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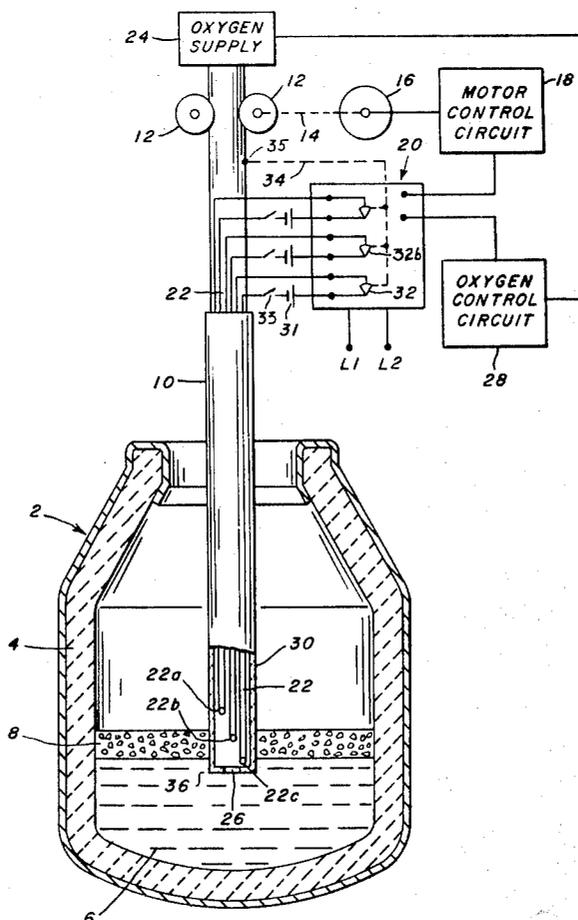
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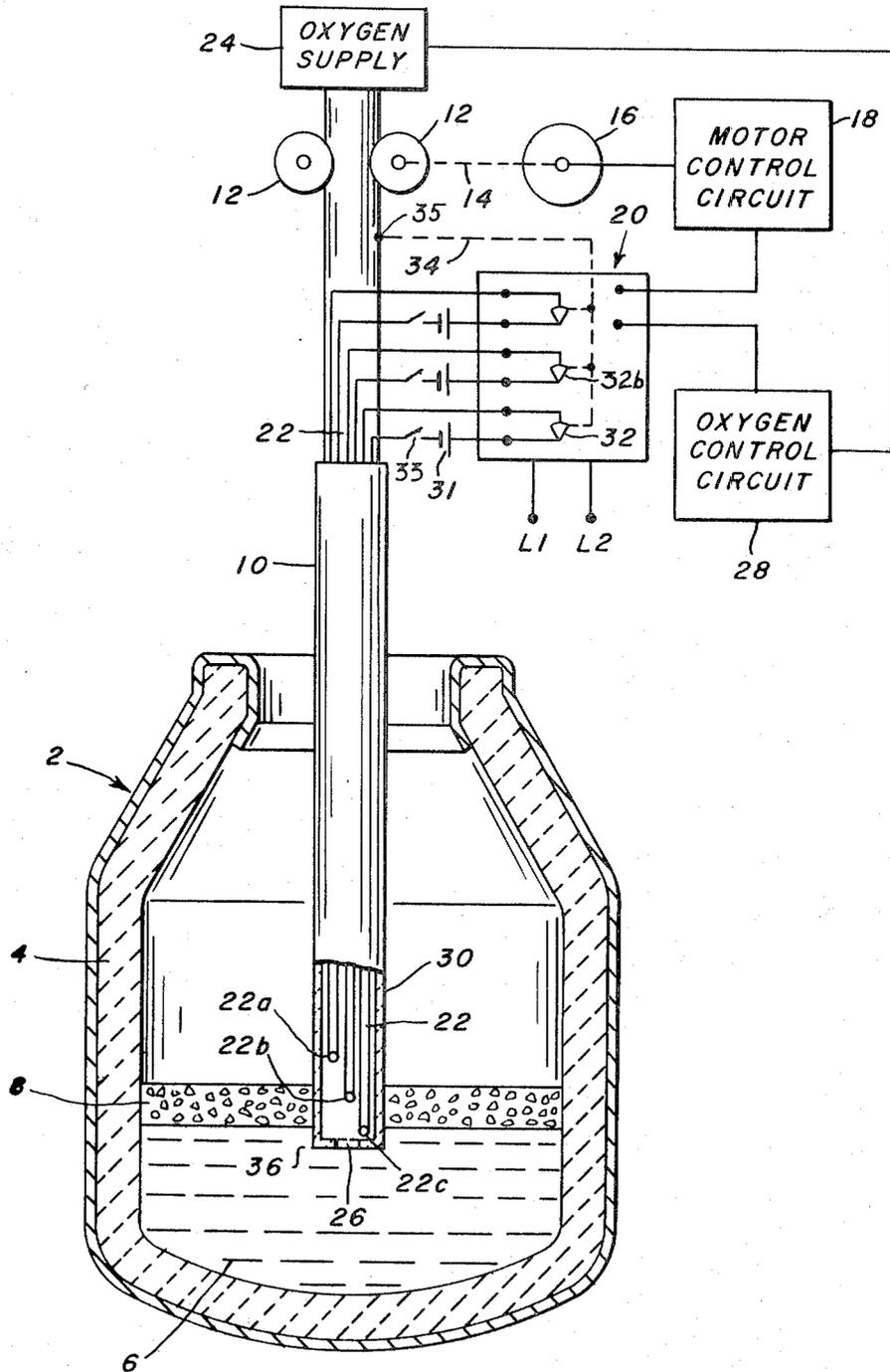
[54] **APPARATUS FOR POSITIONING A CONSUMABLE LANCE**
 7 Claims, 1 Drawing Fig.

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ABSTRACT: A plurality of parallel conductive loops extending longitudinally substantially the length of a consumable lance utilized to supply oxygen to a bath of metal within a vessel for steelmaking. Each conductive loop extends a predetermined distance on said lance and is connected to monitoring means including electric power source and metering means to indicate electrical current flow through the conductive loop. In preferred embodiments, the consumable lance may be positioned by control equipment responsive to signals generated within the monitoring means responsive to changes in current flow or interruptions therein precipitated by physical conditions within the vessel.





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APPARATUS FOR POSITIONING A CONSUMABLE LANCE

BACKGROUND OF THE INVENTION

In modern steelmaking, an essential part of the process is decarburization of a bath of metal and is generally performed by the introduction of oxygen into the vessel in which a molten bath of metal is contained. The introduction of oxygen into the bath causes a reaction between the carbon within the metal and the oxygen giving off various gaseous byproducts including carbon oxidized from the bath. In current practice the oxygen is blown through a lance which is positioned either above, or submerged within the liquid bath. The lance is considered to be submerged when the oxygen outlet openings are below the liquid bath level such that the oxygen is discharged within the bath as opposed to being blown upon the surface thereof. The preferred method of oxygen blowing includes submerging the lance below the bath level because it promotes a more predictable and efficient utilization of oxygen. In top blowing the oxygen reacts with carbon monoxide rising from the bath in preference to the carbon contained in the molten metal thereby increasing the amount of oxygen necessary to remove a given amount of carbon. Submerged blowing also reduces the incidence of equipment damage and decreases the degree of splashing. Where blowing is done in a ladle, splashing may be hazardous to operating personnel and may cause loss of material from the vessel.

Submerged blowing suffers from numerous difficulties including a forced erosion of the oxygen lance due to its submersion within the molten bath and introduction into the high-heat area of reaction between the discharged oxygen and the bath. This continued erosion of the lance requires repeated positioning of the lance to insure its maintaining a submerged relation to the bath. During this repositioning it is possible to excessively immerse the lance into the bath due to lack of reference depth. Such excessive immersion causes the consumable lance to erode faster than the necessary rate, as well as promoting damage to the lining of the vessel by bringing the lance and reaction area too close thereto. In awareness of the foregoing problems, I have developed apparatus for using an oxygen lance to overcome these disadvantages in submerged blowing.

SUMMARY OF THE INVENTION

Apparatus for monitoring the position of an oxygen lance within a vessel containing a bath of molten metal wherein the lance has disposed longitudinally along the length thereof, a conductive loop, extending a predetermined distance longitudinally thereof, and has monitoring means electrically connected to said conductor to indicate the electrical state of the conductive loop. Preferred embodiments include a plurality of conductive loops disposed to extend a variety of predetermined distances longitudinally on the lance and having means connected thereto to establish an electrical current flowing through the conductive loop and means to indicate changes in the current flow or interruptions therein. Further embodiments include lance positioning means responsive to the changes or interruptions in electrical current flow in the conductive loops.

DESCRIPTION OF THE DRAWINGS

The FIGURE is an elevational view of steelmaking apparatus including the conductive loops according to my invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the FIGURE reference numeral 2 indicates a vessel such as used in the process of making steel according to the basic oxygen process having a refractory lining 4. It should be recognized that vessel 2 might also be a ladle or such other container wherein refinement of the contents may be carried out. Within the furnace 2 is a molten metal bath 6

which is usually covered over by a slag layer 8. Extending within furnace 2 is lance 10, conventionally used to supply refining agents such as oxygen, or flushing agents such as inert gases. The lance is moved upwardly or downwardly by means such as rolls 12 mechanically connected as at 14 to a motor 16. In the instance of the conventional BOF, the lance may be vertically moved, however, diagonal and other mountings are known and incorporated within the scope of my invention. Motor 16 is in turn controlled by motor control circuit 18 which in the invention is responsive to monitor circuit 20. The foregoing structure is known in the art. Disposed along lance 10 are conductive loops 22 which extend longitudinally along the lance 10 terminating at predetermined distances and different known points along the length of lance 10. Oxygen for the purpose of decarburizing the molten bath 6 may be supplied by an oxygen supply 24 supplying lance 10 and which in turn, carries the oxygen into the molten bath 6 through nozzle 26. The rate of flow of oxygen may be controlled as by an oxygen control circuit 28 which in turn may be responsive to monitoring circuit 20 as subsequently described.

The embodiment herein described includes a plurality (these are shown by illustration) of conductive loops of a wire of sufficient heat resistance to withstand the heat of the environment, extending along the length of lance 10. These loops may be embedded within a coating of refractory material 30 over lance 10. The conductors may also be affixed to the lance by other known and suitable means such as mechanical bands, either on the inside or outside of lance 10. The loops may be identified as to their terminating position along lance 10 as indicated at 22a, b and c; each loop extending a predetermined known distance along lance 10 as illustrated in the FIGURE. In one embodiment the conductive loops are connected to monitoring circuit 20 which may include a potential source 31 and a meter 32 which may indicate current flow through the conductive loops 22 as upon closing of a switch 33. Conductive loops 22 may take either the form of a full loop extending between monitoring circuit 20 down lance 10 to a point 22a, b or c and returning to monitoring circuit 20 as illustrated in the FIGURE, or may contemplate a single conductor running down the length of lance 10 to a point a, b or c wherein the conductor may be connected to the conductive lance itself and circuit closed as through a conductor 34 connected electrically to lance 10 as at 35.

In the operation of my invention, lance 10 will be lowered into furnace 2 submerged into slag layer 8 and molten bath 6. Initial depth setting of the lance 10 as at 36, may be determined from a prior predetermined depth of slag 8 and bath 6 and the careful lowering of the lance 10 to the initial desired submerged distance from a known height above the slag 8. As the oxygen is supplied from source 24 through lance 10 to nozzle 26, the decarburization of bath 26 takes place. Conjointly with the decarburization of bath 6, the reaction in the vicinity of nozzle 26 causes the lance to erode due to the great amounts of heat generated in the reaction area. The erosion of the lance 10 progresses upwardly on the lance as the reaction continues and reaches point 22c. As the lance erodes to this point, the conductive loop at c also deteriorates thus opening the circuit formed through conductive loop 22, power source 31, meter 32 and conductor 34. At the point of opening of the circuit an indication on meter 32 will signal the progression of the erosion of the lance to point c such as interruption of current flow. At this time and by the known position of point c relative to the depth of slag layer and bath 6, lance 10 may be repositioned to reestablish the desired submerged distance as at 36. Further, as the reaction continues and the bath is further decarburized, the erosion will proceed to points 22b and 22a respectively, each indicating the interruption of current flow in the loop on their respective meters 32b establishing the progression of the erosion of the lance to these points. The lance may be repositioned upon each signal to reestablish the desired submerged position reestablishing the desired parameters of the decarburization.

As previously indicated, the position of the lance may be controlled through motor 16 and motor control circuit 18. While the position of the lance 10 relative to the bath 6 and slag layer may be manually controlled through the motor control circuit and motors 18 and 16 respectively, the repositioning of lance 10 might also be accomplished by causing motor control circuit 18 to be signaled by monitoring circuit 20 affecting the repositioning of lance 10 automatically. This may be accomplished by conventionally known relay means which would energize motor control circuit 18 and motor 16 for a known predetermined time upon the occurrence of the event of the opening of conductive loop 22. It will be apparent to those skilled in the art that a signal other than the opening of the conductive loop 22 may also be accomplished within the monitoring circuit 20. These skilled in the art will be aware of the dependence of a resistive element to temperature change and thus, capable of signaling an event which might be caused by the change of the lance environment temperature through circuitry similar to that disclosed, as by reflecting a change of current through flow in a meter 32 as illustrated. Thus, it will be apparent to those skilled in the art that further control of the lance position 10 might be accomplished responsive to this temperature change. In so doing, an additional embodiment may provide a thermocouple as a source 31 of potential for a monitoring circuit, said thermocouple physically located at points such as *a*, *b* and *c*. Further, since a plurality of sensing circuits 22 may be employed, the various control parameters for controlling such as oxygen through supply 24 and control circuit 28 may be generated by differential sensing as between points *a*, *b* and *c* and the signals deleted therein utilized through comparator circuitry well known in the art.

While in the example described and illustrated, three conductive loops 22*a*, *b* and *c* are shown, it will be appreciated that any number may be employed which will provide convenient monitoring within the dictates of the process to be controlled.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

I claim:

1. In apparatus for steelmaking including a vessel containing a bath of molten metal and a positionable consumable lance for introducing a gaseous refining agent into the bath, the combination of:

a plurality of electrical conductors extending along the length of the lance and terminating at different points above the bottom of the lance;

electrical conducting means extending along the length of the lance and electrically insulated from said plurality of electrical conductors except at the bottoms thereof where an electrical connection of solidified metal is made between the bottom of each conductor and said conducting means;

means for establishing an electrical potential between each of the respective ones of said conductors and said electrical conducting means whereby current can flow between each conductor and said conducting means until the bottom electrical connection therebetween is severed due to erosion of the lance upwardly from the bottom thereof; and

monitoring means arranged for connection between each electrical conductor and the conducting means whereby erosion of the lance to the bottoms of successive ones of said electrical conductors will be indicated by a break in the circuit between a conductor and the electrical conducting means and the absence of current flow through the monitoring means connected thereto.

2. The combination of claim 1 wherein the electrical conducting means comprises a second plurality of electrical conductors each connected at its bottom to a respective one of said first-mentioned electrical conductors and insulated from its associated one of the first-mentioned electrical conductors throughout the remainder of its length.

3. The combination of claim 1 wherein said lance includes a metallic tubular jacket, and said electrical conducting means comprises said jacket.

4. The combination of claim 1 wherein said monitoring means is responsive to the interruption of current through associated ones of said plurality of electrical conductors to indicate that the lance had eroded to the bottom of an electrical conductor and broken its connection at the bottom thereof to said electrical conducting means

5. The combination of claim 1 including means operatively connected to said monitoring means for moving said lance downwardly when the connection between an electrical conductor and said electrical conducting means has been broken due to upward erosion of the lance.

6. The combination of claim 1 wherein said means for establishing an electrical potential comprises thermocouples connected between the bottoms of respective ones of said electrical conductors and said electrical conducting means.

7. The combination of claim 6 including means for comparing the current generated by the respective thermocouples, and means for controlling the introduction of the gaseous refining agent into the molten bath in response to the comparison of currents by said comparing means.

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