Aug. 18, 1964 J. CHEDAILLE 3,145,245

CONVERTER ARRANGEMENT

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Fig. 1

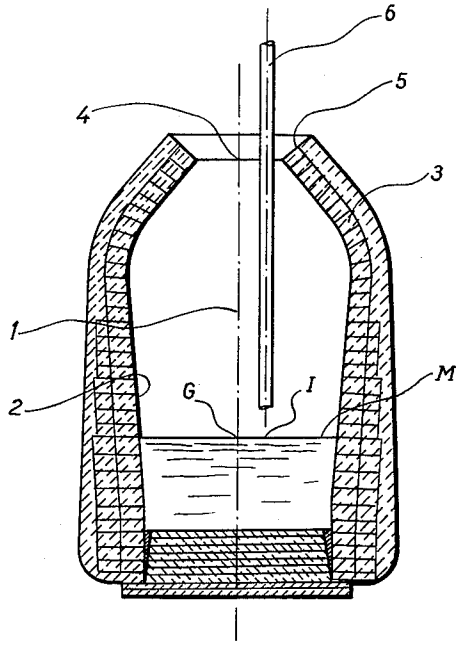
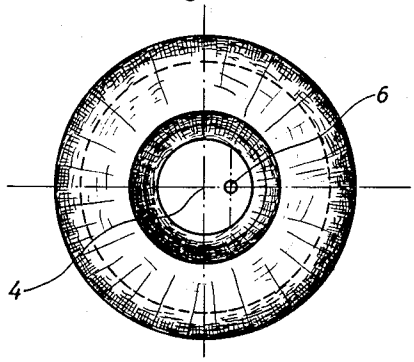


Fig. 2



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Fig. 3

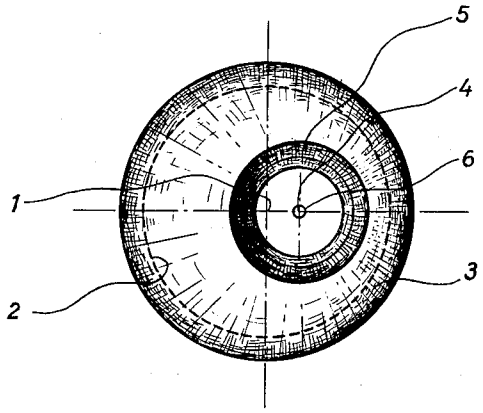
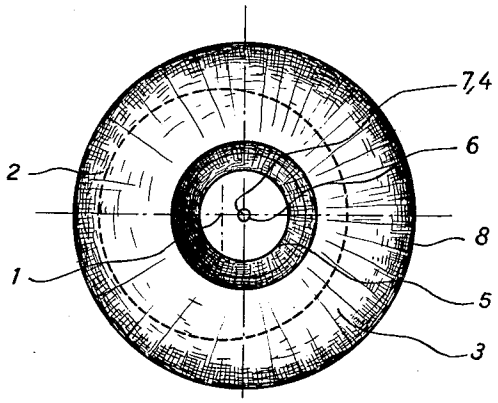


Fig. 4



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CONVERTER ARRANGEMENT

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7 Claims. (Cl. 266—34)

The present invention relates to a converter arrangement and to a method of treating molten metals. More particularly, the present invention is concerned with an arrangement and a method whereby a stream of gas is introduced into a bath of molten metal.

Certain well known metallurgical processes require the introduction of a gas into a bath of liquid metal. Thereby the gas may or may not carry along finely subdivided materials. For instance, a stream of oxygen gas may be introduced and lime particles may be carried by the gas stream. Frequently it is desired to blow the gas from above upon the surface of the molten metal.

Gas has been introduced in the above described manner by blowing, for instance oxygen gas, onto the central portion of the surface of the molten bath, i.e. into the central or axial portion of the converter or crucible containing the molten metal. By thus blowing the gas downwardly from a vertical nozzle into the central or axial portion of the refining vessel and thus onto the center of the upper surface of the bath of molten metal, circular waves or currents of the metal or in the molten metal bath will be formed, which currents will manifest themselves as a depression of the surface in the central portion of the bath of molten metal and as an ascending portion of the molten metal along the periphery of the converter vessel or the like, so that the portions of the metal which are not yet refined, i.e. which have not yet been sufficiently exposed to the gas stream will tend to flow towards the area of direct contact with the gas stream, while the portion of the metal bath which has already reacted to the gas will move away therefrom. However, applicant has found that the thus produced circulating currents of the prior art do not give the most complete and advantageous reaction between the molten metal of the bath and the stream of treating gas which is downwardly directed towards the upper face of the molten metal bath.

The introduction of the stream of gas into the liquid metal bath in downward direction by means of a vertical lance extending downwardly towards but not reaching the surface of the metal bath, will cause, when a sufficient amount of gas is thus introduced and by directing the gas stream towards the center of the surface of the metal bath, mass oscillations of the bath which, in a refining vessel of circular or substantially circular cross section, may appear on the surface of the bath as a revolving or rotating circular wave which will cause increasing spattering of metal through the outlet of the vessel located in the top portion thereof. This results in loss of metal and such losses increase when the rotating wave which is formed by the introduction of the stream of gas is of considerable magnitude, i.e. when the amount of delivery of the gas is increased, all other factors being the same. A given amount of gas being introduced by being blown towards the center of the surface of the molten metal bath, will cause varying degrees of spattering depending on the dimensions and geometrical configurations of the converter.

Thus, the introduction of the stream of gas into the center of the surface of the metal bath as suggested by the prior art, creates certain problems and difficulties.

It is therefore an object of the present invention to

provide an apparatus and method which will overcome the above discussed difficulties.

It is a further object of the present invention to provide a method and apparatus for the introduction of a stream of treating gas into a bath of molten metal, and particularly from a lance spaced upwardly from the surface of the bath of molten metal, according to which the desired intimate contact between the gas and the molten metal of the bath will be accomplished and at the same time spattering will be reduced to a minimum.

Other objects and advantages of the present invention will become apparent from a further reading of the description of the appended claims.

With the above and other objects in view, the present invention comprises in a converter arrangement for treating molten metal, in combination, an upright chamber having an inner surface and a central upright axis and adapted to hold molten metal at a predetermined metal level, and a lance extending downwardly into the chamber terminating therein in a downwardly directed orifice located above the predetermined metal level and laterally spaced from the central upright axis in a predetermined horizontal direction at a distance equal to between 15 and 75% of the horizontal distance of the inner surface from the central upright axis in the predetermined direction.

According to a preferred embodiment of the converter arrangement for treating molten metal according to the present invention, the same comprises, in combination, a converter vessel including a bottom portion, a top portion formed with an opening therethrough and annular wall means interposed between and in contact with said top and bottom portions, said annular wall means having an outer and an inner annular face and said annular faces having central upright axes laterally spced from each other, said inner annular face defining in said converter vessel an upright chamber adapted to hold molten metal at a predetermined metal level, and a lance extending downwardly through the opening into the upright chamber coaxial with the outer annular face and terminating in the upright chamber in a downwardly directed orifice located above the predetermined metal level and laterally spaced from the central upright axis of the inner annular face in a predetermined horizontal direction at a distance equal to between 15 and 75% of the horizontal distance of the inner annular face from its central upright axis in the predetermined direction.

The present invention also contemplates in a method of treating molten metal, the steps of forming in a treating vessel a body of molten metal, and directing from above onto the upper surface of the body of molten metal a stream of treating fluid in such a manner that the stream will contact the upper surface of the body of molten metal at a point located on a straight line from the center of the surface to the periphery thereof spaced from the center of the surface at a distance equal to between 15 and 75% of the distance from the center of the surface to the periphery thereof measured along the straight line.

Thus, according to the present invention, certain geometrical factors are selected in such a manner as to reduce the mass oscillations of the bath which will occur when given amount of gas is delivered from an upwardly spaced lance. The present invention will accomplish a slowing down of these mass oscillations in the metal bath so that the losses of metal by spattering of the same through the outlet of the vessel or converter will be reduced.

Accordingly, the present invention provides an arrangement for treating liquid metals, particularly ferrous metals which provide for introduction of the gas by means of a vertical lance into the refining vessel. The gas may carry pulverized substances which are intended to be introduced into the molten bath together with the gas. In

any event, the lance will be thus arranged relative to the converter vessel that the axis of the stream of gas which contacts the surface of the metal bath will be laterally spaced from the upright central axis of the converter chamber, i.e. of the body of molten metal in the converter. Furthermore, the lateral distance of the lance from the upright axis of the molten metal bath or of the converter chamber will be equal to between 15% and 75% of the distance from the upright axis of the converter chamber from the inner wall of the converter measured along a straight horizontal line at the upper level of the bath of molten metal, which line cross sects the central axis of the bath of molten metal, i.e. of the converter chamber at the level of the molten metal, and also cross sects the axis of the lance from which the gas is blown downwardly towards the surface of the bath of molten metal.

The foregoing can be achieved by various arrangements of the converter and the lance relative to each other.

Thus, the outlet of the refining vessel which is located in the top portion of the converter may be coaxial with the converter chamber and, in such case, the lance will extend downwardly into the converter chamber laterally spaced with respect to the center of the converter outlet or opening in the top portion of the converter.

On the other hand, the arrangement may also be such that the opening in the top portion of the refined vessel, through which the lance is introduced into the vessel, is located eccentrically with respect to the upright axis of the converter chamber, and in this case the lance may extend downwardly through the center of the eccentrically arranged opening in the top of the converter.

Another arrangement according to the present invention would provide for an opening in the top portion of the converter which is coaxial with the outer face of the converter vessel, and the lance will extend downwardly through the opening passing through the center of the same and arranged coaxially with the outer shell of the converter vessel. However, in this case the horizontal cross section of the refractory lining of the converter will be of uneven thickness so that the converter chamber defined by the inner face of the refractory lining will not be coaxial with the outer face of the converter. Consequently, the lance which is arranged coaxially with the outer face of the converter will in this case be laterally spaced from the upright axis of the converter chamber, namely so that the lance will be located nearer to the thicker portion of the refractory lining and farther removed from the refractory wall portion which is of lesser thickness.

Thus, in any event and in accordance with any of the arrangements described above, according to the present invention, the stream of gas will contact the bath of molten metal at a point which is laterally spaced from the upright axis of the body of molten metal, or, which is laterally spaced from the center portion of the free surface of the metal bath.

Surprisingly, it has been found that the arrangement described above will give the particular advantage that for a given distance between the nozzle opening of the lance and the bath, mass oscillations of harmful nature, i.e. a splattering which will cause metal losses, will occur only upon delivery of greater quantities of gas per unit of time, or upon a greater speed of the stream of gas than that which would cause such harmful oscillations if the stream of gas would contact the molten metal at the center of the surface of the bath.

The term "critical delivery" as used herein is intended to designate the minimum delivery of gas which would be capable of causing such undesirable mass oscillations. It has been found that in a converter of circular cross section and upon arranging the lance orifice at a given distance upward from the upper surface of the bath, the amount of gas which will constitute "critical delivery" will be increased by about 20% when the point of impact is located a certain distance from the center of the

surface of the bath as compared with the amount which will constitute "critical delivery" if the stream of gas contacts the center of the surface of the molten bath. The lateral distance of the point of impact of the stream of gas from the center of the surface of the molten bath which will be required in order to permit increase in the delivery by 20% without causing harmful oscillations, in the case of a converter of circular cross section will be equal to about one-third of the radius of the surface of the molten metal bath.

Preferably, the eccentricity of the point of impact between the stream of gas and the surface of the molten metal will amount to at least 15% of the distance between the center of the bath of molten metal and the periphery of the bath or the inner face of the converter, measured along a horizontal line at the surface of the bath of molten metal, which line passes through the point of impact of the stream of gas. On the other hand, preferably, the maximum distance of the point of impact of the stream of molten gas measured as described above preferably should not exceed 75% of the distance between the center of the surface and the periphery of the bath. Thus, according to the present invention, the gas stream, although it is arranged eccentrically with respect to the upright axis of the converter chamber, nevertheless will remain spaced a certain distance from the inner face of the converter wall, in order to avoid that the refractory lining of the converter will be unduly exposed to metallic spatter. Considering the various requirements such as to maintain at least a certain minimum distance from the center of the bath of molten metal in order to achieve the desired degree of supression of oscillation, and also to maintain a certain distance from the refractory inner lining of the converter, has led to the conclusion that the lance which extends downwardly into the converter chamber is preferably laterally spaced from the central upright axis of the converter chamber in a predetermined horizontal direction at a distance equal to between 15 and 75% of the horizontal distance of the inner surface of the converter from the central upright axis thereof measured in said predetermined direction.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing, in which:

FIG. 1 is an elevational view partly in cross section of a converter arrangement according to the present invention;

FIG. 2 is a top view of the arrangement illustrated in FIG. 1;

FIG. 3 is a top view of a different arrangement according to the present invention; and

FIG. 4 is a top view of still another arrangement according to the present invention.

Referring now to FIG. 1, the converter is shown to have a top opening coaxial with the converter chamber, while the lance through which the gas is introduced is laterally spaced from the upright axis of the converter chamber. FIG. 2 illustrates the same arrangement with a dotted line indicating the inner lining of the converter at the upper level of the molten metal bath. According to the arrangement illustrated in FIG. 3, the converter is formed with an outlet or opening in its top which is arranged eccentrically relative to the upright axis of the converter chamber and, in this case, the lance is arranged coaxially with the opening in the top of the converter and thus eccentrically relative to the converter chamber. Finally, according to FIGURE 4, the outlet in the top of the converter and the lance are arranged coaxially with the outer face of the converter. However, the horizontal cross section of the refractory lining is of uneven

thickness so that the axis of the converter chamber defined by the inner face of the refractory lining will be laterally spaced from the lance.

The converter illustrated by FIGURES 1–4, for instance, may be converters capable of holding 50 tons of molten metal. The diameter of the converter chamber when the same is formed with new refractory lining will be 3 meters. In accordance with the invention, the stream of oxygen gas or the like will hit the free surface of the bath of metal at a point which is at least 225 millimeters distant from the center of the surface of the metal bath. The center of the surface of the metal bath is indicated by G, and the point of impact between the surface of the molten metal bath and the stream of gas is indicated by I. Under the given conditions, the distance G–I will be between 225 millimeters and 1125 millimeters. According to FIGURES 1 and 2, axis **1** of the inner face **2** of the refractory lining **3** will pass through the center **4** of outlet opening **5**. The diameter of the outlet opening is 1500 millimeters. Lance **6** extends downwardly in vertical direction and is laterally spaced from axis **1** at a distance of 500 millimeters.

According to FIGURE 3, center **4** of outlet **5** is located at a horizontal distance of 500 millimeters from axis **1** wherein axis **1** again represents the upright axis of the converter chamber defined by the inner surface **2** of refractory lining **3**. Lance **6** extends downwardly in vertical direction passing through the center of outlet **5**. It is a particular advantage of the arrangement of FIGURE 3 according to which the lance passes through the center of the outlet opening, that the danger of attachment of the lance to the top wall of the converter due to spattering molten metal or slag will be substantially avoided due to the fact that the greatest possible distance in all directions is maintained between the lance and the converter wall portion defining outlet **5**.

Contrary to the embodiments illustrated in FIGURES 1–3, according to FIGURE 4, the refractory lining **3** is not of uniform horizontal cross sectional thickness. Nevertheless, the transverse sections of the inner face **2** of lining **3** will represent circles, however, these circles are eccentric with respect to upright axis **7** of the shell or outer face **8** of the converter. The distance between axis **1** of the converter chamber defined by inner face **2** of lining **3** and axis **7** of outer face or shell **8** of the converter equals 300 millimeters. Lance **6** is located in axis **7**. Center **4** of outlet opening **5** is also located in axis **7** of shell **8** so that here again lance **6** passes through the center of opening **5** and, nevertheless, is laterally spaced from the upright axis of the inner converter chamber.

It is noted that while the invention has been described as illustrated in connection with converters having inner converter chambers of circular horizontal cross section, it is of course equally possible to carry out the present invention and to arrange the lance in accordance therewith, when the horizontal cross section of the converter is of other than circular configuration. In any event, it is essential that the upright axis of the inner converter chamber is laterally spaced from the lance through which the treating fluid is blown onto the upper surface of the molten metal, preferably at a distance in the range described further above.

With respect to the embodiment illustrated in FIGURE 4, it is a particular advantage of this arrangement that the wall of the refractory lining which comes nearest to the nozzle and therefore is more exposed to splattering, will also be the thickest portion of the wall. Another advantage is found in the fact that, similarly to the converters of FIGURES 1 and 2, but different from the converter according to FIGURE 3, the outlet opening of the converter is coaxial with the outer face or shell **8** of the converter. Such arrangement facilitates the construction of the converter.

It will be understood that each of the elements described above or two or more together, may also find a useful application in other types of converters differing from the types described above.

While the invention has been illustrated and described as embodied in a converter having an outlet in the top portion thereof, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention, and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed and desired to be secured by Letters Patent is:

1. In a converter arrangement for treating molten metal, in combination, an upright chamber having an inner surface and a central upright axis and adapted to hold molten metal at a predetermined metal level; and a single vertical lance extending downwardly into said chamber and having a stationary vertical axis throughout that portion of its length which is located within said chamber, said lance terminating in said chamber in a downwardly directed orifice located in said stationary vertical axis above said predetermined metal level at a point laterally spaced from said central upright axis in a predetermined horizontal direction at a predetermined distance, said predetermined distance being within the range of between 15 and 75% of the horizontal distance of said inner surface from said central upright axis in said predetermined direction, whereby due to the lateral spacing of said single vertical lance from said axis mass oscillations in the molten metal will be slowed down and spattering of the later will be reduced.

2. In a converter arrangement for treating molten metal, in combination, an upright converter vessel including annular wall means having an outer and an inner annular face said inner and outer annular faces each having a central upright axis, and said inner face defining an upright chamber adapted to hold molten metal at a predetermined metal level; and a single vertical lance extending downwardly into said chamber and having a stationary vertical axis throughout that portion of its length which is located within said chamber, said lance terminating in said chamber in a downwardly directed orifice located in said stationary vertical axis above said predetermined metal level at a point laterally spaced from said central upright axis of said inner annular face in a predetermined horizontal direction at a predetermined distance, said predetermined distance being within the range of between 15 and 75% of the horizontal distance of said inner annular face from said central upright axis thereof in said predetermined direction, whereby due to the lateral spacing of said single vertical lance from said axis mass oscillations in the molten metal will be slowed down and spattering of the latter will be reduced.

3. In a converter arrangement for treating molten metal, in combination, an upright converter vessel including annular wall means having an outer and an inner annular face said inner and outer annular faces having coextensive central upright axes, and said inner face defining an upright chamber adapted to hold molten metal at a predetermined metal level; and a single vertical lance extending downwardly into said chamber and having a stationary vertical axis throughout that portion of its length which is located within said chamber, said lance terminating in said chamber in a downwardly directed orifice located in said stationary vertical axis above said predetermined metal level at a point laterally spaced from said central upright axis of said inner annular face in a predetermined horizontal direction at a predetermined dis-

tance, said predetermined distance being within the range of between 15 and 75% of the horizontal distance of said inner annular face from said central upright axis thereof in said predetermined direction, whereby due to the lateral spacing of said single vertical lance from said axis mass oscillations in the molten metal will be slowed down and spattering of the latter will be reduced.

4. A converter arrangement according to claim 2 wherein said central axes of said inner and outer annular faces are laterally spaced from each other.

5. In a converter arrangement for treating molten metal, in combination, a converter vessel including a bottom portion, a top portion and annular wall means interposed between and in contact with said top and bottom portions, said annular wall means having an outer and an inner annular face and each of said annular faces having a central upright axis, said inner annular face defining in said converter vessel an upright chamber adapted to hold molten metal at a predetermined metal level; and a single vertical lance extending downwardly into said upright chamber and having a stationary vertical axis throughout that portion of its length which is located within said chamber, said lance terminating in said chamber in a downwardly directed orifice located in said stationary vertical axis above said predetermined metal level at a point laterally spaced from said central upright axis of said inner annular face in a predetermined horizontal direction at a predetermined distance, said predetermined distance being within the range of between 15 and 75% of the horizontal distance of said inner annular face from its central upright axis in said predetermined direction, whereby due to the lateral spacing of said single vertical lance from said axis mass oscillations in the molten metal will be slowed down and spattering of the latter will be reduced.

6. In a converter arrangement for treating molten metal, in combination, a converter vessel including a bottom portion, a top portion formed with an opening therethrough and annular wall means interposed between and in contact with said top and bottom portions, said annular wall means having an outer and an inner annular face and said annular faces having central upright axes laterally spaced from each other, said inner annular face defining in said converter vessel an upright chamber adapted to hold molten metal at a predetermined metal level; and a single vertical lance extending downwardly through the center of said opening into said upright chamber and having a stationary vertical axis throughout that portion of its length which is located within said chamber, said lance terminating in said chamber in a downwardly directed orifice located in said stationary vertical axis above said predetermined metal level at a point laterally spaced from said central upright axis of said inner annular face in a predetermined horizontal direction at a predetermined distance, said predetermined distance being within the range of between 15 and 75% of the horizontal distance of said inner annular face from its central upright axis in said predetermined direction, whereby due to the lateral spacing of said single vertical lance from said axis mass oscillations in the molten metal will be slowed down and spattering of the latter will be reduced.

7. In a converter arrangement for treating molten metal, in combination, a converter vessel including a bottom portion, a top portion formed with an opening therethrough and annular wall means interposed between and in contact with said top and bottom portions, said annular wall means having an outer and an inner annular face and said annular faces having central upright axes laterally spaced from each other, said inner annular face defining in said converter vessel an upright chamber adapted to hold molten metal at a predetermined metal level; and a single vertical lance extending downwardly through the center of said opening into said upright chamber coaxial with said outer annular face and having a stationary vertical axis throughout that portion of its length which is located within said chamber, said lance terminating in said upright chamber in a downwardly directed orifice located in said stationary vertical axis above said predetermined metal lever at a point laterally spaced from said central upright axis of said inner annular face in a predetermined horizontal direction at a predetermined distance, said predetermined distance being within the range of between 15 and 75% of the horizontal distance of said inner annular face from its central upright axis in said predetermined direction, whereby due to the lateral spacing of said single vertical lance from said axis mass oscillations in the molten metal will be slowed down and spattering of the latter will be reduced.

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