(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 470 149 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
17.04.2019 Bulletin 2019/16

(21) Application number: **16904744.6**

(22) Date of filing: **24.11.2016**

(51) Int Cl.:
B22D 11/103 (2006.01) ***B22D 11/11*** (2006.01)
B22D 41/00 (2006.01) ***B22D 1/00*** (2006.01)
B22D 11/10 (2006.01) ***B22D 11/117*** (2006.01)
B22D 11/118 (2006.01)

(86) International application number:
PCT/KR2016/013628

(87) International publication number:
WO 2017/213311 (14.12.2017 Gazette 2017/50)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **08.06.2016 KR 20160071229**

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(54) **MELT TREATING APPARATUS AND MELT TREATING METHOD**

(57) The present disclosure provides a melt treating apparatus and a melt treating method applied to the same, comprising: a container is provided with a melt injection unit at the top thereof, and having a hole defined in a bottom thereof; a guide member spaced from the melt injection unit, wherein the guide member is disposed between the hole and the melt injection unit; and a chamber mounted on the top of the container so as to extend in a width direction, wherein the chamber has an inner space and an open bottom, and face away the guide member and the gas injection unit. The melt treating apparatus and the melt treating method applied to the same may effectively remove an inclusion by generating rotational flow of the melt using the guide member and the gas injection unit in the melt treatment, and using the rotational flow.

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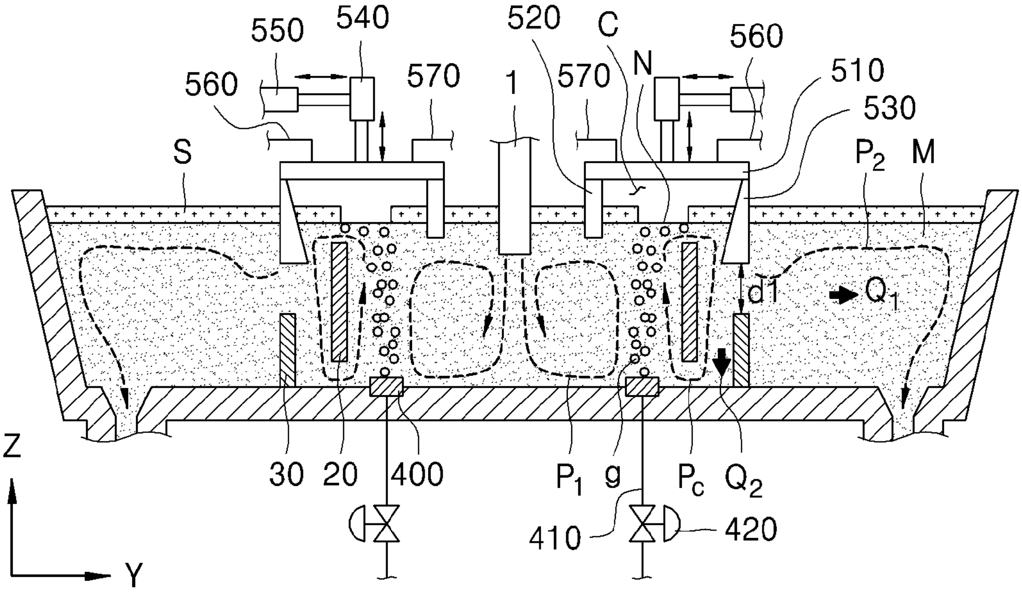
[도3]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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a melt treating apparatus, and a melt treating method. More specifically, the present disclosure relates to a melt treating apparatus capable of effectively removing inclusion, and a melt treating method using the same.

BACKGROUND

[0002] A continuous casting method is superior to a conventional ingot making method in quality uniformity and recovery in steelmaking field. Therefore, many researches and developments have been made on an operation facility and technique, and the like of the continuous casting method. As a result, almost all steel types, including a high alloy steel except a few special applications, may be produced by the continuous casting method. An operation facility for this continuous casting method includes a continuous casting facility.

[0003] The continuous casting facility is a facility for manufacturing a slab with refined molten steel supplied from a steelmaking facility. The continuous casting facility consists of a ladle configured for carrying molten steel, a tundish configured for temporarily storing the molten steel supplied form the ladle, a mold configured for continuously receiving the molten steel from the ladle, and primarily solidifying the molten steel into a slab, and a cooling bed configured for secondarily cooling the slab continuously withdrawn from the mold, and performing a series of molding operations.

[0004] As the molten steel is received in the tundish and remains for a predetermined time, inclusion is floated up and separated. Thus, the slag is stabilized, and reoxidation is prevented. The molten steel is then supplied to the mold, and forms an initial solidification layer in a shape of the slab. At this time, a surface quality of the slab is determined.

[0005] That is, a degree of the surface quality of the slab in the mold is determined by a cleanliness relevant to the inclusion in the molten steel. For example, when the clean degree of the molten steel relevant to the inclusion is low, the inclusion itself may cause defects on the slab surface, or the inclusion may block a submerged entry nozzle, and cause problems in flow of the molten steel. Therefore, the surface quality of the slab may be degraded.

[0006] In the molten steel, the degree of the cleanliness relevant to the inclusion varies considerably depending on a degree of the floatation of the inclusion while the inclusion stays in the tundish for a determined period of time. The degree of the floatation of the inclusion is proportional to the time the molten steel remains in the tundish.

[0007] Therefore, conventionally, as a method for prolonging the retention time of the molten steel in the tundish, the retention time of the molten steel has been controlled by controlling the flow of the molten steel by building a dam or a weir in the tundish.

[0008] However, when a size of the inclusion in the molten steel is less than or equal to 30 μm, a time required for the inclusion to float is longer than a time the molten steel stays in the tundish. For this reason, the inclusion size of 30 μm or less is difficult to remove using the dam and the weir of the tundish.

(Patent Document 1) KR10-2013-0076187 A
(Patent Document 2) KR10-2015-0073449 A

DISCLOSURE

TECHNICAL PURPOSE

[0009] The present disclosure provides a melt treating apparatus and a melt treating method that may effectively remove inclusion by injecting gas into a container containing the melt.

[0010] The present disclosure provides a melt treating apparatus and a melt treating method that may effectively remove inclusion by generating rotational flow of melt with gas injected into a container containing the melt.

[0011] The present disclosure provides a melt treating apparatus and a melt treating method that may effectively remove inclusion by controlling a flow direction and the number of revolutions of rotational flow generated inside a container containing the melt.

[0012] The present disclosure provides a melt treating apparatus and a melt treating method that may effectively prevent naked molten metal surface formed on the melt by rotational flow of the melt contained in a container from contacting the atmosphere.

TECHNICAL SOLUTION

[0013] A melt treating apparatus according to the embodiment of the present disclosure comprises: a container having an inner space and an open top, is provided with a melt injection unit at the top thereof, and having a hole defined in at least a portion of a bottom thereof; a guide member spaced from the melt injection unit, wherein the guide member is disposed between the hole and the melt injection unit; and gas injection unit spaced from the guide member, wherein the gas injection unit is disposed between the melt injection unit and the guide member, wherein the gas injection unit is installed at the bottom of the container.

[0014] The guide member may include a first member spaced from the melt injection unit, wherein the first member is disposed between the hole and the melt injection unit, wherein the first member is extended in a width direction, and wherein the first member is spaced apart from the bottom of the container and installed on both length-directional sidewalls of the container.

[0015] The guide member may include a second member spaced from the first member, wherein the second member is disposed between the hole and the first member, wherein the second member is extended in the width direction, wherein the second member contacts the bottom of the container, and is installed on both length-directional sidewalls of the container.

[0016] The gas injection unit may be spaced from the first member, wherein the gas injection unit is disposed between the melt injection unit and the first member, or between the first and second members.

[0017] A chamber mounted on the top of the container so as to extend in a width direction may be included. The chamber has an inner space and an open bottom, and facing the guide member and the gas injection unit.

[0018] The gas injection unit may include: a block mounted on the bottom of the container, and having a slit defined in a top face thereof; gas injection pipe penetrating the container and communicating with the slit defined in the top face of the block; and a control valve mounted on the gas injection pipe for controlling an opening degree and an opening and closing manner of the gas injection pipe.

[0019] The chamber may include: a lid portion extending in the width direction; wall portions extending in the width direction, and respectively mounted on a bottom face of the lid portion, wherein the wall portions are spaced apart from each other and are disposed in both regions opposing in a longitudinal direction, wherein the first member is centered between the wall portions, wherein the wall portions contact or are spaced from both length-directional sidewalls of the container; and flanges extending in the longitudinal direction, and respectively mounted on both width- directional edges of the lid portion to connecting both of the wall portions.

[0020] Each of the wall portions may include: a first wall portion spaced apart from the gas injection unit and disposed between the melt injection unit and the gas injection unit; and a second wall portion spaced from and disposed above the second member.

[0021] A bottom face of the first wall portion may be positioned higher than a top face of the first member, wherein the bottom face of the first wall portion is immersible into the melt injected into the container. A bottom face of the second wall portion may be positioned lower than a top face of the first member, and is immersible into the melt injected into the container.

[0022] At least one of a supply pipe formed to be capable of supplying gas, and communicating with the inner space of the chamber by passing through the chamber, and an exhaust pipe formed to be capable of exhausting gas, and communicating with the inner space of the chamber by passing through the chamber may be included. At least one of a first actuation unit for supporting the chamber in an ascending or descending manner, and for adjusting a vertical level of the chamber depending on a vertical level of a top face of the melt injected into the container, and a second actuation unit for supporting the chamber in a slidable manner, and for adjusting a position of the chamber in a longitudinal direction depending on a formation position of a naked molten metal surface of the melt injected into the container may be included.

[0023] The melt injection unit may be formed to allow molten steel to pass therethrough, and may be detachably mounted on a ladle of a continuous casting facility. Gas injected into the container through the gas injection unit may include an inert gas.

[0024] A melt treating method according to the embodiment of the present disclosure includes: preparing a container, the container having an inner space and an open top, is provided with a melt injection unit at the top thereof, and having a hole defined in at least a portion of a bottom thereof, and having a guide member between the hole and the melt injection unit; injecting melt into the container; flooding the melt over the guide member; and generating rotational flow of the melt by injecting gas through a gas injection unit into between the guide member and the melt injection unit in the container.

