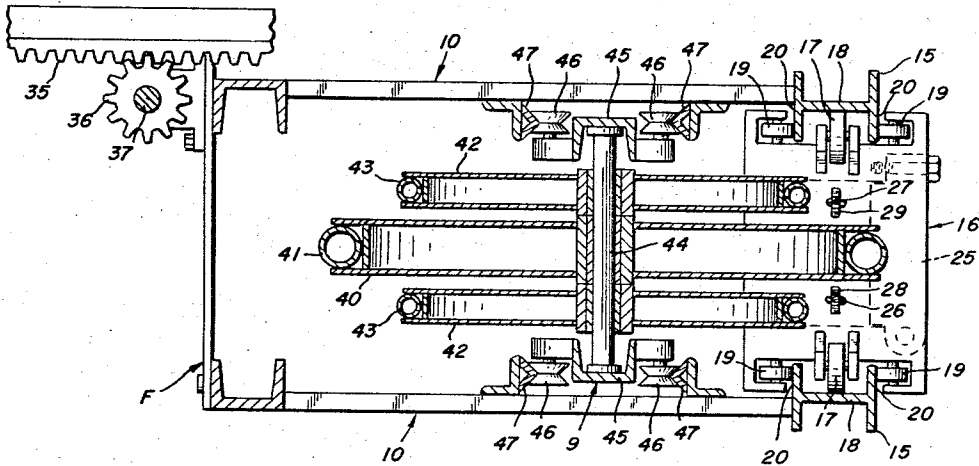
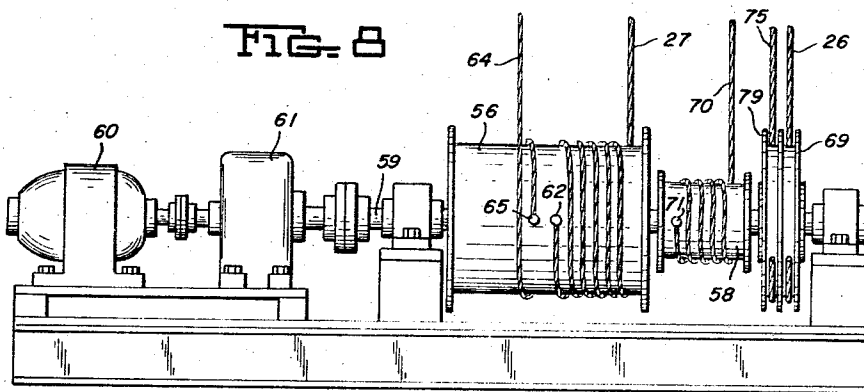


FIG. 8



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**OXYGEN INJECTION APPARATUS FOR
STEELMAKING CONVERTERS**

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Filed Nov. 30, 1964, Ser. No. 414,703
16 Claims. (Cl. 266—34)

ABSTRACT OF THE DISCLOSURE

An oxygen lance for steelmaking converters having cooling water and oxygen supply hoses extending axially upwardly along the vertical path of lance movement and supporting means in the form of vertically movable sheaves arranged tangentially with respect to the said vertical path for guiding the movement of said hoses along such path. Oxygen injection apparatus having a pair of frames respectively mounted for independent movement over intersecting paths to and from operating positions in which oxygen lances respectively mounted thereon are centered over the point of intersection of said paths for vertical movement to an operative blowing position in a steelmaking converter.

This invention relates to oxygen injection apparatus for steelmaking converters and, more particularly, to mechanism for operating a lance through which oxygen is supplied to a converter.

The flexible hoses for circulating cooling water through an oxygen lance and for supplying oxygen thereto are commonly attached to the upper end of the lance and hang freely in a catenary over the space between the lance and their connections with oxygen and water lines. By reason of their size and weight, the suspension of such hoses in this manner exerts a lateral pull on the lance tending to move it to a cocked or vertically inclined position that may interfere with its vertical movement to and from an operative blowing position relative to the converter and may also result in an improper converter operation causing uneven wear on the converter lining. In addition, the length of the catenary required to provide for vertical lance movement and to prevent excessive bending of the hoses presents a troublesome problem with regard to hose kinking and maintenance.

