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(54) **Crucible for the treatment of molten metal and process for the manufacture thereof**

(57) The present invention relates to a refractory crucible (1) for the treatment of molten metal comprising side wall(s) (11) having an inner surface (12) and an outer surface and a bottom wall (13), the crucible having gas diffusing means (2) arranged near the bottom of the crucible and gas supply means (3) for conveying a gas from a gas source to the gas diffusing means (2). This crucible is characterized in that the gas supply means (3) is fixedly arranged adjacent to the inner surface (12) of the side wall (11) or within the side wall (11).

The crucible according to the invention (i) is safer than a crucible with a hole in the bottom wall; indeed, the gas supply means being fixedly arranged adjacent to the inner surface of the side wall or within the side wall, there is no need for a hole in the bottom wall; (ii) that possesses the advantage of a gas diffusing means performing its gas diffusing action from the bottom of the crucible; (iii) does not require the immediate termination of the operation when the purge plug or block is wom or has been damaged; (iv) allows easy displacement of the crucible when required since there is no particular connection with a gas supply means or rigging or support system to take into account; (v) does not require particular adaptation of the furnace; (vi) is reliable; (vii) does not require expensive and cumbersome rigging or support system.

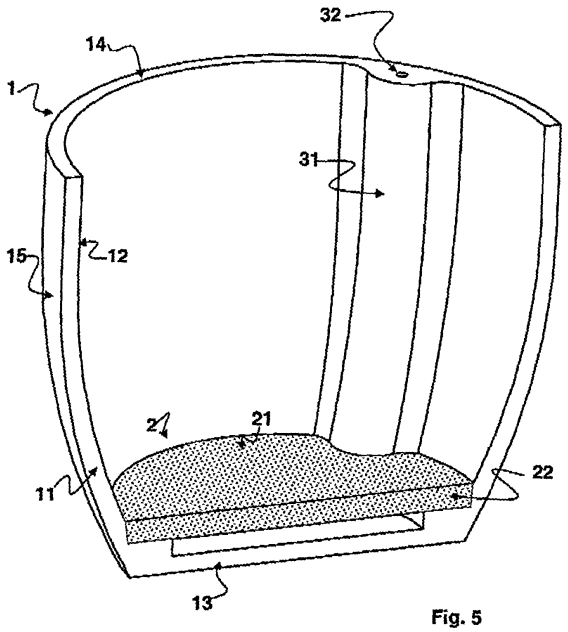

Fig. 5

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Description

[0001] Description.

[0002] The present invention relates to a vessel for the treatment of molten metal and to a process for the manufacture thereof. More particularly, the invention relates to a vessel for gas treatment of a molten metal.

[0003] Gases are often injected into molten metal in vessels such as ladles, crucibles or tundishes for diverse purposes. For instance, a gas may be introduced into the bottom part of a vessel to clear the relatively cool bottom area of solidification products, e.g. to remove them from the vicinity of a bottom pour outlet where the vessel has such an outlet. In steel making for example, the use of slow injection of a fine curtain of gas bubbles in the tundish assists in inclusion removal; the inclusions being attracted to the fine gas bubbles and rising upwards through the melt to the surface where they are conventionally captured by the tundish cover powder or flux. Gas may also be introduced for rinsing or to homogenise the melt thermally or compositionally, or to assist in dispersing alloying additions throughout the melt.

[0004] Usually, an inert gas is used but reactive gases may also be employed, e.g. reducing or oxidising gases, when the melt compositions or components thereof needs modifying. For example, it is customary to inject gases such as nitrogen, chlorine, freon, sulphur hexafluoride, argon, and the like into molten metal, for example molten aluminium or aluminium alloys, in order to remove undesirable constituents such as hydrogen gas, non-metallic inclusions and alkali metals. The reactive gases added to the molten metal chemically react with the undesired constituents to convert them into a form such as a precipitate, a dross or an insoluble gas compound that can be readily separated from the remainder of the melt. These gases (or others) might also be used for example with steel, copper, iron, magnesium or alloys thereof.