[0025] Forming an inert atmosphere or a vacuum atmosphere in a region surrounding a formation position of a naked molten metal surface of melt via gas injected into the container using the chamber may be included.

[0026] The generating of the rotational flow may include controlling each of flux of melt flooding over the guide member and flowing toward the hole, and flux of melt flooding over the guide member and flowing toward the gas injection unit by adjusting an immerse vertical level of the chamber relative to the melt.

[0027] The melt may include molten steel, and the gas may include an inert gas.

ADVANTAGEOUS EFFECTS

[0028] According to the embodiment of the present disclosure, the inclusion may be effectively removed in a manner of injecting the gas into the container containing the melt, and contacting the melt with the inclusion. In addition, the inclusion may be effectively removed in a manner of increasing a contact frequency of inclusion and the gas by generating the rotational flow of the melt with the gas injected into the container containing the melt. In addition, the inclusion may be effectively removed in a manner of increasing the contact frequency of the inclusion and the gas by controlling the flow direction and the number of rotations of the rotational flow generated inside the container containing the melt.

[0029] Further, according to the embodiment of the present disclosure, the naked molten metal surface formed on the melt due to the rotational flow of the melt contained in the container is effectively prevented from contacting the air such that re-oxidation and contamination of the melt is effectively prevented.

[0030] For example, when the embodiment of the present disclosure is applied to a continuous casting process of a steel mill, the inclusion may be effectively removed in a manner of injecting argon gas into the tundish containing refined molten steel to form a large number of bubbles, and collecting various inclusions such as Al_2O_3 and SiO_2. Further, rotational flow of the molten steel may be generated, and the flow direction and the number of rotations of the rotational flow may be controlled by setting an injection position of argon gas relevant to the dam and the weir mounted inside the tundish to a predetermined position, and by injecting the gas into the tundish. Using this, a contact frequency of a micro inclusion, especially a micro inclusion of 30 μm or less with respect to an argon gas or a bubble of the argon gas may be increased such that the micro inclusion may be more effectively removed.

[0031] Further, the naked molten metal surface of the molten steel may be prevented from contacting the air by preparing the chamber at a region where the naked molten metal surface of the molten steel is formed by the rotational flow of the melt, then immersing the lower portion of the chamber to surround the naked molten metal surface, and then injecting the inert gas into the chamber. Using this, re-oxidation and contamination of molten steel may be effectively prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032]

FIG. 1 is a schematic diagram of a melt treating apparatus according to an embodiment of the present disclosure.

FIG. 2 is a top view of a melt treating apparatus according to an embodiment of the present disclosure.

FIG. 3 is a cross-sectional view of a melt treating apparatus according to an embodiment of the present disclosure.

FIG. 4 is a state diagram illustrating a method for removing inclusion according to an embodiment of the present disclosure.

FIG. 5 shows inclusion removal process and result according to an embodiment of the present disclosure.

FIG. 6 is a graphical representation of a structure of a melt treating apparatus for flow analysis of melt according to an embodiment of the present disclosure.

FIG. 7 shows a result of flow analysis of melt according to an embodiment of the present disclosure.

FIG. 8 is a partial view of a melt treating apparatus according to an embodiment and variations of the present disclosure.

FIG. 9 is a schematic diagram of a melt treating apparatus according to a comparative example of the present disclosure.

FIG. 10 shows a result of a melt treatment according to a comparative example of the present disclosure.

DETAILED DSCRIPTION

[0033] Hereinafter, embodiment of the present disclosure will be described in detail with reference to the accompanying drawings. However, the present disclosure is not limited to the embodiment disclosed below, but may be embodied in various different forms. The embodiment of the present disclosure is provided to only make the disclosure of the present disclosure complete and fully inform those skilled in the art to which the present disclosure pertains of the scope of the present disclosure. The relative proportions and ratios of elements in the drawings may be exaggerated in size to illustrate the embodiment of the present disclosure. In addition, the same reference numerals denote the same elements throughout the specification.

[0034] Among the terms used to describe the embodiment of the present disclosure, 'upper' and 'lower' are used to refer to upper and lower portions, respectively, as a part of a component. In addition, 'above' and 'below' are used to refer to a range in which a component or force directly or indirectly touches or acts on a top and bottom of another component.

[0035] The present disclosure relates to a melt treating apparatus and a melt treating method by which, in supplying and treating melt to and in a subsequent facility while the melt is being received and maintained for a predetermined time, an inclusion may be effectively removed from the melt. Hereinafter, the embodiment will be described in detail in accordance with a continuous casting facility and process of steelworks. However, the present disclosure may be applied to various facilities and processes in various industries that treat various types of melt.

[0036] FIG. 1 is a schematic diagram of a melt treating apparatus according to an embodiment of the present disclosure. FIG. 2 is a top view of a melt treating apparatus according to an embodiment of the present disclosure. In addition, FIG. 3 is a cross-sectional view of a melt treating apparatus according to an embodiment of the present disclosure. FIG. 4 is a state diagram illustrating a method for removing inclusion according to an embodiment of the present disclosure.

[0037] With reference to FIG. 1 to FIG. 3, the melt treating apparatus according to an embodiment of the present disclosure includes a container 10 having an inner space and an open top, the container is provided with a melt injection unit 1 at a top thereof, and a hole 14 defined in at least a portion of a bottom 13, a guide member installed apart from the melt injection unit 1 toward the hole 14 side, gas injection unit 400 installed on the bottom 13, and spaced from the guide member toward the melt injection unit 1 side. In addition, the melt treating apparatus according to an embodiment of the present disclosure may include a chamber 500 extending in a width direction (X) and having an inner space and an open bottom. Further, the chamber 500 is installed on the top of the container 10 so as to facing the guide member and the gas injection unit 400. In one example, a plurality of the guide members, a plurality of the gas injection units 400, the plurality of chambers 500, and a plurality of the holes 14 may be provided. Both guide members. both gas injection units 400, both chambers 500, and both holes 14 may be respectively disposed on both regions opposing in a longitudinal direction (Y) with respect to the melt injection unit 1.

[0038] Melt (M) may include molten steel. The molten steel may be provided after refined at a steelmaking facility. Alternatively, the molten steel may be carried in the container 10, for example, in a ladle (not shown) of a continuous casting facility, to above the container 10.

[0039] The melt injection unit 1 may be a hollow refractory nozzle formed to allow the molten steel to pass through. The melt injection unit 1 may include a shroud nozzle. The melt injection unit 1 may be mounted and supported to a manipulator provided outside the container 10. As the manipulator (not shown) rises, the melt injection unit 1 may be coupled to a collector nozzle of the ladle, and communicate with the inner space of the ladle. The melt injection unit 1 may be positioned a predetermined distance apart from the bottom 13 of the container 10. A lower portion of the melt injection unit 1 may be immersed in the melt (M) as the melt (M) is injected into the container 10.

[0040] In one example, gas (g) injected into the container 10 by the gas injection unit 400 may contain an inert gas. The inert gas may contain argon gas (Ar).

[0041] The container 10 may includes the bottom 13 and a side wall portion protruding from a periphery of the bottom 13. The container 10 may be formed in a shape of a container whose inner space is opened upward. In this connection, the sidewall portion may include a pair of sidewalls 12 in a longitudinal direction, and a pair of sidewalls 11 in a widthwise direction. The container 10 may maintain its shape by forming an outer face thereof with, for example, steel shell, and a refractory may be employed on an inner face to accommodate the melt (M). The container 10 may include a tundish of a continuous casting facility.

[0042] The container 10 may be formed into a rectangular shape symmetrical with respect to a center of the longitudinal direction (Y) and the width direction (X). In this connection, the container 10 may have a width in the longitudinal direction (Y) that is greater than a width in the width direction (X). In one example, the melt injection unit 1 may be provided at the top of the container 10. In this connection, the melt injection unit 1 may be vertically aligned in the center of the longitudinal direction (Y) and the width direction (X) of the container 10.

[0043] The hole 14 may be defined in at least a portion of the bottom 13 of the container 10. A plurality of holes 14 may be provided. The plurality of holes 14 may be spaced apart from each other in the longitudinal direction (Y), and defined vertically through both width- directional edges of the bottom 13 in the vicinity of the pair of sidewalls 11. The hole 14 may be bilaterally symmetrical in the center of the longitudinal direction (Y) and the width direction (X) of the container 10. The melt (M) accommodated in the container 10 may be discharged to below the container 10 through the hole 14. The hole 14 may be equipped with a gate 60.

[0044] The guide member may include a first member 20, and a second member 30. In addition, the guide member may be spaced from the melt injection unit 1 toward the hole 14. In this connection, the guide member may include only the first member 20, or may include both the first member 20 and the second member 30. That is, the guide member may include at least the first member 20. The first member 20 and the second member 30 may employ a refractory. When the melt (M) is received in the container 10 up to a desired level, for example a molten steel level in a normal state of a middle stage of the continuous casting operation, the first member 20 and the second member 30 may control flow of the melt (M) in a state of being immersed in the melt (M).

[0045] The first member 20 may be provided to control the flow of the melt (M) injected into the container 10. The first member 20 may be spaced from the melt injection unit 1 toward the hole 14, and extend in the width direction (X). Further, the first member 20 may be spaced upward from the bottom 13 by a predetermined vertical level, and installed to connect the pair of sidewalls 12 facing each other in the direction of length of container 10. The first member 20 may include a weir of the tundish. A plurality of first members 20 may be provided at positions spaced from each other in the longitudinal direction (Y) with respect to the melt injection unit 1. The first member 20 may guide flow (Pi) near the melt injection unit 1 of the melt (M) injected into the container 10 through the melt injection unit 1 to an inner upper or lower portion of the container 10.

[0046] In one example, a flow direction, a flow velocity, and the like of the melt near the first member 20 may be controlled by adjusting at least one of top and bottom levels of the first member 20. The vertical level below the first member 20 may be determined to be an ideal vertical level at which the melt near the first member 20 may pass below the first member 20 and easily recovered toward the gas injection unit 400 due to the Venturi effect near the gas injection unit 400. Further, the top level of the first member 20 may be determined such that a top of the member 20 may be submerged into the melt by an ideal depth.