One object of this invention accordingly is to provide a lance operating mechanism in which the oxygen and water hoses connected therewith do not apply a lateral force to the upper end of the oxygen lance tending to move it out of its vertically aligned position. To this end, the hoses connected with the lance are supported in a manner such that they extend axially upwardly from the upper end of the lance and are fed along a vertical path with the lance as it moves to and from its operative blowing position. For this purpose, the oxygen and water hoses are supported on sheaves that are arranged tangentially relative to the path of lance movement and travel over such sheaves as the lance is raised and lowered vertically with respect to an oxygen converter. In a manner to be described, the invention further contemplates a sheave mounting and operating mechanism that provides for vertical movement of the sheaves with the lance as it is moved to and from its operating position.

According to another object of the invention, duplicate assemblies of lances and associated operating mechanisms therefor enable immediate replacement of a lance upon failure in order that the converter operation may be continued with a minimum of delay. For this purpose, the lances and their respective operating mechanisms are mounted for horizontal movement between retracted parked positions and operating positions over paths which

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intersect at a point that coincides with the vertical path over which the lances travel to and from their operative blowing position relative to a converter. In this manner a replacement is available to continue the converter operation without delay upon failure of a lance, it being only necessary to withdraw the lance that has failed and replace it with the spare lance that was previously in parked position.

Other objects and advantages of the invention will become apparent from the following description.

In the drawings there is shown a preferred embodiment of the invention. In this showing:

FIGURES 1 and 2 are elevational and plan views which show somewhat diagrammatically the general arrangement of the apparatus of this invention relative to a converter;

FIGURE 3 is an enlarged view of a portion of the apparatus shown in FIGURE 1 which illustrates in greater detail the specific structure of the lance operating mechanism of this invention;

FIGURES 4 and 5 are end elevational views looking in opposite directions respectively along the lines IV—IV and V—V of FIGURE 3;

FIGURE 6 is a plan view looking in the direction of the line VI—VI of FIGURE 4;

FIGURE 7 is a sectional view taken substantially along the line VII—VII of FIGURE 3;

FIGURE 8 is a side elevational view of the hoist mechanism for operating the cables attached to the oxygen lance and the sheaves for the hoses attached thereto; and

FIGURE 9 is an enlarged view looking in the direction of FIGURE 1 of a fragmentary portion of the apparatus which illustrates schematically the different positions of the sheaves and hoses supported thereby as the lance to which the hoses are connected moves vertically to and from an operative blowing position, and the carriage frame on which the hose sheaves are supported travels between its inoperative or parked position and its operating position.

The drawings illustrate the manner in which the lance handling mechanism of this invention is applied to an oxygen steelmaking apparatus that includes a refractory lined vessel or converter 1 supported on trunnions 2 for tilting movement to and from an upright blowing position in which its mouth 3 opens upwardly and is positioned under the lower end 4 of a hood 5 for removing fumes from the converter 1. The hood 5 extends upwardly at a vertically inclined angle to a vertical exhaust stack 6 and has an upwardly facing opening 7 through the wall thereof, which is centered over the converter 1 and through which an oxygen lance 8 may be lowered to an operative blowing position. The lance handling mechanism of this invention, generally stated, comprises a movable support or frame F which furnishes a support for both the oxygen lance 8 and an assembly 9 of sheaves which support the hoses for supplying oxygen to the lance 8 and for circulating cooling water therethrough. In a manner to be described, the lance 8 and sheave assembly 9 are both mounted for vertical movement on the frame F which is in the form of a carriage so that it may be moved to and from an operating position in which the vertical path of movement of the lance 8 is centered over the opening 7 in the fume removal hood 5.

As shown in FIGURES 3—7, the frame F has a shallow rectangular shape and is formed by side frames 10 that are assembled in laterally spaced parallel relation. It is mounted in a vertical position with its opposite ends 11 and 12 respectively forming its top and bottom and with its opposite edges 13 and 14 extending vertically. Laterally spaced beams 15 at one side of each frame 10 form a trackway on which a carriage 16 for the lance 8 is mounted for guided axial movement over a vertical path