[0005] In order to efficiently carry out a gas injection operation, it is desirable that the gas be introduced into the molten metal, preferably from the bottom of the recipient, in the form of a very large number of extremely small bubbles. As the size of gas bubbles decreases, the number of bubbles per unit volume increases. An increase in the number of bubbles and their surface area per unit volume increases the probability of the injected gas being utilised effectively to perform the expected operation.

[0006] Document FR-A1-2,671,563 and JP-A-2000-45010 disclose crucibles for the treatment of molten metal according to the preamble of claim 1. These crucibles are provided with a porous block or plug extending through the bottom wall of the crucible. The treatment gas is injected into the molten metal from the bottom of the crucible and achieves efficiently its treatment purpose. However, such kind of arrangement is problematic for the following reasons.

i) The hole in the bottom wall of the crucible which is required for the insertion of the porous plug or block represents a significant source of danger. Molten metal infiltration through the joint between the crucible bottom wall and the porous plug are possible if the joint has not been set properly or if, for whatever reason, the joint has become deteriorated during use of the crucible.

(ii) In addition, the erosion of the porous plug or block can also represent a significant source of molten metal leakage if particular and expensive measures are not taken. Consequently, even though the crucible is still in perfect shape, if some wear of the purge plug of block has been detected, it is necessary to stop the operation and to replace the purge plug of block, resulting in loss of time and production.

(iii) The presence of the purge plug or block extending through the bottom wall of the crucible and particularly of its gas supply line, makes it also difficult to move the crucible when it is fully loaded with molten metal. (iv) Further, the furnace where the crucible is to be used must be specially adapted to accommodate the purge plug or block extending through the bottom wall of the crucible and particularly of its gas supply line.

[0007] As an altemative to these crucibles provided with a purge plug or block extending through the bottom wall of the crucible, it is also possible to use gas treatment means plunging directly into the molten metal bath through the surface of the molten metal bath. Gas lancing or rotary degassers are examples of this technique. While solving some of the above mentioned problems, these arrangements are still problematic for the following reasons. (i) Since the gas treatment is not performed from the bottom surface of the crucible, there remains a zone of the molten metal bath which is never in contact with the gas and the treatment is not perfectly efficient. (ii) Techniques involving a mobile lance are often not reliable since the positioning of the lance may largely vary from one melt to the next. (iii) Altemately, techniques involving a fixed gas diffusing means such as a rotary degasser require a rigging or support system for the gas diffusing means which makes it uneasy to move the crucible and require a particular adaptation of the furnace where the crucible is to be used to accommodate this support or rigging system.

[0008] The object of the present invention is therefore to provide a crucible for the treatment of a molten metal which would not present the inconveniences of the prior art crucibles. In particular, it would be desirable to provide a crucible (i) that would be safer than a crucible with a hole in the bottom wall; (ii) that would possess the advantage of a gas diffusing means performing its gas diffusing action from the bottom of the crucible; (iii) that would not require the immediate termination of the operation when the purge plug or block is wom or has been damaged; i.e. that would allow to pursue the operations even with a reduced ability to diffuse gas into the molten

metal; (iv) that would allow easy displacement of the crucible when required; (v) that would not require particular adaptation of the furnace to accommodate bottom diffusing means or some rigging/support system; (vi) that would be reliable; (vii) that would not require expensive and cumbersome rigging or support system.

[0009] This objective is reached with a crucible as defined in claim 1.

[0010] Indeed, it has been found that a refractory crucible for the treatment of molten metal comprising side wall(s) having an inner surface and an outer surface and a bottom wall, the crucible having gas diffusing means arranged near the bottom of the crucible and gas supply means for conveying a gas from a gas source to the gas diffusing means, wherein the gas supply means is fixedly arranged adjacent to the inner surface of the side wall or within the side wall solves the above mentioned problems.

[0011] First, it is to be noted that the crucible according to the invention can have any conventional shape; i.e. it can be polygonal, for example square or rectangular (trough-shaped) with a plurality of side walls or more conventionally, rounded with a circular single wall. By "adjacent to the inner surface of the side wall or within the side wall", it is meant that the gas supply means does not extend through the bottom surface of the crucible. However, it would not be excluded to have the gas supply means extending thorough a region of the side wall which is normally not in contact with molten metal; i.e. which is above the normal level of molten metal, for example near the upper surface of the crucible.