[0047] The second member 30 may be provided to control the flow of the melt (M) injected into the container 10. The second member 30 may be spaced from the first member 20 toward the hole 14, and extend in the width direction (X). Further, the second member 30 may be installed so as to contact the bottom 13, and installed to connect the pair of sidewalls 12 facing each other in the direction of length of container 10. The second member 30 may include a dam of the tundish. A plurality of second members 30 may be provided at positions spaced from each other in the longitudinal direction (Y) with respect to the melt injection unit 1. In this connection, the second member 30 may be placed closer to the first member 20 than to the hole 14. In one example, a remained molten metal hole (not shown) may be provided at a predetermined lower portion of the second member 30. The remained molten metal hole may be defined by penetrating the second member 30 in the longitudinal direction (Y) at a position in contact with the bottom 13.

[0048] The second member 30 may divide flow of the melt (M) near the second member 30 guided toward the second member 30 by flowing above or below the first member 20 in a direction toward the hole 14 from the melt injection unit 1 into flow (P_2) near the hole 14 toward the hole 14, and rotational flow (Pc) of the melt (M) toward the first member 20. In one example, a flow direction, and a flow velocity of the melt (M) near the second member 30 may be controlled by adjusting at least one of a vertical level of above the second member 30, and a separation distance of the second member 30 relative to the first member 20.

[0049] The inclusion may be floated while the melt (M) stays in the container 10 for a predetermined time because of the first member 20 and the second member 30. However, when a size of the inclusion is equal to or less than 30 μm, it is difficult to float the inclusion by only a flow control by the first member 20 and the second member 30. This is because, in the case of the flow control using only the first member 20 and the second member 30, the melt (M) may not be sufficiently retained in the container 10 during a time when the micro-inclusion of 30 μm or less may be floated.

[0050] Thus, in an embodiment of the present disclosure, the gas injection unit 400 may be provided between the guide member and the melt injection unit 1, and the rotational flow (Pc) of the melt (M) may be generated near the guide member. For example, when the guide member includes only the first member 20, the gas injection unit 400 may be installed between the first member 20 and the melt injection unit 1, and installed spaced apart from the first member 20 toward the melt injection unit 1. In addition, when the guide member includes both the first member 20 and the second member 30, the gas injection unit 400 may be installed between the first member 20 and the melt injection unit 1, or between the first member 20 and the second member 30, and installed spaced apart from the second member 30 toward the first member 20.

[0051] That is, the gas injection unit 400 may be provided between the first member 20 and the melt injection unit 1, or between the first member 20 and the second member 30, and the gas (g) may be injected near the first member 20. Therefore, a strong upward flow and rotational flow (Pc) of the melt (M) may be generated. Thus, the melt (M) in the vicinity of the first member 20 may be sufficiently rotated several times, and maintained inside the container 10 so that the micro-inclusion of 30 μm or less may be floated. In particular, it is possible to increase the number of rotations of the rotational flow (P_C), thereby greatly increasing a contact frequency between the inclusion and the gas.

[0052] In this case, the inclusion (s') incorporated into the melt (M) may be floated along the rotational flow (P_C) of the melt (M) during staying in the vicinity of the first member 20 for a long time to be easily collected to the slag (S) and removed. Further, while the inclusion (s') incorporated into the melt staying in the vicinity of the first member 20 for a long time, the inclusion (s') incorporated into the melt (M) may frequently contact the bubbles in the gas (g) injected into the melt (M) by the gas injection unit 400 along the rotation flow (Pc) of the melt (M), as shown in FIG. 4, and thus may be easily collected onto an interface of the bubbles. Thus, the inclusion may be more effectively removed.

[0053] In one example, when the guide member only includes the first member 20, the gas injection unit 400 may be installed in closer to the first member 20 between first member 20 and hole 14. In this connection, an upward flow due to the gas (g) injected from the gas injection unit 400 is guided to flood over the first member 20 in a direction from the hole 14 toward the melt injection unit 1 by a wall portion of the chamber 500 described below. Further, a pressure of the melt (M) of both regions opposing in the longitudinal direction (Y) with respect to the first member 20 is changed because of the gas (g) injected from the gas injection unit 400 so that flow passing below the first member 20 in a direction from the melt injection unit 1 toward the hole 14 may be formed. From this, rotational flow of the melt (M) rotating repeatedly around the first member 20 may be formed. A rotation direction of the rotational flow at this point may be different from that of the rotational flow (Pc) of Fig. 3, for example.

[0054] The gas injection unit 400 may be installed on the bottom 13, spaced from the guide member toward the melt inlet 1. For example, the gas injection unit 400 may be spaced from the first member 20 toward the melt injection unit 1 or the second member 30, and may be installed on the bottom 13. A plurality of gas injection units 400 may be provided on both sides with respect to the longitudinal direction (Y) with respect to the melt injection unit 1. A configuration and manner of a porous plug used in a ladle furnace, and the like may be applied to the gas injection unit 400.

[0055] The gas injection unit 400 extends in the width direction (X) and protrudes from the top face of the bottom 13. The gas injection unit 400 may include: a block having a vertical level lower than a vertical level of a bottom face of the first member 20; a plurality of slits defined in a top face of the block; gas injection pipe 410 penetrating the bottom 13 of the container and the block in order and communicating with the slit defined in the top face of the block; and a control valve 420 mounted on the gas injection pipe 410 for controlling an opening and closing manner. In this connection, the control valve 420 may control opening/closing manner so that the gas (g) in the melt (M) is injected continuously or intermittently.

[0056] The block may be formed of a high dense refractory, and may be formed in various shapes having a top face of a predetermined area. The slit may extend into the block and may pass through the top face of the block in a vertical level direction. The slit may be defined in a hollow pipe shape, or may be formed of a porous refractory so that gas (g) may flow inside. The gas g may be injected into the container 10 through the slit in a fine bubble state.

[0057] The block of the gas injection unit 400 may be located relatively closer to the first member 20 than to the melt injection unit 1. In this connection, at least one of the melt flow direction and the number of rotations due to the gas (g) injected into the container 10 from the gas injection unit 400 may be controlled by adjusting a separation distance (W1) between the block and the first member 20.

[0058] For example, the shorter the separation distance (W1) between the first member 20 and the block, the more steeply vertically rising melt flow due to the gas (g) may be generated. In the opposite case, the melt flow may be generated in a direction that the melt flow relatively gently rises along the first member 20.

[0059] Further, as the separation distance W1 is shorter, the rotational flow (P_C) of the melt (M) between the first member 20 and the second member 30 is more smoothly collected toward the gas injection unit 400 by the venturi effect, thereby increasing the number of rotations of the rotational flow (P_C). On the other hand, the longer the separation distance W1, the smaller the collection degree of the melt (M) between the first member 20 and the second member 30, thereby reducing the number of rotations of the rotational flow (P_C).

[0060] As described above, the gas injection unit 400 may be located near the first member 20 to cause the venturi effect. That is, as the melt (M) near the first member 20 repeatedly rotates depending on the install position of the gas injection unit 400, and generates a continuous and strong rotational flow (P_C), micro inclusions of size 3 μm or less may float up to the top face of the melt (M) or be collected by the gas (g) bubbles.

[0061] In one example, a naked molten metal surface N of a predetermined size may be formed above the gas injection unit 400 or the first member 20. This is because the slag (S) formed on the top face of the melt (M) is pushed out because of the rapid upward flow of the melt (M) between the gas injection unit 400 and the first member 20 due to the gas (g) injected into the melt (M) through the gas injection unit 400. In this case, the cleanliness of the melt (M) may be lowered because the melt (M) is reoxidized by contacting the atmosphere through the naked molten metal surface (N).

[0062] Thus, as in the embodiment of the present disclosure, the chamber 500 is provided above the guide member and the gas injection unit 400. When the naked molten metal surface (N) is formed on the top face of the melt (M), by generating a vacuum atmosphere or an inert atmosphere by covering a vicinity (C) of the naked molten metal surface (N) with the chamber 500, the melt (M) may be effectively prevented from being re-oxidized by contacting the atmosphere. Thus, as the naked molten metal surface N is protected from the outside air by the chamber 500, the gas (g) may be sufficiently injected through the gas injection unit 400 regardless of the formation of the naked molten metal surface (N), thereby achieving a formation of sufficiently strong rotational flow (P_C).

[0063] In addition, the melt (M) flooding over the first member 20 in a direction from the melt injection unit 1 toward the hole 14 may be guided toward below the first member 20 by immersing a lower portion of the chamber 500 into the melt (M), and using the immersed portion of the chamber 500. Thus, the rotational flow (Pc) may be stably generated in the vicinity of the first member 20. That is, the chamber 500 helps form the rotational flow (Pc) while protecting the naked molten metal surface (N), and increases the number of rotations of the rotational flow (Pc). Therefore, the inclusion removing efficiency may be improved by the chamber 500, and the cleanliness of the melt (M) may be further improved.

[0064] The chamber 500 may be installed so that it extends in the width direction (X) and the inner space thereof is opened downwardly. In addition, the chamber 500 may be installed on the top of the container 10 so as to face away the guide member and the gas injection unit 400. In this connection, a plurality of the chambers 500 may be provided at positions spaced apart from each other in the longitudinal direction (Y) with respect to the melt injection unit 1.

[0065] The chamber 500 may include a lid portion 510 extending in the width direction (X), wall portions extending in the width direction, and respectively mounted on a bottom face of the lid portion 510, wherein the wall portions are spaced apart from each other and are disposed in both regions opposing in a longitudinal direction, wherein the first member 20 is centered between the wall portions, wherein the wall portions contact or are spaced from both length-directional sidewalls of the container 10, and flanges 511 extending in the longitudinal direction (Y), and respectively mounted on both edges in the width direction (X) of the lid portion 510 to connect the wall portions. The wall portions and the flanges 511 are immersed in the melt (M) so that the naked molten metal surface (N) may be airtightly protected by the chamber 500.

[0066] In this connection, at least part of the portions, for example, the wall portions and the flanges 511, that are immersed in the melt (M) may be protected by a refractory. In addition, a bottom face of the flanges 511 may be higher than a bottom face of the wall portions and a top face of the first member 20 so as to prevent collision or interference of the flange 511 with respect to the first member 20 when they are immersed in the melt (M).

[0067] The lid portion 510 may be formed in a plate shape, and may be formed with an area sufficiently covering the naked molten metal surface (N) formed on the top face of the melt (M). An installation vertical level of the lid portion 510 may be determined such that the lid portion 510 may be spaced apart from the top face of the first member 20 or the top face of the melt (M) injected into the container 10 by a predetermined vertical level. The wall portions may include a first wall portion 520, and a second wall portion 530. The first wall portion 520 may be spaced apart from the gas injection unit 400 toward the melt injection unit 1, and the second wall portion 530 may be spaced above the second member 30.

[0068] For example, the first wall portion 520 may be a vertical wall extending in the width direction (X). A bottom face of the first wall portion 520 may be positioned at a position higher than the top face of the first member 20, and may extend downward to a vertical level that may be immersed in the melt (M) injected into the container 10. For example, the second wall portion 530 may be a vertical wall extending in the width direction (X). A bottom face of the second wall portion 530 may be positioned at a position lower than the top face of the first member 20, and may extend downward to a vertical level that may be immersed in the melt (M). The second wall portion 530 may determine each of flux (Q1) of the melt flowing toward the hole 14 and flux (Q2) of the melt flowing toward the gas injection unit 400 of the melt (M) flooding over the first member 20 by adjusting a separation distance (d1) relative to the second member 30. The second wall portion 530 may adjust a relative magnitude or absolute magnitude of the flux (Q1) and the flux (Q2), respectively.

[0069] For example, as the separation distance (d1) with respect to the second member 30 decreases, the flux (Q2) of the melt flowing toward the gas injection unit 400, and used for generating the rotational flow (P_C) becomes larger than the flux (Q1) of the melt flowing toward the hole 14. On the contrary, as the separation distance (d1) with respect to the second member 30 increases, the melt flux (Q1) flowing toward the hole 14 becomes larger than the melt flux (Q2) flowing toward the gas injection unit 400, and used for generating the rotational flow (P_C).

[0070] In this connection, these fluxes are also closely related to the rotational speed of the rotational flow (P_C). That is, as the flux Q2 of the melt, which flows toward the gas injection unit 400, and used to generate the rotational flow (P_C), increases, the rotational flow (P_C) may be smoothly generated, and the number of rotations may be increased.

[0071] That is, the second wall portion 530 of the chamber 500 and the second member 30 of the guide member are main components for determining the number of rotations of the rotational flow (P_C). In addition, the number of rotations of the rotational flow (P_C) may be determined by the distance (d1) between the second wall portion 530 and the second member 30. Thus, it is preferable that the second member 30 is mounted at a predetermined position spaced apart from the first member 20 toward the hole 14 so as to face the second wall portion 530 at least vertically.

[0072] In one example, the second wall portion 530 is provided spaced from the gas injection unit 400 with respect to the first member 20. In this connection, an inclined face may be provided on one face of the second wall portion 530 facing the first member 20. The inclined face may be formed to be inclined upward from a bottom to a top of the second wall portion 530, from the first member 20 toward the second member 30. The inclined face smoothly descends the melt (M) flooding over the first member 20 in a direction from the melt injection unit 1 toward the second member 30, and may guide the melt (M) toward bottom of the first member 20.

[0073] A negative pressure is generated by the gas (g) flowing into the chamber 500 through the naked molten metal surface (N), so that the chamber 500 may be formed in an inert atmosphere. Of course, the chamber 500 may be equipped with a supply pipe 560 and an exhaust pipe 570, respectively, so that the inner space atmosphere of the chamber 500 may be directly controlled.

[0074] The supply pipe 560 is formed to be capable of supplying gas. The supply pipe 560 may communicate with inside by passing through, for example, one end of the lid portion 510 of the chamber 500. The exhaust pipe 570 is formed to be capable of exhausting gas. The exhaust pipe 570 may communicate with inside by passing through, for example, the other end of the chamber 500. An inlet of the supply pipe 560 may be connected to gas supply (unshown), and may receive an inert gas to form an inert atmosphere inside the chamber 500. An inlet of the exhaust pipe 570 may be connected to an exhaust pump (unshown) and a vacuum pump (unshown), and may form an inert atmosphere or a vacuum atmosphere inside the chamber 500 using these pumps.

[0075] In one example, the melt treating apparatus according to the embodiment of the present disclosure may include a first actuation unit 540 that supports the chamber 500 in an ascending or descending manner, and is able to adjust a vertical level of the chamber 500 depending on a vertical level of the top face of the melt (M) injected into the container 10. Further, the melt treating apparatus may include a second actuation unit 550 that supports the chamber 500 in a slidable manner, and is able to adjust a vertical level of the chamber 500 in the longitudinal direction Y depending on a formation position of the naked molten metal surface N of the melt injected into the container 10. These actuation units may be, but not limited to, formed in a structure such as a hydraulic cylinder, and the like which is applied to a manipulator of the continuous casting facility.

[0076] The first actuation unit 540 may be mounted on a center portion of the top face of the lid portion 510, and may be formed to be stretchable in the vertical level direction (Z) using, for example, hydraulic pressure, and the like. The second actuation unit 550 may be mounted on a top face of the first actuation unit 540, and may be formed to be stretchable in the longitudinal direction (Y) using, for example, hydraulic pressure, and the like. The movement in the longitudinal direction Y of the second actuation unit 550 may be transmitted to the chamber 500 through the first actuation unit 540.

[0077] In one example, the melt treating apparatus according to an embodiment of the present disclosure may further include a second gas injection unit (unshown) installed at the bottom 13 spaced apart from the gas injection unit 400 with respect to the first member 20. For example, when the gas injection unit 400 is installed spaced from the first member 20 toward the melt injection unit 1, the second gas injection unit may be provided between the first member 20 and the second member 30. When the gas injection unit 400 is provided between the first member 20 and the second member 30, the second gas injection unit may be installed spaced from the first member 20 toward the melt injection unit 1. A configuration and operation method of the second gas injection unit may be the same as the configuration and operation method of the gas injection unit 400, and thus a detailed description thereof will be omitted.

[0078] In this case, the rotational flow (P_C) may be controlled more precisely because the second gas injection unit may inject the gas (g) in the melt (M) spaced from the gas injection unit 400 with respect to the first member 20, and directly control the flow of the melt.

[0079] The gate 60 may be so as to be capable of opening and closing the hole 14, and may be mounted on the bottom face of the container 10 so as to be vertically aligned with the hole, respectively. The gate 60 may include a slide gate of the continuous casting facility, and the slide gate may control the melt (M) discharge by adjusting an opening degree of the hole 14. A nozzle 70 may be mounted beneath the gate 60.

[0080] The nozzle 70 may include a hollow refractory nozzle extending in the vertical level direction (Z), and may be mounted on the bottom face of the gate 60 to communicate with the hole 14. The melt (M) discharged from the hole 14 may flow into the nozzle 70 passing through the gate 60, and may be supplied to a mold (unshown) provided to surround a lower portion of the nozzle 70. For example, the nozzle 70 may include a submerged entry nozzle of the continuous casting facility.

[0081] The mold may be formed in a rectangular or square hollow block shape, and inside thereof may be vertically opened upward and downward. The melt (M) supplied to the mold may be primarily solidified into a slab, and may be secondarily cooled while passing a cooling bed (unshown) having a curved or vertically curved shape provided at a lower portion of the mold, and molded, so that the melt (M) may be continuously casted into a slab, which is a semi-finished product.

[0082] In the operation of the melt treating apparatus formed as described above, after melt is transported by a transport container, melt (M) is injected into the container 10 through the melt injection unit 1 which is connected to the transport container. In this connection, the injected melt forms flow along the bottom 13 towards the guide member. Then, an upward flow is formed by gas (g) injection of the gas injection unit 400 installed at a position preceding the guide member. Some of the upward flow is circled toward the melt injection unit 1, and most of which flows over the first member 20 and bumps into the second wall portion 530 of the chamber 500, and flow thereof is switched downward. Some of the flow toward downward floods over the second member 30, and is discharged toward the hole 14, while the rest of the flow descends to reach the bottom 13, then floods below the first member 20 to generate the rotational flow (Pc) due to the venturi effect near the gas injection unit 400. Using this rotational flow, inclusion (s') in the melt (M) may contact the gas (g) multiple times, and may be removed. During this process, the chamber 500 encloses the naked molten metal surface (N) to form the inert or vacuum atmosphere, thereby preventing contamination of the melt (M) due to the atmosphere.

[0083] Hereinafter, a melt treating method according to an embodiment of the present disclosure will be described in detail. A melt treating method according to an embodiment of the present disclosure is applicable to the aforementioned melt treating apparatus according to the embodiment of the present disclosure. The melt treating method includes: preparing the container having an inner space and an open top, is provided with a melt injection unit at the top thereof, and having a hole defined in at least a portion of a bottom thereof, and having a guide member between the hole and the melt injection unit; injecting the melt into the container; flooding the melt over the guide member; and generating the rotational flow of the melt by injecting gas through the gas injection unit into between the guide member and the melt injection unit in the container. In this connection, the melt (M) may include molten steel, and the gas (g) may include an inert gas.

[0084] Firstly, the container 10 having the inner space and the open top, having the hole 14 defined in the bottom 13, and having the guide member between the hole 14 and the melt injection unit 1 is prepared. In this connection, the guide member may include the first member 20 spaced from the melt injection unit 1 toward the hole 14, and mounted on both of the longitudinal sidewalls 12 of the container 10 spaced apart from the bottom 14, and the second member 30 spaced from the first member 20 toward the hole 14, and mounted on both of the longitudinal sidewalls 12 of the container 10 with contacting the bottom 13.

[0085] Thereafter, the transport container (unshown) is mounted above the melt injection unit 1. Then, the melt injection unit 1 is opened so that the melt (M) in the transport container is injected into the container 10.

[0086] Thereafter, the melt (M) is continuously injected so as to raise the level of the melt (M), thereby flooding the melt (M) over the guide member. At this time, the melt (M) may flood over the first member 20 and the second member 30, and flow toward the hole 14. For example, the melt (M) flowing from the melt injection unit 1 toward the first member 20 floods over and below the first member 20, then flows toward the second member 30. In addition, the melt (M) floods over the second member 30, then flows toward the hole 14.

[0087] Thereafter, the gas is injected into the container 10 between the guide member and the melt injection unit 400 through the gas injection unit 400, thereby generating the rotational flow (Pc) of the melt (M). At this time, the gas (g) may be injected into the container 10 between the first member 20 and the melt injection unit 1 through the gas injection unit 400, thereby generating the rotational flow (Pc) of the melt (M). Alternately, the gas (g) may be injected into the container 10 between the second member 30 and the first member 20 through the gas injection unit 400, thereby generating the rotational flow (Pc) of the melt (M).

[0088] In addition to the process of generating the rotational flow (Pc) of melt (M), the chamber 500 is used to form the vacuum atmosphere or the inert atmosphere in the region surrounding the position of the naked molten metal surface of the melt (M) formed by the gas (g) injected into the container 10.

[0089] This process may be performed by moving the chamber 500, for example, in the longitudinal direction (Y) depending on the position of the naked molten metal surface. Further, this process may be performed by moving the chamber 500, for example, in the vertical level direction (Z) depending on a change of the top face of the melt (M) due to the continuous casting, or the like. Accordingly, the immersion depth of the chamber 500 may be constant, and the immersion position of the chamber 500 may be constant in a position where surrounding the naked molten metal surface (N).

[0090] In addition, this process may be performed by aligning the chamber 500 above the naked molten metal surface (N) and by immersing the lower portion of the chamber 500 into the melt (M) to enclose the vicinity of the naked molten metal surface (N), and then using the gas (g) injected into the chamber 500 through the naked molten metal surface (N) to form the inert atmosphere. Alternately, this process may be performed by injecting a separate inert gas directly into the chamber 500, or by discharging gas inside the chamber 500 and forming the vacuum atmosphere, and the like.

[0091] In this connection, the process of forming the rotational flow, and forming the vacuum atmosphere or the inert atmosphere at the naked molten metal surface may be sequentially performed in an arbitrary order, or may be performed simultaneously. Therefore, it is possible to prevent the melt (M) from being contaminated using the naked molten metal surface (N) generated by the rotational flow (P_C) while eliminating the inclusion (s') by generating the strong rotational flow (P_C) in the melt (M).

[0092] In one example, in forming the rotational flow (P_C), by varying the gas injection position of the gas injection unit 400 relative to the guide member, for example the first member 20, at least one of the flow direction and the number of rotations of the rotational flow (P_C) may be controlled. For example, by adjusting the separation distance (W1) of the gas injection unit 400 relative to the first member 20 to change the gas injection position of the gas injection unit 400 relative to the first member 20, a working range and a size of the venturi effect by the first member 20 may be varied. From this, the flow direction and the number of rotations of the rotational flow (Pc) may be controlled. In this connection, the smaller the separation distance (W1) of the gas injection unit 400 relative to the first member 20, the flow direction of the rotational flow (P_C) may be formed perpendicular to the first member 20 and the number of rotations may be increased.

[0093] Further, in generating the rotational flow (P_C), by adjusting the vertical level of the second wall in a manner of adjusting the immersion vertical level of the chamber 500 relative to the melt (M), the separation distance (d1) of the second wall portion 530 relative to the second member 30 may be adjusted. From this, the flux (Q1) of the melt, which floods over the guide member, and flows toward the hole 14, and the flux (Q2) of the melt, which floods over the guide member and flows toward the gas injection unit 400, and is collected to the rotational flow (P_C) may be controlled, respectively.

[0094] Therefore, by adjusting the number of rotations of the rotational flow (P_C) to rotate the melt (M) several times near the guide member and keep the melt (M) for a long time, the contact frequency of the gas (g) to the melt (M) near the guide member may be significantly increased.

[0095] Further, in generating the rotational flow (P_C), by controlling the gas (g) injection manner of the gas injection unit 400 in at least one of the continuous manner and the intermittent manner, the flow of the rotational flow (P_C) near the guide member may be controlled in various ways into desired flow. That is, by continuously injecting the gas (g) while treating the melt (M), the intensity, the number of rotations of the rotational flow (P_C), and the like, may be constantly controlled over time. Alternatively, during the treatment of the melt (M), by jetting the gas (g) in a predetermined cycle, or intermittently jetting the gas (g) irregularly, flow characteristics such as the intensity, the number of rotations, and the like of the rotational flow (P_C) may controlled to change with time, and to have, for example, pulsation.

[0096] In this way, the flow characteristics such as the flow direction, the number of rotations, and the like of the rotational flow (P_C) generated near the guide member may be controlled in various ways by jetting the gas (g) in various positions near the guide member.

[0097] In one example, in generating the rotational flow (P_C), the gas is injected through the second gas injection unit (unshown) into between the gas injection unit 400 and the guide member in the container such that at least one of the flow direction and the number of rotations of the rotational flow may be controlled.

[0098] For example, the gas (g) is injected through the gas injection unit 400 into between the first member 20 and the melt injection unit 1 in the container 10, and the gas is injected through the second gas injection unit (unshown) installed at the bottom 13 spaced apart from the first member 20 in the opposite side of the gas injection unit 400 into between the second member 30 and the first member 20 in the container 10 such that the rotational flow (P_C) of the melt may be controlled.

[0099] In this connection, at least one of gas injection amount and an injection manner of the second gas injection unit is controlled differently from at least one of gas injection amount and an injection manner of the gas injection unit 400 such that an injection amount and an injection manner of the gas (g) may be controlled differently in the longitudinal direction (Y) with respect to the first member 20. From this, the flow of the melt (M) near the first member 20 may be variously controlled in a desired flow.

[0100] While performing the above process, the inclusion may be effectively removed from the melt (M) supplied into the container 10 to discharge the melt (M) to the outlet 14. The discharged melt (M) may be cast into the slab (unshown) in the mold (unshown) provided below the outlet (14). Thus, a quality of the slab being cast may be improved, and inclusion defects on a slab surface may be prevented.

[0101] FIG. 5 shows inclusion removal process and result according to an embodiment of the present disclosure. In this connection, (a) of FIG. 5 is a photograph showing, via capturing using an electron microscope, a state of a cross-section of a solidified steel after performing a property test including injecting argon gas into molten steel and solidifying the molten steel. (b) of FIG. 5 is a photograph showing, via magnifying using the electron microscope, an area near bubble in the solidified steel after performing the above-described property test. (c) of FIG. 5 is a graph showing, using the electron microscope, a component around the bubble in the solidified steel after the above-mentioned property test. In this connection, as shown in (c) of FIG. 5, a horizontal axis represents, for example, a keV spectrum of an X-ray energy intensity detected by the electron microscope. With reference to FIG. 5, a process and a result of the property test will be described to show that the micro inclusion may be effectively collected and removed by injecting the argon gas into the molten steel.

[0102] First, in order to perform a property test of collecting and removing inclusion in molten steel by argon gas, molten steel is prepared, and solidified by blowing argon gas into the molten steel. When the molten steel is solidified, a cross section of the solidified steel is observed with the electron microscope such that the presence of the inclusion is observed at the bubble, and around the bubble formed in the steel solidified by the prepared argon gas. Then, a property of the inclusion is analyzed. The above process and result are shown in (a), (b), and (c) of FIG. 5.

[0103] As a result of this property test, as shown in (a) of FIG. 5, when the bubble due to the argon gas is formed in the solidified steel, it may be seen that there is a large amount of micro inclusion of equal to or less than 30 μm around the bubbles, as shown in (b) of FIG. 5. As a result of a component analysis of the micro inclusion, it was proved to be inclusion of Al_2O_3, as shown in (c) of FIG. 5. This shows that the bubble of the argon gas may be used to effectively remove the micro inclusion in the molten steel.

[0104] In this way, when the argon gas bubble is injected into the molten steel, the inclusion attaches to an interface of the argon gas bubble because the inclusion has a property of attaching to an area where an interfacial tension is lower. That is, since an interfacial tension of the bubble due to the argon gas is relatively low compared to an interfacial tension of the molten steel, the inclusion may be collected at the interface of the argon gas bubble.

[0105] In this connection, in the embodiment of the present disclosure, in collecting and removing the inclusion in the molten steel using the argon gas, a rotational flow (P_C) may be generated in a predetermined area in the molten steel where the argon gas is jetted such that the same molten steel may be rotated several times and repeatedly contact the argon gas at high frequency.

[0106] Thus, micro inclusion having a component such as Al_2O_3, SiO_2, and the like may be effectively collected and removed from the molten steel. In this connection, the bubble of the argon gas collected the inclusion at the interface thereof may rise to the molten metal face and escape to the outside the molten steel. In addition, the inclusion may be adsorbed to the slag layer, and may be removed.

[0107] As described above, in the embodiment of the present disclosure, the inclusion may be easily collected and removed from the molten steel, and therefore the molten steel with ensured cleanliness relevant to the inclusion may be injected into the mold. Thus, applying this to the continuous casting process may prevent the inclusion defect in the mold, and reduce a clogging of the nozzle due to the inclusion. As a result, a slab quality, a process stability and a productivity in the continuous casting process may be improved.

[0108] FIG. 6 is a graphical representation of a structure of a melt treating apparatus for flow analysis of melt according to an embodiment of the present disclosure. FIG. 7 shows a result of melt flow analysis for a melt treating apparatus according to an embodiment of the present disclosure. First, an internal structure of the melt treating apparatus is modeled graphically as shown in Fig. 6 for numerical analysis using computational fluid dynamics for the melt treating apparatus.

[0109] In this connection, in the modeled drawing, reference numeral 1' denotes a melt injection unit, reference numeral 10' denotes a container, and reference numeral 20' denotes a first member. In addition, reference numeral 30' denotes a second member, reference numeral 400' denotes gas injection unit, and reference numeral 500' denotes a chamber. Further, reference numeral 70' denotes a nozzle. Further, reference signal P_1 denotes flow near the melt injection unit, P_2 denotes melt flow near the nozzle, P'_C denotes melt flow near the first member, and V denotes an area where the venturi effect is formed.

[0110] Thereafter, predetermined analytical conditions are input, and the modeling result is numerically analyzed using CFD (Computational Fluid Dynamics). The analysis result is shown graphically in FIG. 7.

[0111] With reference to FIG. 6 and FIG. 7 together, as a result of the above numerical analysis, melt flow is generated in a direction from the melt injection unit 1' toward the first member 20', and the melt flow rises along the first member 20' due to an influence of gas lift from the gas injection unit 400'. Some of the ascending melt flow is returned toward the melt injection unit 1', and most of which is rotated from the first member 20' toward the third member 30'. The melt flowing toward the third member 30' is bumped against a wall portion of the chamber 500', and is directed downward. At this time, some of the melt flows over the second member 30', and escapes toward the nozzle 70', and the rest continues to flow below the wall portion. It may be seen that the melt flowing downward of the wall portion travels below the first member 20' toward the gas injection unit 400' along the bottom of the container 10' due to the venturi effect generated above the gas injection unit 400' such that rotational flow may be generated around the first member 20'.

[0112] Shapes of the first wall portion 520, and the second wall portion 530 of the chamber 500 according to the embodiment of the present disclosure may be variously changed. Hereinafter, with reference to FIG. 8, shapes of the first wall portions and the second wall portions of the chamber 500 according to variations of the present disclosure will be described in detail.

[0113] FIG. 8 is a partial view of the chamber of the melt treating apparatus according to an embodiment and variations of the present disclosure. In this connection, (a) of FIG. 8 is a partial view of the chamber according to the embodiment of the present disclosure, and (b) of FIG. 8 to (i) of FIG. 8 are partial views showing the chambers according to the first variation to the eighth variation in order.

[0114] In one example, in the reference numeral shown in the drawings, 'b' to 'i' were used to distinguish components according to each variation from the components of the embodiment. For example, with reference to FIG. 8, reference numeral 510b to reference numeral 510i are used to distinguish a lid portion according to each variation from the lid portion 510 of the embodiment. In addition, reference numeral 520b to reference numeral 520i are used to distinguish a first wall portion according to each variation from the first wall portion according to the embodiment. Further, reference numeral 530b to reference numeral 530i are used to distinguish a second wall portion according to each variation from the second wall portion according to the embodiment.

[0115] In comparing (a) of FIG. 8 with (b) of FIG. 8 to (i) of FIG. 8, in the variation of the present disclosure, shapes of the first wall portion and the second wall portion of the chamber may be various. The first wall portion may be formed in a rectangular shape as shown in (b), (c), (f), (g), (h) and (i) of FIG. 8 or may be in a right triangular shape as shown in (d) and (e) of FIG. 8. In this connection, in the case of a right triangular shape, a face corresponding to a hypotenuse may be directed toward the inside or the outside of the chamber.

[0116] The second wall portion may have at least one of an upwardly inclined face 531, a downwardly inclined face 531', a vertical face 532, a curved face 533, and a concave groove 534 on one face thereof facing the first wall portion, and the other face to the opposite. Its specific shape is as shown in (a) of FIG. 8 to (i) of FIG. 8, respectively.

[0117] Thus, in the variation of the present disclosure, the shape of the first wall portion and the second wall portion may be partially or completely different such that the flow characteristics of the melt passing each of the wall portions may be variously adjusted. Accordingly, the melt flow formed below the chamber 500 may be adjusted into a desired flow.

[0118] FIG. 9 is a schematic diagram of a melt treating apparatus according to a comparative example of the present disclosure. FIG. 10 shows a result of a melt treatment according to the comparative example of the present disclosure, which is a result of performing an operation using a conventional melt treating apparatus according to the comparative example of the present disclosure.

[0119] The conventional melt processing apparatus according to the comparative example of the present disclosure has a tundish 81 receiving molten steel (M') and slag (S), a melt injection unit 1 located at a center of the tundish 81, an upper weir 82 spaced from the melt injection unit 1 toward a tap hole 84, and a lower dam 83 spaced from the upper weir 82 toward the tap hole 84. In a melt treatment operation using the conventional melt treating apparatus, as indicated by the dotted arrow on the drawing, no rotational flow surrounding the upper weir 82 is generated inside the tundish 81. After applying the apparatus to the continuous casting process and performing the operation several times, as shown in FIG. 10, it may be seen that an inclusion defect is formed on a surface of slab. This is because, unlike the embodiment of the present disclosure, no rotational flow has been generated and no gas has been injected so as to float, or collect and remove micro inclusion in the tundish 81.

[0120] For example, during casting of molten metal, such as in a continuous casting process, cleanliness of the molten metal is an important factor in determining a quality of the casted product. In the continuous casting process, aluminum or silicon used in a deoxidation process of molten steel (M') reacts with oxygen in the molten steel, and is mostly removed as an inclusion, but very small inclusions remain in the molten steel. These inclusions not only interfere with a molten steel injection into the mold by causing a clogging of a submerged entry nozzle of the tundish 81 in the continuous casting process, but are also incorporated into the slab during a solidification process, and cause a defect in the inclusion itself, as shown in FIG. 10. These inclusions have been removed in a variety of ways, but, in case of inclusion of 30 μm or less, the upper weir 82 and the lower dam 83 have a limitation in floating the inclusion using the molten steel (M') flow.

[0121] On the other hand, according to the embodiment of the present disclosure, a rotational flow is generated by injecting, for example, argon gas into melt as a means for maximizing a removal efficiency of an inclusion. In this connection, a chamber is provided above a first member, for example, a weir so as to maximize a generation of the rotation flow by adjusting an injection position of the argon gas, and to prepare for an occurrence of a naked molten metal surface caused by the rotation and the argon gas injection. Therefore, while a strong rotational flow is generated in the melt, and repeatedly contacts the argon gas to efficiently remove the inclusion, an inert atmosphere is formed at the naked molten metal surface due to the strong rotational flow and the argon gas injection, thereby preventing melt contamination.

[0122] It should be noted that the embodiment of the present disclosure is for the explanation of the present disclosure, and not for the limitation of the present disclosure. It should also be noted that the arrangements and methods presented in the embodiment of the present disclosure will be combined or cross-linked to one another and will be transformed into a variety of different forms, and these variations may be regarded as the scope of the present disclosure. As a result, the present disclosure will be implemented in a variety of different forms within the scope of claims and equivalents thereof. Those skilled in the art will appreciate that various modifications of the present disclosure are possible within the scope of the technical idea of the present disclosure.

Claims

1. A melt treating apparatus comprising:

   a container having an inner space and an open top, is provided with a melt injection unit at the top thereof, and having a hole defined in at least a portion of a bottom thereof;
   a guide member spaced from the melt injection unit, wherein the guide member is disposed between the hole and the melt injection unit; and
   a gas injection unit spaced from the guide member, wherein the gas injection unit is disposed between the melt injection unit and the guide member, wherein the gas injection unit is installed at the bottom of the container.

2. The apparatus of claim 1, wherein the guide member includes a first member spaced from the melt injection unit, wherein the first member is disposed between the hole and the melt injection unit, wherein the first member is spaced apart from the bottom of the container.

3. The apparatus of claim 2, wherein the guide member includes a second member spaced from the first member, wherein the second member is disposed between the hole and the first member, wherein the second member contacts the bottom of the container.

4. The apparatus of claim 3, wherein the gas injection unit is spaced from the first member, wherein the gas injection unit is disposed between the melt injection unit and the first member or between the first and second members.

5. The apparatus of one of claims 1 to 4, further comprising a chamber mounted on the top of the container so as to extend in a width direction, wherein the chamber has an inner space and an open bottom, and facing the guide member and the gas injection unit.

6. The apparatus according to any one of claim 1 to claim 4, wherein the gas injection unit includes:

   a block mounted on the bottom of the container, and having a slit defined in a top face thereof;
   gas injection pipe communicating with the slit; and
   a control valve mounted on the gas injection pipe for controlling an opening degree and an opening and closing manner of the gas injection pipe.

7. The apparatus of claim 5, wherein the chamber includes:

   a lid portion extending in the width direction;
   wall portions extending in the width direction, and respectively mounted on a bottom face of the lid portion, wherein the wall portions are spaced apart from each other and are disposed in both regions opposing in a longitudinal direction, wherein the first member is centered between the wall portions, wherein the wall portions contact or are spaced from both of longitudinal sidewalls of the container; and
   flanges extending in the longitudinal direction, and respectively mounted on both width-directional edges of the lid portion to connecting both of the wall portions.

8. The apparatus of claim 7, wherein each of the wall portions includes:

   a first wall portion spaced apart from the gas injection unit and disposed between the melt injection unit and the gas injection unit; and a second wall portion spaced from and disposed above the second member.

9. The apparatus of claim 8, wherein a bottom face of the first wall portion is positioned higher than a top face of the first member, wherein the bottom face of the first wall portion is immersible into the melt injected into the container,
wherein a bottom face of the second wall portion is positioned lower than a top face of the first member, and is immersible into the melt injected into the container..

10. The apparatus of claim 5, further comprising at least one of a supply pipe formed to be capable of supplying gas, penetrating the chamber, and communicating with the inner space of the chamber, and an exhaust pipe formed to be capable of exhausting gas, penetrating the chamber, and communicating with the inner space of the chamber,
further comprising at least one of:

a first actuation unit for supporting the chamber in an ascending or descending manner, and for adjusting a vertical level of the chamber depending on a vertical level of a top face of the melt injected into the container; and
a second actuation unit for supporting the chamber in a slidable manner, and for adjusting a position of the chamber in a longitudinal direction depending on a formation position of a naked molten metal surface of the melt injected into the container..

11. The apparatus of one of claims 1 to 4, wherein the melt injection unit is formed to allow molten steel to pass therethrough, and is detachably mounted on a ladle of a continuous casting facility,
wherein gas injected into the container from the gas injection unit includes an inert gas..

12. A melt treating method comprising:

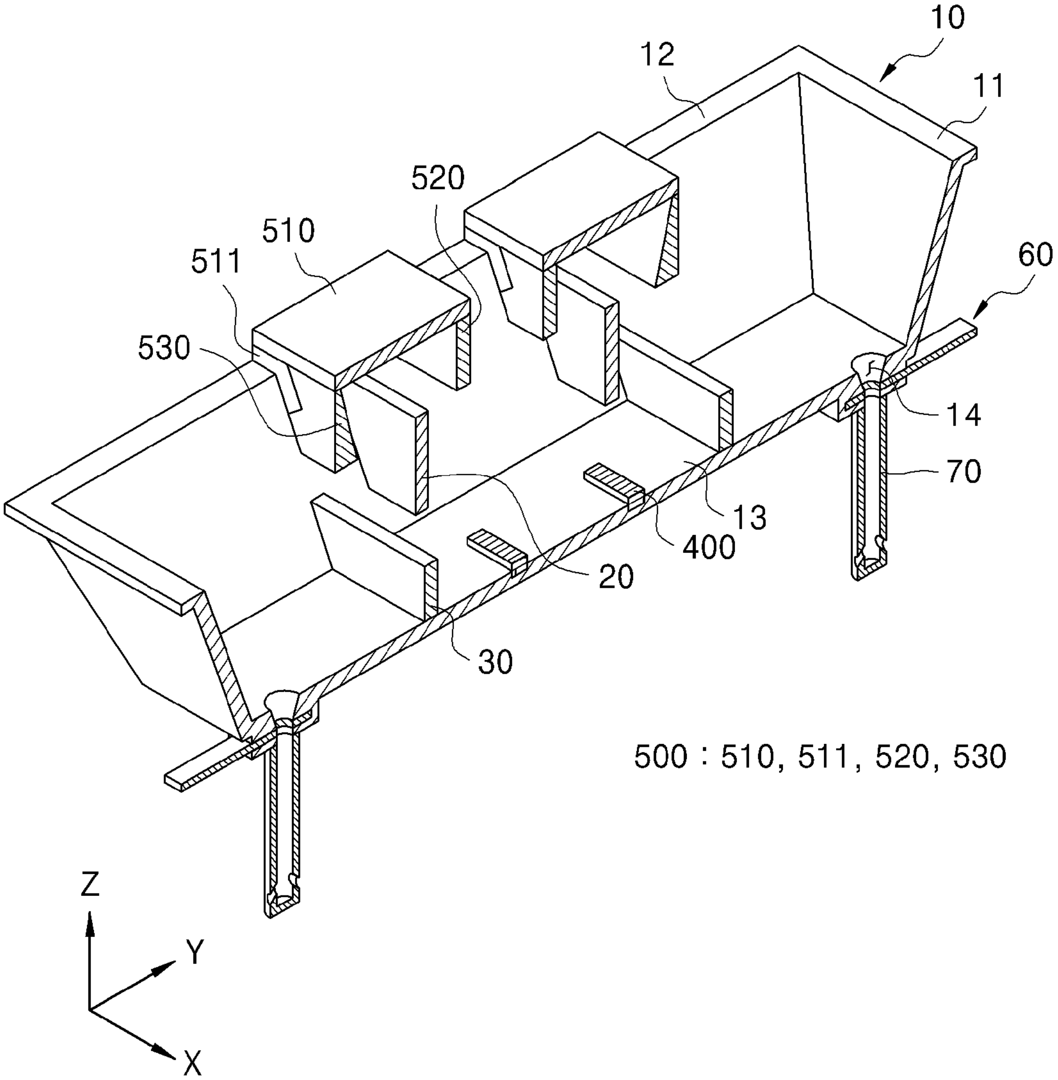
preparing a container, the container having an inner space and an open top, is provided with a melt injection unit at the top thereof, and having a hole defined in at least a portion of a bottom thereof, and having a guide member between the hole and the melt injection unit;
injecting melt into the container;
flooding the melt over the guide member; and
generating rotational flow of the melt by injecting gas through a gas injection unit into between the guide member and the melt injection unit in the container.

13. The method of claim 12, comprising forming an inert atmosphere or a vacuum atmosphere in a region surrounding a formation position of a naked molten metal surface of the melt via gas injected into the container using the chamber.

14. The method of claim 13, wherein generating the rotational flow includes controlling each of flux of melt flooding over the guide member, and flowing toward the hole, and flux of melt flooding over the guide member, and flowing toward the gas injection unit by adjusting an immerse vertical level of the chamber relative to the melt.

15. The method of one of claims 12 to 14, wherein the melt includes molten steel, and wherein the gas includes an inert gas.

[도1]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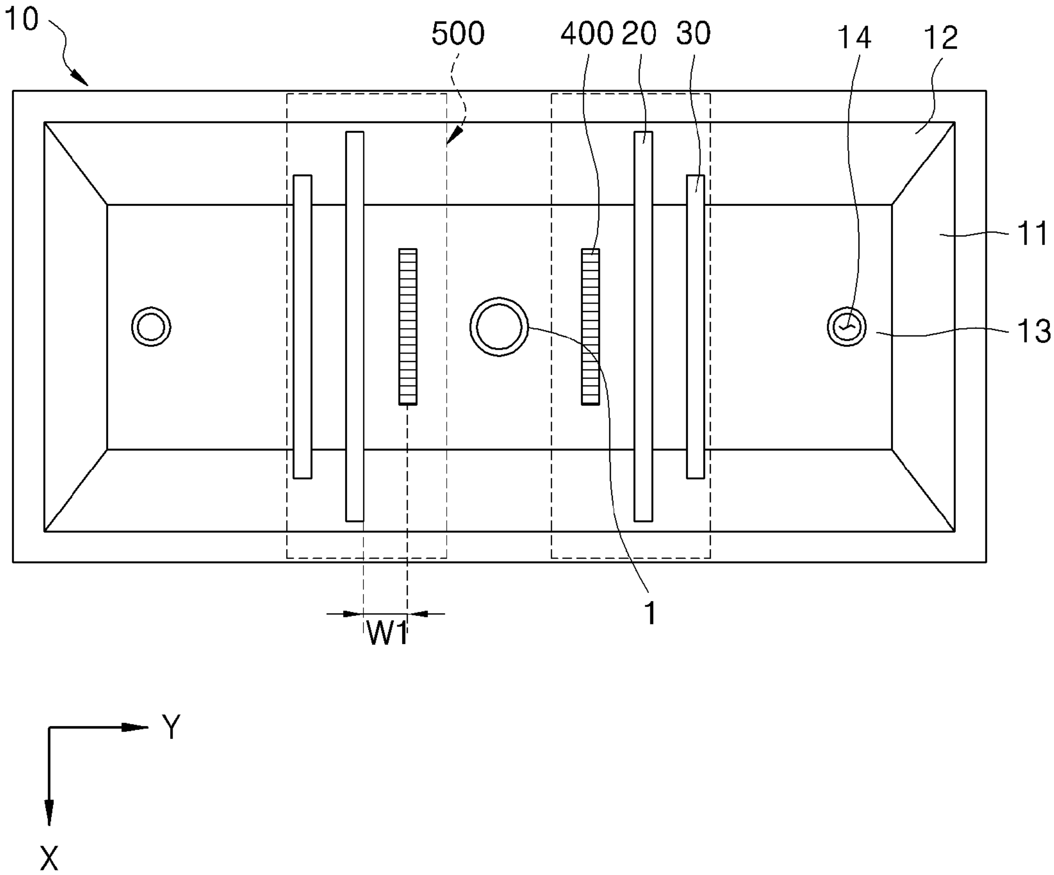
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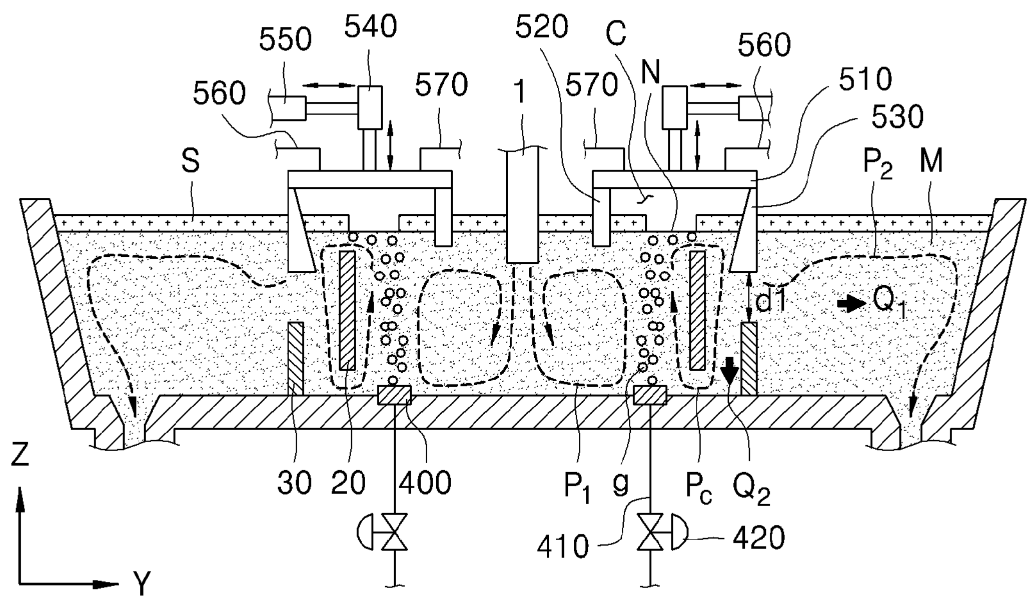
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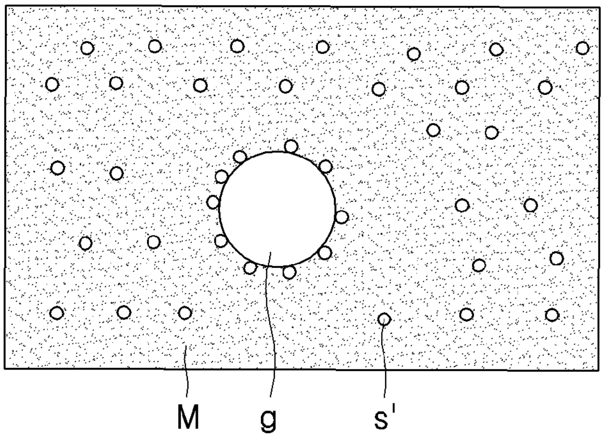

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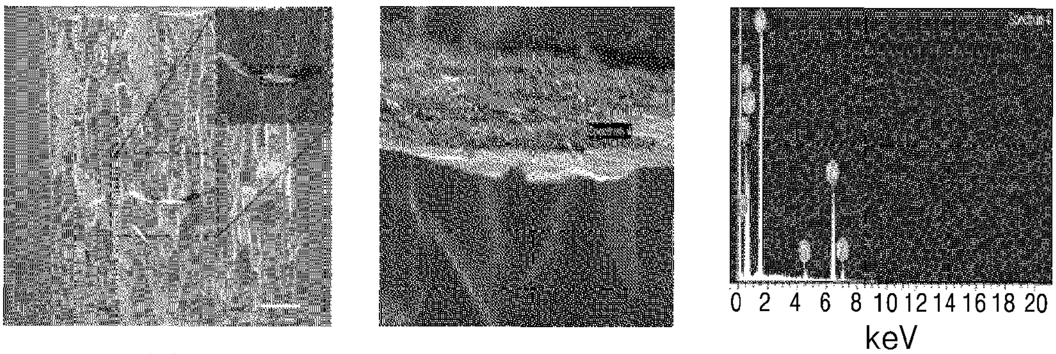

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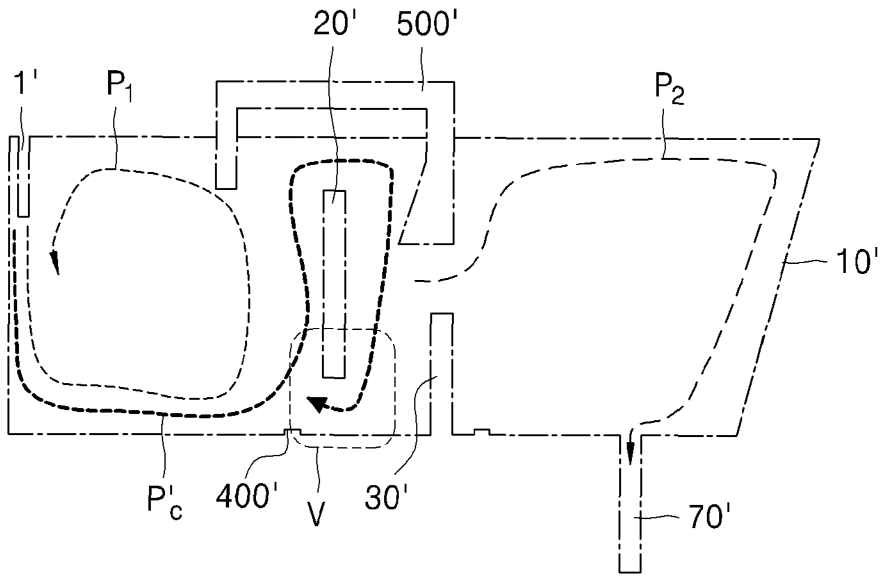
[도6]



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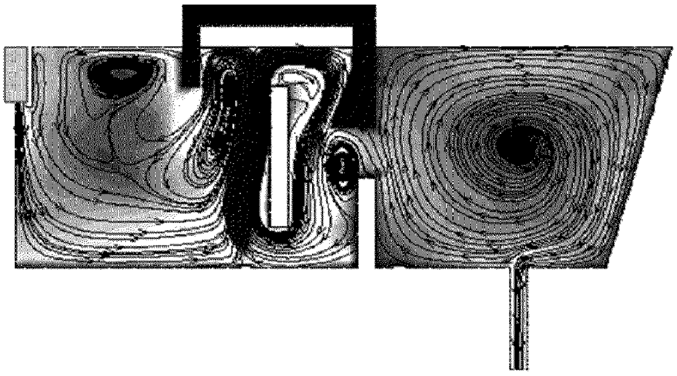

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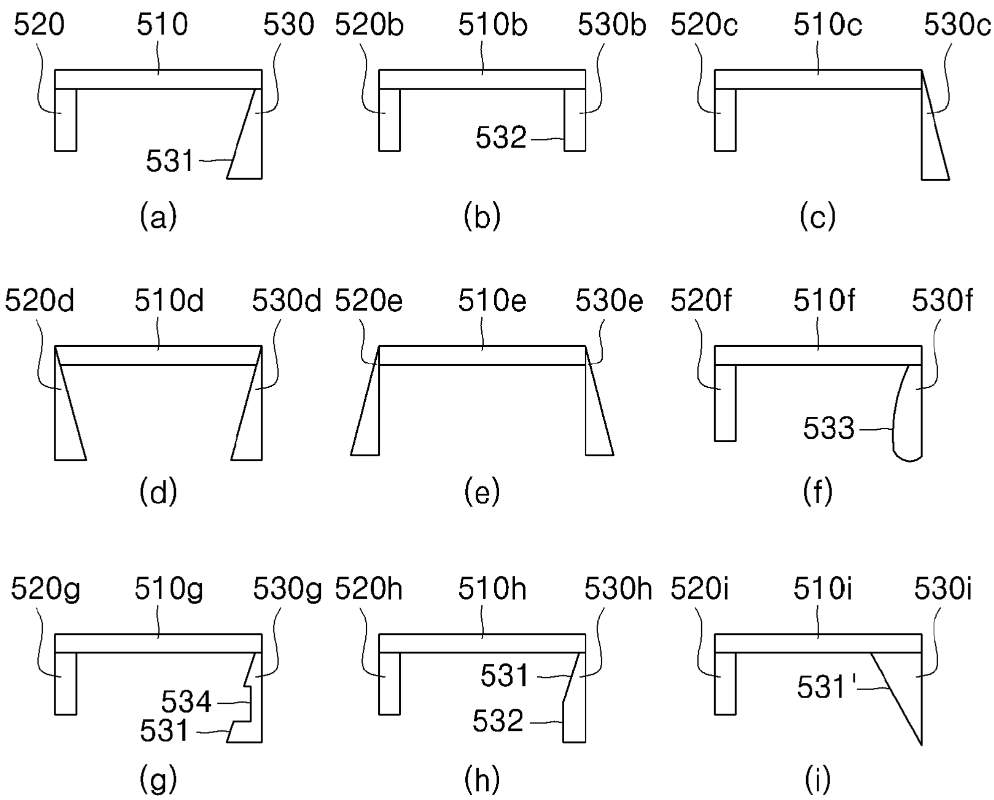
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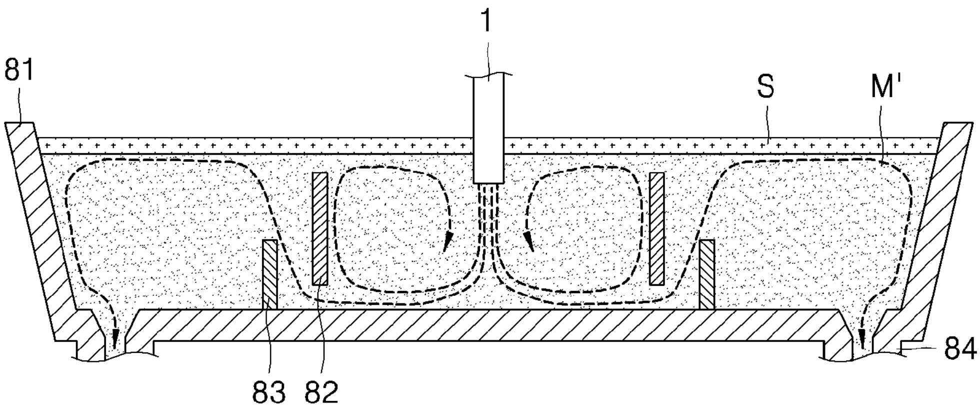
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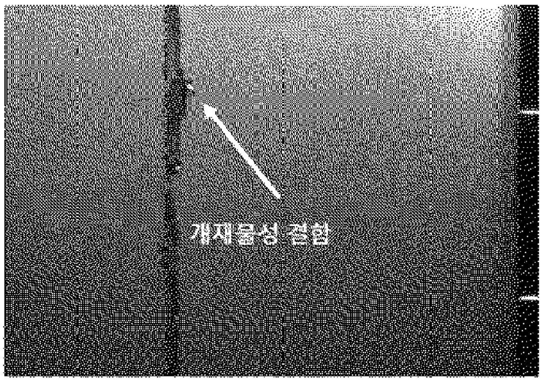

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2016/013628

A. CLASSIFICATION OF SUBJECT MATTER

B22D 11/103(2006.01)i, B22D 11/11(2006.01)i, B22D 41/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B22D 11/103; B22D 41/00; B01D 33/00; C21C 5/48; C21C 5/52; C21C 7/00; B22D 41/58; B22D 11/10; B22D 41/56; B22D 11/11

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal) & Keywords: molten material, molten steel, gas, gas, inclusion, container, tundish, refractories, dam, wall, rotating flow, circulation flow

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 07-268437 A (KAWASAKI STEEL CORP.) 17 October 1995 See paragraphs [0023]-[0028], [0038], [0042], [0045]-[0048], claims 1-4, 9, 12, 15 and figures 1-4, 12-18.	1-26
A	US 5551672 A (SCHMIDT, Manfred) 03 September 1996 See column 3, lines 20-column 4, line 44 and figure 1.	1-26
A	KR 10-2012-0033102 A (HYUNDAI STEEL COMPANY) 06 April 2012 See paragraphs [0030]-[0040], claim 1 and figure 2.	1-26
A	KR 10-2013-0119252 A (POSTECH ACADEMY-INDUSTRY FOUNDATION) 31 October 2013 See paragraphs [0027]-[0031] and figure 2.	1-26
A	KR 10-2009-0126625 A (POSCO) 09 December 2009 See paragraphs [0041]-[0048], claims 1-9 and figure 3a.	1-26

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search	Date of mailing of the international search report
09 FEBRUARY 2017 (09.02.2017)	**10 FEBRUARY 2017 (10.02.2017)**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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KR 10-2009-0126625 A	09/12/2009	KR 10-1018148 B1	28/02/2011

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- KR 1020130076187 A **[0008]**
- KR 1020150073449 A **[0008]**