along the frame edge 14. The mechanism for guiding the vertical movement of the carriage 16 over the trackway beams 15 is shown diagrammatically as comprising rollers 17 that have rolling engagement over the webs 18 of the beams 15 and by rollers 19 that have rolling engagement with the flanges 20 thereof. The lance 8 is suspended on the carriage 16 in a position extending axially along its vertical path of movement by two vertically spaced supporting members 21 that form part of the carriage 16 and respectively have semi-circular recesses which fit against the side of the lance 8. The lower member 21 has supporting engagement with a flange 22 secured to the lance 8 and the upper member 21 has supporting engagement with a collar 23 at the lower end of the head 24 of the lance. The lance 8 is held in snug engagement with the supporting members 21 by clamping members 25 that are detachably secured to the carriage 16 and have semi-circular recesses which fit against the lance 8. The clamping members 25 when secured in position as shown in the drawings also have supporting engagement respectively with the lower end of the lance head collar 23 and with the flange 22 so that they serve as part of the suspension for the lance 8 on the carriage 16. When replacement of a lance is required, the clamping members 25 are removed or swung to a position clear of the side of the carriage 16 at the right as viewed in FIGURE 3 so that the lance 8 may be removed from the carriage 16. Vertical movement of the lance carriage 16 and thereby axial movement of the lance 8 to and from an operative blowing position relative to the converter 1 is controlled in a manner to be described by a pair of cables 26 and 27 which respectively have connections 28 and 29 with the upper end of the carriage 16.

The carriage frame F is movable horizontally between a parked or inoperative position and the operating position shown in the drawings, in which position the lance 8 is centered over the opening 7 so that its path of vertical movement extends axially through such opening and it can be raised and lowered therethrough to and from an operative blowing position relative to the converter 1. For this purpose, the upper end 11 of the frame F is suspended from a trolley carriage 30 that is equipped with rollers 31 which guide its movement over supporting beams 32. Guide rollers 33 on the lower frame end 12 have rolling engagement with guide beams 34 which are parallel to the guide beam 32. In this manner the rollers 31 and 33 operate to guide the movement of the frame F over a rectilinear path that extends centrally between and parallel to the side frames 10. Movement of the frame F over this path is effected by vertically spaced rack and pinion drives which respectively include a stationary gear rack 35 and pinion 36 in meshing engagement therewith. The pinions 36 are mounted on a common drive shaft 37 which is rotatably supported on the frame F in a position extending along the edge 13 thereof and is driven by a reversible electric motor 38 through a gear reduction drive 39. Energization of the motor 38 is under the control of suitable reversing and limit switches which operate to control the movement of the frame F between its operative position in which the lance 8 is centered over the converter 1 as shown in the drawings and a retracted position to the left of that shown in FIGURE 1 in a manner to be described.

As indicated, the sheave assembly 9 furnishes a support for the water circulating and oxygen supply hoses during movement of the lance to and from an operative blowing position. For this purpose, such assembly includes a center sheave 40 for the hose 41 through which oxygen is fed to the lance 8 and a pair of sheaves 42 on opposite sides of the sheave 40 for the water inlet and exhaust hoses 43 which circulate cooling water through the lance 8. The sheaves 40 and 42 are mounted for independent rotation on a shaft 44 that extends transversely of the side frames 10 as best shown in FIGURE 7. To provide for vertical movement of the assembly 9,

opposite ends of the shaft 44 are supported by carriages 45 that have guided vertical movement along the length of the side frames 10. The mechanism for guiding the vertical movement of the carriages 45 is shown diagrammatically as comprising rollers 46 that have rolling engagement with trackway guides 47 extending along the length of each of the frame sides 10. Each of the hoses 41 and 43 has opposite end portions 48 and 49 extending vertically downwardly from opposite sides of the sheaves 40 and 42 on which they are supported. At their right side, as viewed in FIGURE 9, the sheaves 40 and 42 are arranged tangentially relative to the path of axial movement of the lance 8 so that the hose end portions 48 form an axial extension of the lance 8 with which they are connected by detachable couplings 50. At the opposite side of the sheaves 40 and 42, stationary connections 51 join the end portions 49 of the oxygen supply hose 41 with an oxygen supply line 52 and the end portions 49 of the flexible hoses 43 with water circulating inlet and exhaust conduits 53 and 54 which extend through floor 55.