[0012] The crucible according to the invention can be a crucible used for the processing of metal, including melting and/or treating the metal or it can be a crucible which is temporary used, for example for treating, transporting or pouring the molten metal.

[0013] The crucible according to the invention (i) is safer than a crucible with a hole in the bottom wall; indeed, the gas supply means being fixedly arranged adjacent to the inner surface of the side wall or within the side wall, there is no need for a hole in the bottom wall; (ii) possesses the advantage of a gas diffusing means performing its gas diffusing action from the bottom of the crucible; (iii) does not require the immediate termination of the operation when the purge plug or block is wom or has been damaged since there is no risk of leakage through the gas diffusing means; (iv) allows easy displacement of the crucible when required since there is no complicated connection with a gas supply means or rigging or support system to take into account; (v) does not require particular adaptation of the furnace; (vi) is reliable; (vii) does not require expensive and cumbersome rigging or support system.

[0014] The connection of the gas supply means to a gas source can be performed by any known technique. For example, advantage can be taken from the particularly useful gas-tight connection system as disclosed in WO-A1-2004/069451.

[0015] Advantageously, the gas supply means comprises a duct fixedly arranged adjacent to the inner surface of the side wall. Preferably, this duct is made of refractory material, preferably of the same refractory material as the crucible. The duct can advantageously be formed by an inward protrusion extending from the inner surface of the side wall. It can be made integral with the crucible or formed separately and then glued or cemented into place. Such a protrusion can be shaped manually or mechanically from soft material such as clay graphite or other ceramic and/or metal or can be copressed together with the crucible.

[0016] The gas supply means might also comprise an inlet orifice arranged in the upper surface of the crucible or in the outer surface of the crucible side wall at a level which is higher than the maximum level of the molten metal.

[0017] The gas diffusing means comprises advantageously a porous refractory plug or brick for injecting gas into molten metal through a molten metal-contacting surface with a porous refractory body substantially encased in a refractory substantially non-porous body except at the molten metal-contacting surface.

[0018] According to one embodiment of the present invention, the non-porous bodies is constituted from the crucible wall itself and the porous and non porous bodies have been co-pressed.

[0019] According to another embodiment, the porous and non porous bodies form a monobloc entity which is manufactured separately and then fixedly attached at the bottom of the crucible. The document WO-A1-02/074470 discloses a purge plug or bubbling block particularly suitable for use in a crucible according to the invention.

[0020] According to another of its aspects, the present invention also relates to a process for the manufacture of a crucible which comprise the steps of

a) forming the crucible,
b) forming the gas supply means adjacent to the inner surface of the side wall or within the side wall, and
c) arranging the gas diffusing means at the bottom of the crucible.

[0021] Advantageously, steps a), b) and c) are carried out at once, for example by isostatic pressing. Altemately, the gas diffusing means can be formed separately and then fixedly arranged near the bottom of the crucible. The voids present in the gas supply means (plenum chamber under the porous body for example or the gas passage bore in the duct can be produced according to known and conventional techniques (wax, combustible material, low melting point metal or metal alloys,...).

[0022] In order to enable a better understanding of the invention, it will now be described with reference to the figures illustrating particular embodiments of the invention, without however limiting the invention in any way.

[0023] Figs. 1 and 3 show cut view of two embodiments of crucibles according to the invention (cut in the middle

in a vertical plane);

Figs. 2 and 4 are top views of the crucible of Figs. 1 and 3 respectively;
Fig. 5 is a perspective view of a cut of the crucible of Figs. 2 and 4.

[0024] On these Figs., crucibles have been represented with the reference '1. Each of these crucibles has a bottom wall 13 and a side wall 11 with an inner surface 12, an outer surface 15 and a top surface 14. The gas diffusing means 2 has a molten metal contacting surface 21 and a porous body 22 encased in a substantially non-porous (tight) body. This non porous body can be the crucible itself (Figs. 3, 4, 5) or a separate body 23 fixedly attached at the bottom 13 of the crucible (Figs. 1 and 2).
[0025] The gas supplying means 3 are formed of a duct 31 extending from an orifice 32 at the top surface 14 of the wall 11 to the gas diffusing means 2. This duct can be a protrusion formed adjacent to the inner surface 12 of the wall as depicted on Figs. 1 to 5 or can be formed directly within the wall.

Claims

1. Refractory crucible (1) for the treatment of molten metal comprising side wall(s) (11) having an inner surface (12) and an outer surface and a bottom wall (13), the crucible having gas diffusing means (2) arranged near the bottom of the crucible and gas supply means (3) for conveying a gas from a gas source to the gas diffusing means (2), **characterized in that** the gas supply means (3) is fixedly arranged adjacent to the inner surface (12) of the side wall (11) or within the side wall (11).

2. Refractory crucible (1) according to claim 1, **characterized in that** the gas supply means (3) comprises in a duct (31) fixedly arranged adjacent to the inner surface (12) of the side wall (11).

3. Refractory crucible (1) according to claim 2, **characterized in that** the duct (31) is made of refractory material, preferably of the same refractory material as the crucible (1).

4. Refractory crucible (1) according to claim 3, **characterized in that** the duct (31) is formed by an inward protrusion extending from the inner surface (12) of the side wall (11).

5. Refractory crucible (1) according to claim 4, **characterized in that** the duct (31) is made integral with the crucible side wall (11).

6. Refractory crucible according to any one of claims 1 to 5, **characterized in that** the gas supply means (3) comprises an inlet orifice (32) arranged in the upper surface (14) of the crucible or in the outer surface (15) of the crucible side wall (11) at a level which is higher than the maximum level of the molten metal.

7. Refractory crucible (1) according to any one of claims 1 to 6, **characterized in that** the gas diffusing means (2) comprises a porous refractory plug or brick for injecting gas into molten metal through a molten metal-contacting surface (21) with a porous refractory body (22) substantially encased in a refractory substantially non-porous body (1,23) except at the molten metal-contacting surface (21).

8. Refractory crucible (1) according to claim 7, **characterized in that** the porous and non-porous bodies (22,23 or 1) have been co-pressed.

9. Refractory crucible (1) according to claim 7, **characterized in that** the porous and non porous bodies (22,23) form a monobloc entity which is fixedly attached at the bottom of the crucible.

10. Process for the manufacture of a crucible (1) comprising the steps of

    a) forming the crucible (1),
    b) forming the gas supply means (3) adjacent to the inner surface (12) of the side wall (11) or within the side wall (11),
    c) arranging the gas diffusing means (3) at the bottom of the crucible.

11. Process according to claim 10, **characterized in that** steps a), b) and c) are carried out at once by isostatic pressing.

12. Process according to claim 10, **characterized in that** the gas diffusing means (3) are formed separately and then fixedly arranged near the bottom of the crucible.

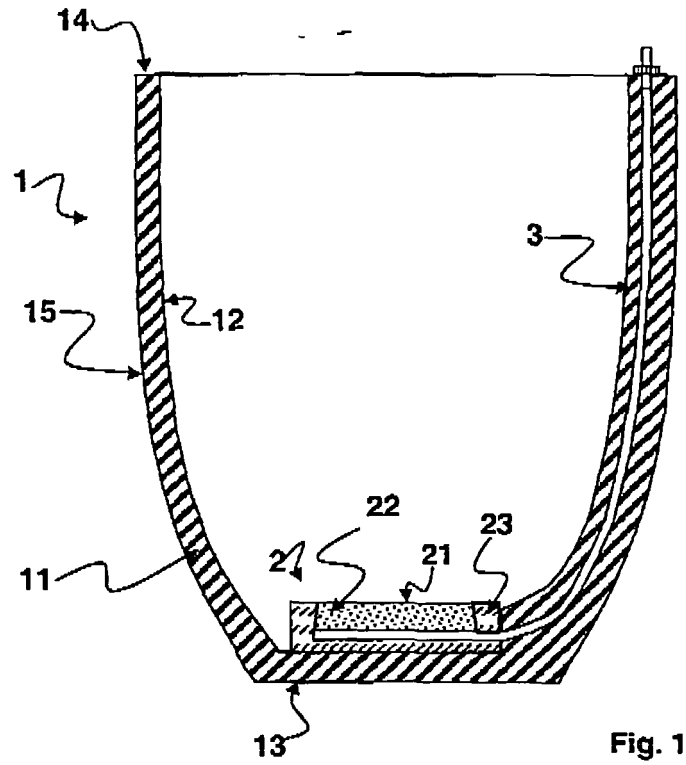

Fig. 1

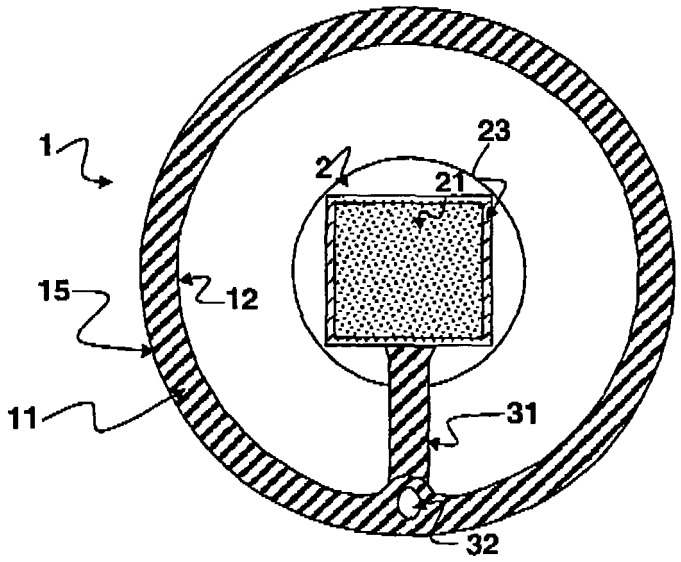

Fig. 2

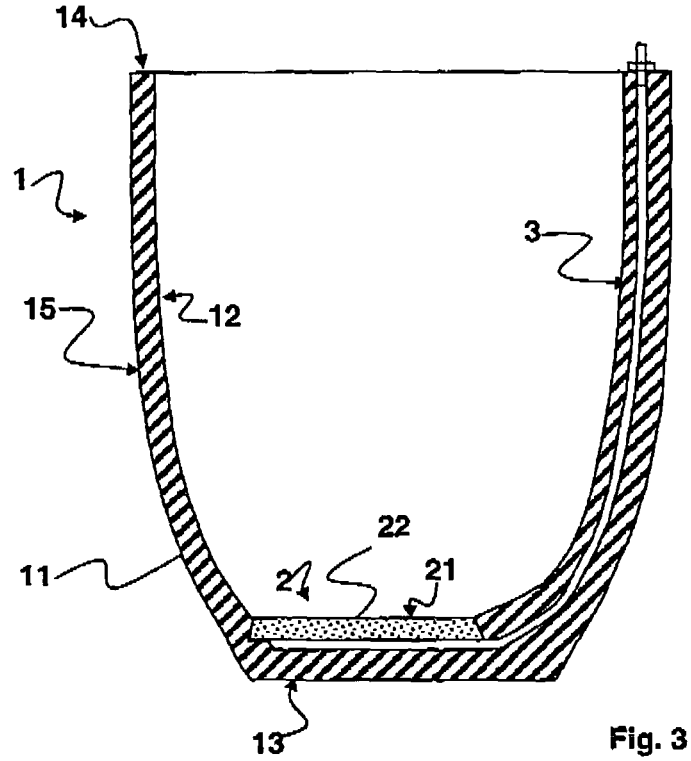

Fig. 3

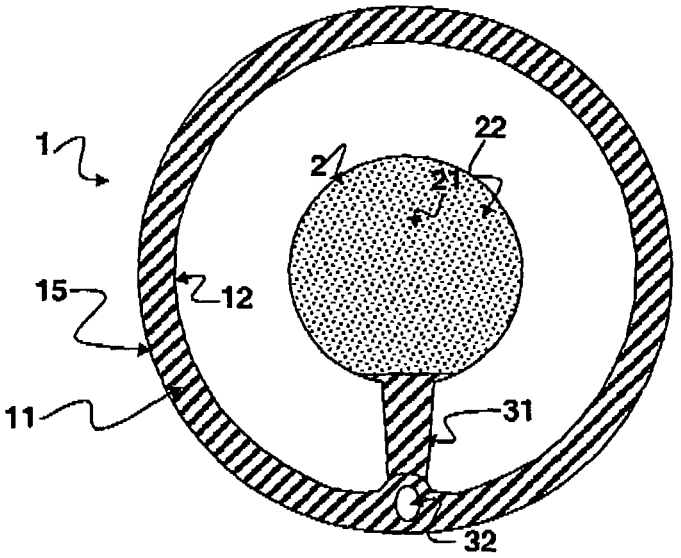

Fig. 4

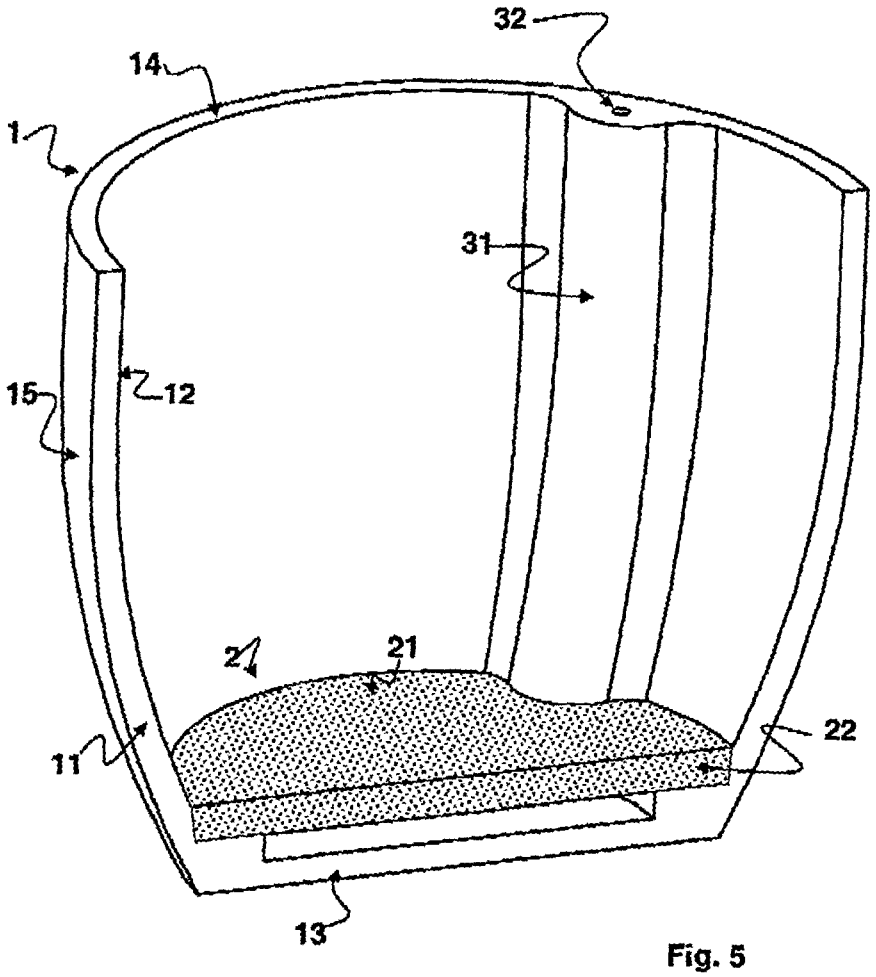

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 07 6814

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X	US 5 219 514 A (BLOSTEIN ET AL) 15 June 1993 (1993-06-15) * column 1, line 5 - line 8 * * column 1, line 55 - line 68 * * column 2, line 40 - column 3, line 9 * * figures 1-4 *	1-12	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 December 2005	Peis, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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