METHOD OF INSPECTION AND CONTROL OF THE REACTION PERFORMANCE DURING THE OXYGEN BLOWING PROCESS

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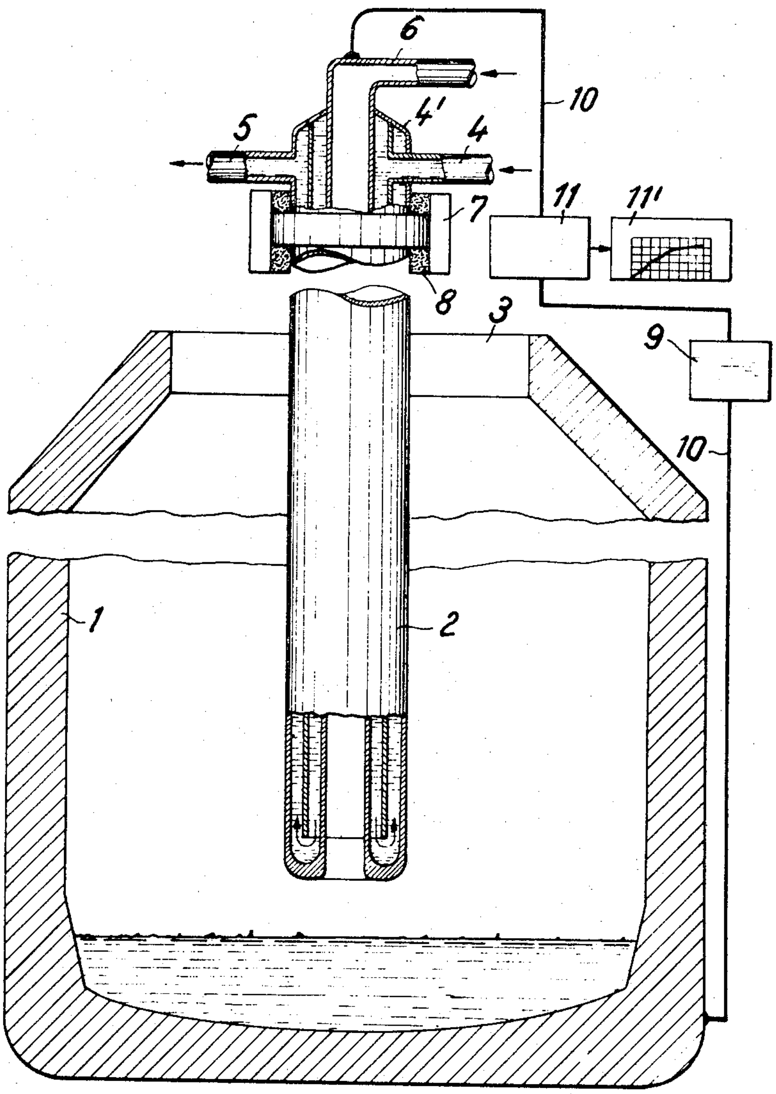

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METHOD OF INSPECTION AND CONTROL OF THE REACTION PERFORMANCE DURING THE OXYGEN BLOWING PROCESS

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ABSTRACT OF THE DISCLOSURE

A method of inspection and control of the conditions prevailing in a converter during the oxygen blowing process of refining molten metal which includes the steps of positioning a single electrically conductive and insulated member in the converter spaced above the surface of the metal bath therein, passing an electric current through a closed circuit which includes the member, the atmosphere in the space between the surface of the metal bath and the member, the metal bath, and a wall of the converter, providing an electrical resistance between the member and ground of about 10 ohms to about 10,000 ohms, measuring the electric current passing through the circuit during the refining of the metal, and varying the conditions under which the refining of the metal in the converter takes place in accordance with the variations in the flow of electric current through the circuit as determined by the measurement.

The present invention relates to a method of inspection and control of the reaction performance during the oxygen blowing process.

A similar method has been disclosed in the copending patent application Ser. No. 441,484, filed Mar. 22, 1965.

The inspection of the reactions occurring during the decarburization of pig iron with oxygen has been performed until now substantially by observation of the flame. An observation of the flame is, however, rather difficult if the converter gases are to be caught without access of false air and are to be exploited.

It is one object of the present invention to provide a method of inspection and control of the reaction performance during the oxygen blowing process, which constitutes a technically simple solution, requiring little effort for the inspection and control of the oxygen blowing process, and permitting an automation performance.

It is another object of the present invention to provide a method of inspection and control of the reaction performance during the oxygen blowing process, wherein the electrical conductivity, which is dependent upon the reaction performance between the electrically insulated blower tube and the metal bath, is determined and is used for the control of the reaction performance.

It has been proposed in said copending patent application Ser. No. 441,484 to insulate electrically the oxygen blowing tube from the remaining parts of the entire unit and to provide an electrical resistance for the insulation as high as possible and preferably to 10,000 ohms or even more.

It is, however, a further object of the present invention to provide a method of inspection and control of the reaction performance during the oxygen blowing process,

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wherein the electric resistance of the insulation amounts to much less than 10,000 ohms, as for instance 10 ohms.

With these and other objects in view, which will become apparent in the following detailed description, the present invention will be clearly understood in connection with the accompanying drawing, in which the only figure discloses a converter with its blowing tube in axial section.

Referring now to the drawing, the apparatus capable of performing in accordance with the method of the present invention comprises a converter 1 of conventional structure, which is equipped with an upper mouth portion 3 through which a blowing tube 2 is inserted for blowing oxygen into the converter 1. The blowing tube 2 is cooled and for this purpose the blowing tube 2 includes a jacket 4′ forming the outer part of the blowing tube 2. A feeding-in tube 4 leads into the jacket 4′ and a feeding-off tube 5 leads off the jacket 4′, so that cooling water is continuously fed through the jacket 4′.

An oxygen feeding tube 6 is disposed on top of the blowing tube 2 and communicates with the latter. A moving slide 7 surrounds the blowing tube 2, which moving slide 7 is adapted to lift and lower, respectively, the blowing tube 2. An electrical insulation ring 8 is disposed between the blowing tube 2 and the moving slide 7 for a purpose more clearly disclosed below.

An electric source 9 feeds electric current into a circuit comprising an electrical conduit 10 which has one terminal at the oxygen feeding tube 6 and another terminal at the outer face of the converter 1, so that the oxygen blowing tube 2 and the converter 1 are disposed in series in the electrical circuit. The circuit includes a conductivity measuring device 11 which is disposed in series in said circuit and which conductivity measuring device is operatively connected with an indicating device 11′ in order to indicate on a diagram the conductivity of the current through the metal bath to be processed.

It is thus apparent that the oxygen-blowing tube 2 used in the method of the present invention is electrically insulated from the remaining parts of the entire unit by means of the insulating ring 8. As an alternative, the oxygen blowing tube 2 can also be grounded. The electrical resistance should amount less than 10,000 ohms and may assume values of about 10 ohms. Generally, the resistance of the cooling water and oxygen feeding tubes amounts to a multiple of this value in case non-metallic tubes are used. The insulation of the oxygen blowing tube towards its supporting device and moving slide 7, respectively, or any other carrying means can be obtained by insertion of insulating layers between the blowing tube and its mounting, as for instance, by means of the insulation ring 8.

The present invention is not only applicable to a method performed in a LD-converter, but also in such decarburization methods in which the blowing of oxygen takes place on a rotating converter, for instance, in a Kaldo-converter rotating in an oblique position.

By means of a device suitable for measuring the conductivity within a wide range, in case of application of low direct-current or alternating-current voltages, up to a few volts, the conductivity between the blowing tube and the metal bath and the inner wall of the reaction vessel, which is connected for a good electrical conducting with a converter jacket as well as with the other parts of the unit, is continuously determined and recorded. In order to increase the measuring exactness, two or more resistance measuring ranges, capable of switching over, can be used, whereby the switching over from one range to another range can be obtained automatically by any conventional means upon reaching a predetermined value.

Prior to the start of the blowing operation, by lowering the oxygen feeding tube to engagement with the bath surface, its height can be determined and, thereby, the distance between the blowing nozzle and the bath surface required for the process can be set exactly with distances required for the process, whereby the time of engagement is indicated by a strong change of the electric conductivity. If the oxygen feeding tube cannot be lowered as far or if an immersion of the tube should be avoided, the latter can be extended for a predetermined length by means of an electrically conducting extension member (not shown), which is electrically conducting with the oxygen feeding tube.

At the start of the oxygen blowing at the moment of ignition, that means, at the start of a reaction accompanied with a strong light phenomenon on the hitting range of the oxygen stream and in the oxygen stream itself, conductivity is appreciably increased. Any lighting-prevention and retardation is easily recognized momentarily in the change of the conductivity in dependency upon the time and can be used for instance, upon ignition delay, for an automatic lowering of the blowing tube and after the ignition for a return movement into the blowing position or upon termination of a certain time period without ignition for the automatic stopping of the oxygen feed and/or for the release of an alarm.

The conductivity between the blowing tube and the bath is determined during the blowing process in dependency of a series of influences. An appreciable influence has the conductivity of the reaction gases rising from the bath and of the oxygen stream burning at a certain distance from the blower nozzle in which temperatures between 2000–3000° C. occur. This conductivity is, for instance, a function of the quantity of reaction gases formed in the bath within a given time unit, which reaction gas quantity is proportional to the carbon loss. In addition, also the loading of the gases with iron smoke and squirters, as well as the formation of a froth slag have their effect on the conductivity. Furthermore, during the blowing, a voltage is created between the blowing tube and the bath depending upon the prevailing conditions, which voltage, for instance, varies strongly within the range of +0.1 to −0.1 volt.

In spite of these processes occurring partly simultaneously, certain influences clearly ascribed to metallurgy play a decisive part in the conductivity and can thus be recognized. The conductivity is also influenced by the metallurgical processes, by the apparatus, by the particular process and by the measuring method. First of all, at the start of the blowing process, the presence of accompanying elements, for instance Si, which binds preferably the oxygen, the carbon residue remains low as long as the accompanying elements are mostly slag. The more or less steep rise of the conductivity indicates clearly this metallurgical process. At the end of the blowing period, a clear lowering of the conductivity, depending upon the process conditions of a few tenths percent C., for instance 0.3% C., is easily to be recognized and can be used for removal of the melt. In very low carbon contents in the bath and particularly in case of overblowing the melt, the conductivity rises again for a short time. Similarly, as also during a prior state, the formation of a froth slag, which occurs for instance during the working of phosphor-rich pig iron, is indicated by a decreasing velocity of the decarburization. This high-rising froth slag increases again the conductivity. If the froth slag reaches the blowing tube, the conductivity rises again suddenly. The froth height can be measured also by a short-time lowering of the blowing tube before the slag reaches the blowing tube. From the changes of the conductivity capacity the formation of a froth slag can be early recognized, and metallurgical measures can be timely instituted in order to avoid an overfrothing and, thereby, a discharge bringing about losses for the process. The resistance changes in metallurgically equal melts conform to a great extent and offer the possibility for an automatic inspection or control of the reaction procedure.

The method in accordance with the present invention can be performed also such that the conductivity between a particular probe and the bath surface is determined. The probe must, of course, be electrically insulated and water cooled.

While we have disclosed one embodiment of the present invention, it is to be understood that this embodiment is given by example only and not in a limiting sense, the scope of the present invention being determined by the objects and the claims.

We claim:

1. A method of inspection and control of the conditions prevailing in a converter during the oxygen blowing process of refining molten metal, comprising the steps of

positioning a single electrically conductive and insulated member in said converter spaced above the surface of the metal bath therein,

passing an electric current through a closed circuit which includes said member, the atmosphere in the space between the surface of said metal bath and said member, said metal bath, and a wall of said converter,

providing an electrical resistance between said member and ground of about 10 ohms to about 10,000 ohms,

measuring the electric current passing through said circuit during the refining of said metal, and

varying the conditions under which the refining of said metal in said converter takes place in accordance with the variations in the flow of electric current through said circuit as determined by said measurement.

2. A method of inspection and control of the conditions prevailing in a converter during the oxygen blowing process of refining molten metal, comprising the steps of

positioning a single electrically conductive and insulated member in said converter spaced above the surface of the metal bath therein,

passing an electric current through a closed circuit which includes said member, the atmosphere in the space between the surface of the metal bath and said member, said metal bath and a wall of said converter,

measuring the electric current passing through said circuit during the refining of the metal, and

varying the conditions under which the refining of the metal in the converter takes place in accordance with the variations in the flow of electric current through said circuit as determined by said measurement.

3. The method, as set forth in claim **2**, wherein said electrically conductive insulated member comprises an oxygen blowing tube.

4. The method, as set forth in claim **3**, which includes the step of

lowering said oxygen blowing tube prior to the start of the blowing process in order to determine the level of the bath surface, and

setting the distance between said blowing tube and the metal bath surface in dependency upon said level determination, whereby the reaction performance is influenced.

5. The method, as set forth in claim **2**, wherein the conditions under which the refining of the metal takes place due to the variations of the flow of electric current through said circuit are varied automatically.

6. The method, as set forth in claim **3**, wherein the conditions varied are the distance between said oxygen blower tube and the level of the metal bath surface.

7. The method, as set forth in claim **2**, wherein the conditions varied are the quantity of oxygen blown onto the metal bath.

8. The method, as set forth in claim 4, wherein the conditions varied comprises the control of the start and of the end of the addition of material.

9. The method, as set forth in claim 2, wherein said electrically conductive and insulated member comprises a probe.

10. The method, as set forth in claim 2, wherein two measuring devices of different ranges are provided.

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