The flexible hoses 41 and 43 are conventional steel reinforced hoses that may be obtained from a number of suppliers. They may, for example, be the "Ben Flex Hose," Type BD1515, interlock pressure hose of the Atlantic Flexible Metal Hose Co., New York City. By reason of their steel reinforcement, such hoses have a limited bending radius which determines the minimum diameter of the sheaves 40 and 42 and, since the smaller water hoses 43 have a sharper bending radius, the diameter of the sheaves 42 supporting such hoses may be smaller than that of the sheave 40. This permits triangular grouping of the connections 50 on the lance head 24.

The cables 26 and 27, which control the vertical movement of the lance carriage as mentioned above, are operated by the cable hoist mechanism shown in FIGURE 8. Such hoist mechanism comprises a hoist drum 56 for the cable 27 and hoist drum 58 for operating the sheave assembly 9 in a manner to be described. The drums 56 and 58 are mounted on a common shaft 59 which is driven by an electric motor 60 through a speed reducing drive 61. The cable 27 is anchored at 62 to the drum 56 and extends upwardly over guide pulleys 6 at the top 11 of the frame F to its connection 29 with the lance carriage 16 so that rotation of the drum 56 in opposite directions is effective to raise and lower the lance carriage 16. Operation of the hoist drum 56 is counterbalanced by a cable 64 which is wound on the drum 56 in an opposite direction to that of the cable 27 and has an anchored connection 65 therewith. The free end of the counterbalance cable 64 extends upwardly from the drum 56 over guide pulleys 66 (see FIGURE 1) and then downwardly to the vertically movable counterweight 67 which is suspended from its lower end.

The cable 26 provides a safety counterbalance for the lance 8 to prevent its gravitating into the converter 1 in the event of breakage of the operating cable 27. For this purpose, the cable 26 extends upwardly from its connection 28 with the lance carriage 16 and over guide pulleys 68 at the top of the frame F and then downwardly and around a guide pulley 69 which is concentrically mounted on the hoist drive shaft 59. From the pulley 69, the cable 26 extends upwardly and over guide pulleys (not shown) which are concentrically supported with respect to the pulleys 66 and then downwardly for connection to the counterweight 67 in the same manner that the hoist drum counterbalance cable 64 is connected thereto.

Vertical movement of the sheave assembly 9 is controlled by a cable 70 which is wound on the small hoist drum 58 and has an anchored connection 71 therewith. The other end of the cable 70 has a connection at 72 with a member 73 which joins the carriages 45 and forms part of the vertically movable carriage suspension of the

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sheave assembly 9. From the connection 72, the cable 70 extends upwardly over a pair of spaced guide pulleys 74 at the top 11 of the frame F and then downwardly to the hoist drum 58. By reason of the manner in which the flexible hoses are trained over the supporting sheaves 40 and 42 and the stationary connections 51 of their end portions 49, the sheaves 40 and 42 must be raised and lowered at half the linear speed of axial movement of the lance 8 in order that axial movement of the hose end portions of 48 and the axial movement of lance 8 will be the same. This requirement with respect to speed of vertical movement of the sheave assembly 9 relative to the speed of vertical movement of the carriage 16 and the lance 8 suspended therefrom is met by using a hoist drum 58 for the cable 70 which has a diameter half that of the drum 56 for the lance carriage cable 27. Since the drums 56 and 58 are mounted on a common shaft, the gravitational bias of the counterweight 67 applied to the drum 56 also counterbalances the operation of the hoist drum 58 and the cable 70 for the sheave assembly 9.

A safety counterbalance that will operate to hold the sheave assembly 9 against unrestricted downward movement in the event of breakage of its operating cable 70 is provided by a safety counterbalance cable 75. The safety cable 75 has a stationary anchoring connection 76 with the top 11 of the frame F and extends downwardly therefrom over a pulley 77 which is connected with the sheave assembly carriage member 73 for vertical movement therewith. From the pulley 77, the cable 75 extends upwardly over guide pulleys 78 at the top 11 of the frame F and then downwardly over a guide pulley 79 which is mounted on the hoist drive shaft 59 in the same manner as the pulley 69 for the cable 26. From the guide pulley 79, the cable 70 extends upwardly over guide pulleys (not shown) arranged concentrically behind the pulleys 66 and thence downwardly to a connection with the counterweight 67. By reason of its being trained over the pulley 77, the safety cable 75 will allow vertical movement of the sheave assembly 9 at a speed half that of the speed of the vertical movement of the counterweight 67 and lance 8.

Attention is directed to the fact that the mounting of the pulleys 69 and 79 on the shaft 59 in concentric relation with respect to the hoist drums 56 and 58 is required in order to maintain the same degree of tautness in the hoist and safety cables during movement of the frame F by its rack and pinion drive. By reason of this arrangement each of the cables 26, 27, 70 and 75 has the same length between the guide pulleys on the upper end 11 of the frame and the hoist unit drive shaft 59, and movement of the frame F to and from the operative position shown in the drawings has the same effect on the length of all of such cables. As the frame F moves to the left as viewed in FIGURE 1, the distance between its corner at the upper end of its side 13 and the shaft 59 decreases, and movement of the frame F in an opposite direction will increase this distance, but since each of the cables 26, 27, 70 and 75 travels about the shaft 59 as a center to the counterweight 67 change in this distance affects each of the cables equally so that all are maintained equally taut.

As shown diagrammatically in FIGURE 2 of the drawings, the apparatus preferably includes duplicate assemblies of lances and operating mechanisms therefor in order to enable immediate replacement of a lance in the event of a failure during operation of the converter 1. In this showing, the two frames of the duplicate lance operating mechanisms are shown diagrammatically and are designated by the letters F₁ and F₂. Each of the frames F₁ and F₂ furnishes a support for a vertically movable lance 8 and has the same operating parts including a vertically movable lance carriage 16 and a vertically movable sheave assembly 9 as described above in connection with the frame F shown in FIGURES 1-8. The operating mechanism for each of the frames F₁ and F₂ further includes a stationary rack 35 and a pinion 36 for

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effecting horizontal movement thereof over paths 81 and 82 which respectively extend centrally between and parallel to the sides 10 of the frames F₁ and F₂. The mounting of the frames F₁ and F₂ is arranged in such a manner that their respective paths 81 and 82 of horizontal movement intersect at the point 83 which is aligned vertically and centrally with respect to the hood opening 7 through which the lances 8 travel to and from their operative blowing positions relative to the converter 1. The point 83 thus lies along a vertical line which forms an extension of the axis of the lance 8 which is to be lowered to its operative blowing position and thus determines the operating positions of the frames F₁ and F₂. In FIGURE 2, frame F₁ is shown in its operating position with its lance axis at the point 83 and thus centered over the hood opening 7 and the frame F₂ is shown in its retracted or inoperative position. Both frames F₁ and F₂ may be moved to their parked positions, corresponding to the position of the frame F₂ in FIGURE 2, but only one can be moved to its operative position corresponding to the position of the frame F₁ in FIGURE 2.

When the frames F₁ and F₂ are in their inoperative or parked positions, their sheave assemblies 9 occupy a position as shown in dotted lines in FIGURE 9 with the ends 49 of their flexible hoses supported thereby curving downwardly to the stationary connections 51. In order that a lance 8 may be lowered to its operative blowing position relative to a converter, the frame F on which it is carried must be first moved horizontally to an operative position in which its sheave assembly 9 is positioned as shown in solid lines in FIGURE 9 and, in this position, it will be noted that the hose end portions 48 and 49 are tangential to and extend vertically downwardly from the sheaves 40 and 42 and with the hose end portions 48 forming an axial extension of the lance 8 along its path of vertical movement. In this position of the frame F and the sheave assembly 9 carried thereby, the hoisting cables can be operated to lower the sheave assembly 9 and the lance 8 to the lower positions shown in dotted lines FIGURE 9 and, during this movement, the lance head 24 travels twice as far as the sheave assembly 9. In FIGURE 1, the lowered position of the lance carriage 16 when the lance carried thereby is in its operative blowing position is shown in dotted lines. Movement of a lance 8 upwardly to its upper retracted position and of the frame F on which it is mounted to its parked position, corresponding to the position of the frame F₂ in FIGURE 2 is effected by a reversal of the operations described above.

Attention is particularly directed to the fact that the load of the flexible hoses 41 and 43 is carried by the sheaves 40 and 42 during vertical movement of a lance to and from its operative blowing position relative to a converter 1 and during horizontal movement of the frame F on which it is mounted between its parked and operating positions. By reason of the support for the flexible hoses which is afforded by the sheaves on which they are mounted, it will be apparent that the hoses do not apply a lateral force at the upper end 4 of the lance 8 tending to move it out of a vertically aligned position. It should be noted further that this is accomplished by suspending each hose on one of the sheaves 40 and 42 in the shape of an inverted loop with its lance-connected end 48 held in a vertical position extending along the path of vertical movement of the lance 8. This arrangement and the provision for vertical movement of the lance assembly 9 with vertical movement of the lance 8 operate to feed the ends 48 of the hoses 41 and 43 in an axial direction along the vertical path of movement of the lance 8 as it travels axially to and from its operative blowing position.

From the foregoing it will be apparent that the lance operating mechanism of this invention provides a straight-in-line connection for the flexible oxygen and water hoses with the lance. The elimination of the laterally extending hose connections previously required thus enables a sim-

plified lance design, and, compared to previous arrangements in which the flexible hoses are suspended in a catenary to provide for vertical movement of the lance, it will be further apparent that the lance operating mechanism of this invention enables the use of shorter lengths of oxygen and water supply hoses. The axially extending straight-in-line connection of the flexible hoses with the upper end of the lance further eliminates lance unbalance and thus the complex guiding mechanism required when such unbalance is encountered. As a consequence the lance guide and suspension of this invention has a simplified construction and contribute a safety feature in that they reduce the possibility of dropping the lance into the furnace during lowering movement and prevent angular cocking of the lance to an extent that may interfere with its movement through the opening 7 during such lowering movement. In addition and by reason of the location of all parts of the lance operating mechanism directly above the fume hood removal 5, it will also be apparent that the hoses and operating mechanism are protected against damage from flame and fumes escaping from the converter 1, for example, as it is tilted to and from its operating blowing position shown in FIGURE 1 of the drawings.

While one embodiment of my invention has been shown and described it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. An oxygen injection apparatus for a steelmaking converter comprising a supporting frame, an elongated lance mounted on said frame for guided movement over a vertical and axially extending path to and from an operative blowing position relative to said converter, means mounting said frame for movement between an inoperative retracted position and an operating position in which said path of axial lance movement is centered over said converter, a flexible supply hose connected with the upper end of said lance and extending axially upwardly therefrom along said path, and guide means mounted on said frame above said lance and over which said hose travels in response to vertical movement of said lance, means for feeding said hose over said guide means independently of movement of said lance, said guide means including means operating to maintain the end portion of said hose connected to said lance in a vertical position forming an axial extension of said lance and to guide the movement of said end portion along said path in response to movement of said lance.

2. An oxygen injection apparatus as claimed in claim 1 characterized by said guide means comprising a sheave mounted for rotation on said frame about a horizontal axis and in a position tangential to said hose end portion.

3. An oxygen injection apparatus as claimed in claim 2 characterized by means mounting said sheave for vertical movement on said frame, and elevator means for raising and lowering said sheave in response to raising and lowering movement of said lance.

4. An oxygen injection apparatus as claimed in claim 3 characterized by said hose having an opposite end portion extending vertically downwardly from said sheave parallel to the said end portion thereof connected with said lance, said opposite end portion having a stationary connection with a supply line.

5. An oxygen injection apparatus as defined in claim 4 characterized by said sheave elevator means including means operating to raise and lower said sheave at half the speed of lance movement along said path.

6. A pair of oxygen injection apparatus as defined in claim 1 characterized by their respective frames having intersecting paths of movement and by one of said frames being adapted to occupy its said retracted position while the other is in its said operating position, said lances when said frames are in their said operating positions being

movable respectively to their said blowing position over a common path which is centered over said converter and passes through the point of intersection of said paths of frame movement.

7. An oxygen injection apparatus as defined in claim 5 characterized by said hose guide means comprising separate guide sheaves on each of said frames over which said hoses travel in response to vertical movement of the lances with which they are connected, said guide sheaves being arranged tangentially relative to the said vertical end portions of said hoses and operating to hold the said hose end portions against movement out of said vertical positions.

8. An oxygen injection apparatus as defined in claim 1 characterized by said flexible hose being an oxygen supply hose and by a pair of water circulating hoses respectively connected with the upper end of said lance and extending axially upwardly therefrom, and by said guide means comprising an assembly of three sheaves mounted for rotation about a common horizontal axis, each of said hoses being trained over and supported by one of said sheaves, said sheaves respectively being arranged tangentially relative to the said vertical end portions of the hoses supported thereon and operating to hold the said hose end portions against movement out of said vertical positions.

9. Apparatus as defined in claim 8 characterized by said hose feeding means comprising a carriage mounted for vertical movement, means supporting said sheaves on said carriage for movement therewith, and means for moving said carriage vertically in response to vertical movement of said lance.

10. Apparatus as defined in claim 8 characterized by said oxygen hose having a diameter greater than the diameters of said water hoses, and by the supporting sheave for said oxygen hose having a diameter greater than the diameter of the supporting sheaves for said water hoses.

11. In an oxygen injection apparatus for a steelmaking converter, a shallow frame of rectangular shape supported in a vertical position with its opposite longitudinal edges extending vertically upwardly, carriage means mounted for vertical movement along one of said frame edges, an oxygen lance supported at its upper end on said carriage for movement therewith, said lance extending axially and vertically downwardly from said carriage means parallel to its path of movement over said frame edge, said frame having laterally spaced sides and guide means along its upper and lower ends for guiding its movement over a horizontal path extending between and parallel to said sides, means for moving said frame over its said guided path of movement from an inoperative retracted position to an operating position in which said lance is centered over said converter, a sheave arranged between said frame sides and mounted for rotation about an axis extending transversely therebetween, means at opposite ends of said sheave axis mounting said sheave on the sides of said frame for vertical movement with respect thereto, a flexible supply hose trained over and supported on said sheave with opposite end portions parallel and depending vertically therefrom, one of said end portions having a connection at its lower end with said lance and projecting upwardly therefrom along its path of vertical movement, the other of said end portions having a stationary supply line connection at its lower end, and elevating means for moving said sheave and lance vertically and including means operating to move said sheave vertically at half the speed of vertical movement of said lance.

12. Apparatus as defined in claim 11 characterized by said elevating means comprising a first operating cable connected with said lance and a second operating cable connected with said sheave, and hoist drums for said cables mounted on a common shaft, the hoist drum for said lance cable having a diameter twice that of the hoist drum for said sheave cable.

13. Apparatus as defined in claim 12 characterized by

a common counterweight means counterbalancing the vertical movement of said lance and the vertical movement of said sheave comprising a vertically movable counterweight, and a cable connected with said counterweight and an anchoring connection with one of said drums for winding thereon in a direction opposite to the operating cable wound thereon.

14. Apparatus as defined in claim 13 together with a safety cable counterbalance system comprising a pair of safety cables connected with said counterweight and connected respectively with said lance and sheave, a pair of guide pulleys for said safety cables on the upper end of said frame for movement therewith, and a pair of guide pulleys concentrically mounted on said hoist drum shaft over which said safety cables travel from said frame pulleys to said counterweight.

15. An oxygen injection apparatus as defined in claim 11 characterized by said frame and sheave mounting means having three of said sheaves supported thereon for independent rotation about said sheave axis, with separate flexible supply hoses trained over said sheaves and having opposite end portions connected with said lance

and with stationary line connections, there being one of said hoses for supplying oxygen to said lance and the remaining two for circulating cooling water therethrough.

16. An oxygen injection apparatus as defined in claim 11 characterized by said frame moving means comprising a pair of vertically spaced drives respectively including a gear rack and a pinion, and a common drive shaft for said pinions, said drive shaft being rotatably supported on said frame and extending along the longitudinal edge thereof opposite said one edge on which said lance carriage means is mounted.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,366,376

January 30, 1968

Jesse D. Marino

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 29, for "22" read -- 42 --; line 44, for "6" read -- 63 --; column 6, line 58, for "4" read -- 24 --; column 7, lines 58 and 59, strike out "said sheave in response to raising and lowering"; column 8, line 5, for the claim reference numeral "5" read -- 6 --; lines 15 and 16, for "suppe" read -- supply --.

Signed and sealed this 22nd day of April 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents