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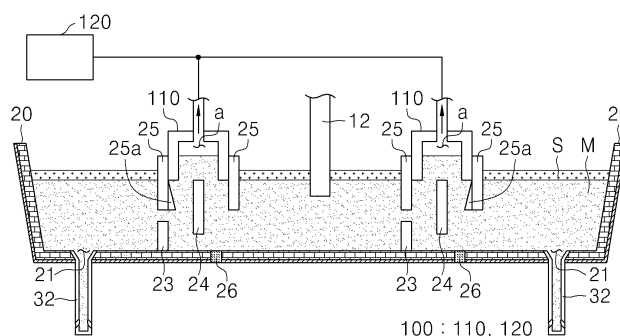
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(54) **CASTING EQUIPMENT AND CASTING METHOD USING SAME**

(57) The present disclosure relates to casting equipment and a casting method using same. A casting method includes: preparing a tundish; injecting molten steel to the tundish; installing a vacuum forming member on an upper portion of the tundish to form vacuum in at least a partial area of an upper portion of a melting surface of molten steel accommodated in the tundish; forming a ro-

tational flow by blowing a gas into the molten steel; and forming vacuum in at least a partial area of the upper portion of the melting surface of the molten steel. More particularly, the present disclosure may effectively remove inclusions in the molten steel and restrict reoxidation of the molten steel.

Fig.2



Description**TECHNICAL FIELD**

[0001] The present disclosure relates to casting equipment and a casting method using same, and more particularly, to casting equipment capable of effectively removing inclusions in molten steel and restricting reoxidation of the molten steel, and a casting method using same.

BACKGROUND ART

[0002] Continuous casting equipment receives molten steel from steel manufacturing equipment to manufacture a slab. The continuous casting equipment includes: a ladle transporting molten steel; a tundish that receives the molten steel from the ladle to temporarily store the received molten steel; a mold that continuously receives the molten steel from the tundish and primarily coagulates the molten steel into a slab; and a cooling zone performing a series of molding works while secondarily cooling the slab, which is continuously drawn from the mold.

[0003] While the molten steel is accommodated in the tundish and remained for a predetermined time, inclusions float to be separated, slag is stabilized, and reoxidation is prevented. Thereafter, the molten steel is supplied to the mold to form an initial coagulated layer as a shape of the slab. Here, a surface quality of the slab is determined.

[0004] A degree of the surface quality of the slab in the mold is determined according to cleanliness of the molten steel with respect to inclusions. For example, when the cleanliness of the molten steel with respect to inclusions is poor, a defect may be generated on a surface of the slab due to the inclusion itself, and, as a submerged nozzle is clogged by the inclusions, a flow of the molten steel may become abnormal to degrade the surface quality of the slab.

[0005] The cleanliness of the molten steel with respect to inclusions may be greatly varied according to a degree of floating and separation of the inclusions while the molten steel remains for a predetermined time in the tundish, and the degree of floating and separation of the inclusions may be proportional to a time in which the molten steel remains in the tundish.

[0006] Thus, a residence time of the molten steel is typically adjusted by controlling a flow of the molten steel by building a dam or a weir in the tundish as a method for extending the residence time of the molten steel in the tundish. However, when each of the inclusions mixed to the molten steel has a size of 30 μm or less, a time in which the inclusions float to be separated is greater than the residence time of the molten steel. Due to this reason, the inclusions each having a size of 30 μm or less may be hardly removed by using the dam and the weir of the tundish.

(Prior art document)**[0007]**

Japanese Registered Patent No. 4096635
Japanese Registered Patent No. 3654181

DISCLOSURE OF THE INVENTION**10 TECHNICAL PROBLEM**

[0008] The present disclosure provides casting equipment capable of restricting a nozzle clogging phenomenon during casting by effectively removing inclusions in molten steel and a casting method using same.

[0009] The present disclosure also provides casting equipment capable of securing cleanliness by restricting reoxidation of molten steel and a casting method using same.

TECHNICAL SOLUTION

[0010] In accordance with an exemplary embodiment, casting equipment includes: a cover member installed on a tundish to define a space in at least a portion of an upper portion of a melting surface of molten steel accommodated in the tundish; a vacuum pump connected to the cover member to form vacuum in the space; and a control unit configured to control an operation of the vacuum pump.

[0011] The cover member may include: a vertical part having a hollow shape in which upper and lower portions are opened and vertically provided so that at least a portion is submerged into the molten steel; and a horizontal part connected to an upper portion of the vertical part to define a space between the vertical part and the horizontal part. Here, an exhaust hole may be defined in the horizontal part for connection with the vacuum pump.

[0012] The horizontal part may cover only the upper portion of the vertical part.

[0013] The horizontal part may be seated on an upper portion of the tundish.

[0014] A structure and an induction member may be provided in the tundish. Here, the structure may cross an inside of the tundish while being spaced apart from a bottom surface of the tundish in order to form a flow of molten steel, and the induction member may be disposed at each of both sides of the structure in parallel to the structure while being spaced apart from the bottom surface of the tundish.

[0015] The induction member may have a top surface higher in position than a top surface of the structure.

[0016] A nozzle may be provided to supply a gas to the tundish, and the nozzle may be provided at one side of the structure between the induction members.

[0017] The casting equipment may further include a detection unit configured to measure a level of the melting surface of the molten steel in the space.

[0018] The detection unit may include at least one of a distance sensor and a temperature sensor.

[0019] In accordance with another exemplary embodiment, a casting method includes: preparing a tundish; injecting molten steel to the tundish; installing a vacuum forming member on an upper portion of the tundish to form vacuum in at least a partial area of an upper portion of a melting surface of molten steel accommodated in the tundish; forming a rotational flow by blowing a gas into the molten steel; and forming vacuum in at least a partial area of the upper portion of the melting surface of the molten steel.

[0020] The preparing of the tundish may include forming an induction member configured to define an area for forming vacuum. Here, the induction member may be formed at each of both sides of a structure, which crosses an inside of the tundish while being spaced apart from a bottom surface of the tundish, in parallel to the structure.

[0021] The installing of the vacuum forming member may include: installing a cover member between the induction members; forming a space, which is spaced apart from the melting surface of the molten steel, in the cover member by submerging at least a portion of the cover member into the molten steel; and connecting a vacuum pump to the cover member.

[0022] The forming of the rotational flow may include blowing a gas to one side of the structure.

[0023] The forming of the vacuum may include suctioning the space by operating the vacuum pump.

[0024] The forming of the vacuum may be performed when at least a portion of the cover member is submerged into the molten steel.

[0025] The forming of the vacuum may include measuring variation in level of the melting surface of the molten steel in the space, and a degree of vacuum of the space may be adjusted according to the variation in level of the melting surface of the molten steel.

ADVANTAGEOUS EFFECTS

[0026] According to the casting equipment and the casting method using same in accordance with the exemplary embodiment, the rotational flow may be continuously formed in the molten steel regardless of the variation of the melting surface of the molten steel to effectively remove the inclusions in the molten steel. That is, as the space is formed in at least a portion of the upper portion of the melting surface of the molten steel accommodated in the tundish, and the inside of the space is suctioned to form vacuum, the level of the melting surface of the molten steel may be constantly maintained at all times. Thus, as the level of the melting surface of the molten steel is constantly maintained by forming the vacuum in the space regardless of the variation of the melting surface of the molten steel outside the space, the residence time of the molten steel in the tundish may increase to effectively remove the inclusions in the molten steel.

[0027] Also, since the gas injected to form the rotation-

al flow is discharged to the outside through the space in which vacuum is formed, the exposed molten steel generated by the gas discharge may be prevented from contacting the atmosphere to restrict or prevent the reoxidation of the molten steel.

[0028] Also, as the cleanliness of the molten steel is maintained, the nozzle clogging or the slab defect, which may be generated during the casting, may be restricted or prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. 1 is a schematic view illustrating casting equipment in accordance with an exemplary embodiment. FIG. 2 is a view illustrating a main constitution of the casting equipment in accordance with an exemplary embodiment.

FIG. 3 is a view an example of a vacuum forming member that is applied to the casting equipment in accordance with an exemplary embodiment.

FIG. 4 is a view illustrating a modified example of the vacuum forming member that is applied to the casting equipment in accordance with an exemplary embodiment.

FIG. 5 is a view illustrating an example of installing a detection unit for measuring a level of a melting surface of molten steel in the casting equipment in accordance with an exemplary embodiment.

FIG. 6 is a view illustrating a state of forming a rotational flow in molten steel during casting by using the casting equipment in accordance with an exemplary embodiment.

MODE FOR CARRYING OUT THE INVENTION

[0030] Hereinafter, exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings. The present invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that the present invention will be thorough and complete, and will fully convey the scope of the present invention to those skilled in the art. Like reference numerals in the drawings denote like elements.

[0031] FIG. 1 is a schematic view illustrating casting equipment in accordance with an exemplary embodiment, FIG. 2 is a view illustrating a main constitution of the casting equipment in accordance with an exemplary embodiment, FIG. 3 is a view an example of a vacuum forming member that is applied to the casting equipment in accordance with an exemplary embodiment, FIG. 4 is a view illustrating a modified example of the vacuum forming member that is applied to the casting equipment in accordance with an exemplary embodiment, and FIG. 5 is a view illustrating an example of installing a detection

unit for measuring a level of a melting surface of molten steel in the casting equipment in accordance with an exemplary embodiment.

[0032] Referring to FIG. 1, casting equipment 1, e.g., continuous casting equipment, may include: a tundish 20 storing and distributing molten steel M provided from a ladle 10 that is a vessel for storing molten steel, which has undergone refining; a stopper (not shown) or a sliding plate (not shown) for controlling a flow rate of the molten steel M; a submerged nozzle 32 providing the molten steel M in the tundish 20 to a mold 30; and a mold 30 producing a slab S by coagulating the molten steel M. Also, a cooling line 50 for cooling the slab S may be provided below the mold 30.

[0033] Referring to FIG. 2, the tundish 20 may have a hollow shape in which an upper portion is opened and a steel outlet hole 21 through which molten steel is discharged is defined in a lower portion. Various structures may be provided to form a flow of molten steel in the tundish 20. The structures may include a dam 23, a weir 24, and a vortex prevention dam (not shown). Here, the dam 23 may protrude upward from a bottom surface of the tundish 20. The weir 24 may be spaced apart from the bottom surface of the tundish 20 and provided on a side wall of the tundish 20 to cross an inside of the tundish 20 at a position higher than each of a level of molten steel and a height of the dam 23. Also, the vortex prevention dam may be provided adjacent to the steel outlet hole 21 in a lower portion of the tundish 20 to restrict vortex generation so that slag is prevented from being introduced to the mold 30. The dam 23 and the weir 24 may be arranged in parallel while being spaced apart from each other, and a passage through which the molten steel flows may be defined between the dam 23 and the weir 24.

[0034] One steel outlet hole 21 may be provided to each of both sides in a longitudinal direction of the tundish 20, and as a shroud nozzle 12 is disposed at a center in the longitudinal direction of the tundish 20, the molten steel accommodated in the ladle 10 may be injected to the tundish 20.

[0035] Through the above-described constitution, the molten steel injected through the nozzle 12 may move through a passage defined by the weir 24 and the dam 23 in the tundish 20 and be discharged through the steel outlet hole 21. As described above, as a residence time of the molten steel in the tundish 20 increases by forming a flow of the molten steel in the tundish 20, inclusions in the molten steel may be collected by a slag S disposed on the molten steel.

[0036] However, since the molten steel injected from the shroud nozzle 12 forms a flow that simply passes the passage defined by the weir 24 and the dam 23 in the above-described structure of the tundish 20, the inclusions in the molten steel may not be sufficiently removed. Thus, a rotational flow of the molten steel may be formed in the tundish by installing a nozzle 26 at a lower portion of the tundish 20 and blowing a gas, e.g., inert gas, into

the tundish 20. Here, the nozzle 26 may be provided to one side of the weir 24, e.g., a portion adjacent to the shroud nozzle 12. As a result, the molten steel may form the rotational flow flowing by the gas supplied from the nozzle 26 while surrounding the weir 24, and the residence time of the molten steel in the tundish 20 may further increase.

[0037] However, in this case, since while the gas injected into the tundish is discharged, the slag moves to form naked molten steel, the molten steel contacts the atmosphere and is reoxidized. Also, since the level of the melting surface of the molten steel in the tundish 20 decreases when the ladle is replaced, the rotational flow of the molten steel in the tundish 20 is not smoothly generated.

[0038] Thus, in accordance with an exemplary embodiment, as a vacuum forming member 100 capable of forming vacuum in at least a portion of the tundish 20 is installed to continuously generate a rotational flow regardless of variation in level of the melting surface of the molten steel, the inclusions in the molten steel may be effectively removed, and the reoxidation, which is caused by contact between the molten steel and the atmosphere, may be restricted.

[0039] An induction member 25 that defines an area for constantly maintaining the level of the melting surface of the molten steel in the tundish 20, i.e., an area for forming the rotational flow, may be provided to install the vacuum forming member 100. In case of forming vacuum in a predetermined area in the tundish 20 by using the vacuum forming member 100, since a vacuum state is hardly maintained when the level of the melting surface of the molten steel is lower than an upper portion of the weir 24, an area for installing the vacuum forming member 100, i.e., an area for forming the rotational flow, may be prepared in advance by providing the induction member 25 to the tundish 20. For example, while vacuum may be formed by using the vacuum forming member 100 when the level of the melting surface of the molten steel is higher than the upper portion of the weir 24, the vacuum may be released when the level of the melting surface of the molten steel is lower than the upper portion of the weir 24 because a space is formed between the vacuum forming member 100 and the melting surface of the molten steel.

[0040] The induction member 25 may cross the inside of the tundish 20 while being spaced apart from the bottom surface of the tundish 20, and be disposed at each of both sides of the weir while being parallel to the weir 24. Here, the induction members 25 may be provided at an upper side, at which the nozzle 26 is defined, to form the rotational flow of the molten steel therebetween. Also, the weir 24 may be disposed between the induction members 25, and the rotational flow may be formed by the molten steel moving along the weir 26 between the induction members 25 by a gas supplied through the nozzle 26. Here, a guide member 25a may be provided to at least one side surface of the induction member 25 to

smoothly generate the rotational flow of the molten steel. The guide member 25a may control a movement direction of the molten steel by forming an inclined surface on one side surface of the induction member 25. Although the inclined surface 25a is provided to the induction member 25 disposed at one side of the weir 24 at which a downward flow is formed in the drawing, the inclined surface may be provided to the induction member 25 disposed at the other side of the weir 24 at which an upward flow is formed. Here, directions of the inclined surfaces provided to the side at which the upward flow is formed and the side at which the downward flow is formed may be different from each other.

[0041] The induction member 25 may have a lower portion disposed lower than the upper portion of the weir 24 and an upper portion disposed higher than the upper portion of the weir 24. Thus, even when the level of the melting surface of the molten steel decreases, e.g., when the ladle is replaced, the molten steel may smoothly generate the rotational flow while maintaining the level of the melting surface to be higher than the upper portion of the weir 24.

[0042] Referring to FIG. 3, the vacuum forming member 100 may include: a cover member 110 that defines a space (a) in at least a portion of the inside of the tundish 20; and a vacuum pump 120 connected to the cover member 110 to suction an inside of the cover member 110. Also, the vacuum forming member 100 may further include: a detection unit 130 for measuring the level of the melting surface of the molten steel in the cover member 110; and a control unit (not shown) for controlling an operation of the vacuum pump 120 according to the measured level of the melting surface of the molten steel.

[0043] The cover member 110 may be disposed along a width direction of the tundish 20 and have an opened lower portion and a hollow upper portion in which an exhaust hole 114 is defined. The cover member 110 may include a vertical part 111 extending in a vertical direction and a horizontal part 112 connected to an upper portion of the vertical part 111. Here, the exhaust hole 114 may be defined in the horizontal part 112 and connected to the vacuum pump 120 through a separate exhaust pipe.

[0044] As the vertical part 111 is inserted between the induction members 25, a lower portion of the vertical part 111 may be submerged into the molten steel, and the vertical part 111 may have a length to define the space (a) upward from the melting surface of the molten steel in the cover member 110 while being submerged into the molten steel. Through the above-described constitution, the cover member 110 may have at least a portion, e.g., a lower portion, submerged into the molten steel to define the space (a) therein at an upper portion of the tundish 20.

[0045] Also, the horizontal part 112 may connect upper portions of the vertical parts 111 to define the space (a) between the horizontal part 112 and the vertical part 111. The horizontal part 112 may have an area corresponding to an area defined inside the vertical part 111 to cover only the upper portion of the vertical part 111. Alternatively,

as illustrated in FIG. 4, a cover member 110a may cover the upper portion of the tundish 20. In this case, a horizontal part 112a may be seated on the upper portion of the tundish 20, i.e., cover the upper portion of the tundish 20, and a vertical part 111a may vertically extend at a portion below the horizontal part 112a.

[0046] Also, the cover member 110 may include a detection unit 130 for measuring the level of the melting surface of the molten steel in the space (a). As illustrated in (a) of FIG. 5, a distance sensor 130a disposed on the horizontal part 112a to measure a distance from the horizontal part to the melting surface of the molten steel may be used for the detection unit 130. Also, as illustrated in (b) of FIG. 5, a temperature sensor 130b disposed on the vertical part 111a, which is submerged into the molten steel, to measure a temperature of the molten steel may be used for the detection unit 130.

[0047] The vacuum pump 120 may be connected to the cover member 110 to suction the space (a) in the cover member 110, thereby forming vacuum in the space (a). Thus, as an inner pressure of the cover member 110, i.e., a pressure of the space (a), is less than a surrounding pressure, the level of the melting surface of the molten steel inside the cover member 110 is greater than surroundings, i.e., that of the melting surface of the molten steel outside the cover member 110.

[0048] The control unit may receive a result measured from the detection unit 130 and control an operation of the vacuum pump 120 according to the level of the melting surface of the molten steel, thereby constantly controlling the level of the melting surface of the molten steel in the space (a). For example, when the molten steel is continuously injected to the tundish 20 from the ladle 10, the rotational flow may be smoothly formed by the gas blown through the nozzle 26. However, when the supply of the molten steel is temporarily stopped for replacing the ladle 10, the level of the melting surface of the molten steel in the tundish 20 may be lowered. Thus, the level of the melting surface of the molten steel in the cover member 110 may be constantly maintained by appropriately adjusting the pressure of the space (a) through controlling of the operation of the vacuum pump 120 according to variation in level of the melting surface of the molten steel inside the cover member 110.

[0049] Hereinafter, a casting method in accordance with an exemplary embodiment will be described.

[0050] FIG. 6 is a view illustrating a state of forming the rotational flow in the molten steel during casting by using the casting equipment in accordance with an exemplary embodiment.

[0051] First, the molten steel, which has undergone refining, is inserted to the ladle 10, and then the ladle 10 moves to continuous casting equipment and is seated on a ladle turret. When the ladle is seated on the ladle turret, a nozzle unit (not shown) including the shroud nozzle 12 is connected to the steel outlet hole at a lower portion of the ladle 10.

[0052] When the nozzle unit is connected to the ladle

10, the vacuum forming member 100 is installed at an upper portion of the tundish 20, and the steel outlet hole at the lower portion of the ladle 10 is opened to inject the molten steel to the tundish 20.

[0053] When the molten steel is injected to the tundish, and the level of the melting surface of the molten steel injected to the tundish 20 reaches to form the rotational flow, e.g., reaches to an upper portion of the weir 24, a gas is blown to the molten steel through the nozzle 26. Here, the gas blown into the tundish 20 may include an inert gas such as argon (Ar). When the gas is supplied to the tundish 20, as illustrated in (a) of FIG. 6, the rotational flow of the molten steel may be formed in the tundish 20. The rotational flow of the molten steel may be formed between the induction members 25. An upward flow may be formed at one side of the weir 24 at which the nozzle 26 is provided, and a downward flow may be formed at the other side of the weir 24. Also, as the molten steel passes through a space formed between the induction members 25 and the dam 23 at the other side of the weir 24, the molten steel moves toward the steel outlet hole 21 of the tundish.

[0054] When the level of the melting surface of the molten steel increases by injecting the molten steel to the tundish 20, a lower portion of the cover member 110 installed on the tundish 20, i.e., a portion of the vertical part 111, may be submerged into the molten steel, and the space (a) may be formed at the upper portion of the melting surface of the molten steel inside the cover member 110.

[0055] When the vertical part 111 is submerged into the molten steel to form the space (a) inside the cover member 110, the control unit may operate the vacuum pump 120 to suction the inside of the cover member 110, thereby forming vacuum. Here, since air may be introduced into the tundish 20 when the vacuum pump 120 suctions the inside of the cover member 110 before the vertical part 111 is submerged, vacuum is preferably formed by suctioning the inside of the cover member 110 after the vertical part 111 of the cover member 110 is submerged into the molten steel.

[0056] Whether the vertical part 111 is submerged into the molten steel may be measured through the detection unit 130. As illustrated in (a) of FIG. 5, when the distance sensor 130a is used as the detection unit 130, whether the vertical part 111 is submerged may be determined by measuring a distance to the melting surface of the molten steel in the cover member 110 by the distance sensor 130a. That is, when a result measured by the distance sensor 130a is transmitted to the control unit, the control unit may compare the distance to the melting surface of the molten steel, which is measured by the distance sensor 130a, with a preset distance to determine whether the vertical part 111 is submerged.

[0057] Also, as illustrated in (b) of FIG. 5, when the temperature sensor 130b is used as the detection unit 130, whether the vertical part 111 is submerged may be determined by detecting temperature change of the ver-

tical part 111 submerged into the molten steel using a plurality of temperature sensors 130b installed to the vertical part 111 in a longitudinal direction thereof.

[0058] A slab may be manufactured by injecting the molten steel to the mold 30 through the submerged nozzle 32 connected to communicate with the steel outlet hole 21 at the lower portion of the tundish 20 by opening the steel outlet hole 21.

[0059] During casting of the slab, the rotational flow of the molten steel may be formed by continuously injecting a gas into the tundish 20, and the vacuum state may be maintained by suctioning the inside of the cover member 110 through the vacuum pump 120. Thus, the rotational flow may be continuously formed in the tundish 20 during the casting. Also, since the gas generating the rotational flow is discharged to an area at which the vacuum is formed, the molten steel may be prevented from contacting the atmosphere.

[0060] On the other hand, the supply of the molten steel to the tundish 20 may be temporarily stopped while the ladle is replaced. In this case, as illustrated in (b) of FIG. 6, since the molten steel in the tundish 20 is continuously injected to the mold 30, the level of the melting surface of the molten steel in the tundish 20 decreases. When the level of the melting surface of the molten steel decreases as described above, as the inside of the cover member 110 is further strongly suctioned by using the vacuum pump 120, an inner vacuum formation degree may be adjusted. That is, when the level of the melting surface of the molten steel in the tundish 20 decreases, the level of the melting surface of the molten steel in the cover member 110 may decrease in a corresponding manner. Thus, as the operation of the vacuum pump 120 is controlled according to variation in level of the melting surface of the molten steel, which is measured by the detection unit 130, and the inner vacuum formation degree in the cover member 110 increases more than that when the level of the melting surface of the molten steel decreases, the level of the melting surface of the molten steel in the cover member 110 may be constantly maintained. Here, since the molten steel may be discharged through the exhaust hole 114 when the inside of the cover member 110 is excessively suctioned, the operation of the vacuum pump 120 is preferably controlled suitable to a variation quantity of the level of the melting surface. Also, since the level of the melting surface of the molten steel between the induction members 25 may be constantly maintained, the rotational flow of the molten steel may be continuously formed regardless of the variation in level of the melting surface.

[0061] As described above, the rotational flow of the molten steel, which is formed between the induction members 25, i.e., the lower portion of the cover member 110, may be continuously maintained regardless of the variation in level of the melting surface of the molten steel in the tundish 20. As the rotational flow of the molten steel is continuously formed in the tundish 20 during the casting of the slab, the residence time of the molten steel in

the tundish 20 may increase to effectively remove the inclusions in the molten steel. Also, the molten steel may be prevented from contacting the atmosphere in the area at which the rotational flow of the molten steel is formed to prevent the reoxidation of the molten steel.

[0062] Although the specific embodiments are described and illustrated by using specific terms, the terms are merely examples for clearly explaining the embodiments, and thus, it is obvious to those skilled in the art that the embodiments and technical terms can be carried out in other specific forms and changes without changing the technical idea or essential features. Therefore, it should be understood that simple modifications according to the embodiments of the present invention may belong to the technical spirit of the present invention.

INDUSTRIAL APPLICABILITY

[0063] The casting equipment and the casting method using same in accordance with the exemplary embodiment may effectively remove the inclusions in the molten steel to maintain the cleanliness of the molten steel. Thus, the nozzle clogging or the slab defect, which are generated during casting, may be restricted or prevented, and, through this, the process efficiency and the productivity may be enhanced.

Claims

1. Casting equipment comprising:

a cover member installed on a tundish to define a space in at least a portion of an upper portion of a melting surface of molten steel accommodated in the tundish;
a vacuum pump connected to the cover member to form vacuum in the space; and
a control unit configured to control an operation of the vacuum pump.

2. The casting equipment of claim 1, wherein the cover member comprises:

a vertical part having a hollow shape in which upper and lower portions are opened and vertically provided so that at least a portion is submerged into the molten steel; and
a horizontal part connected to an upper portion of the vertical part to define a space between the vertical part and the horizontal part, wherein an exhaust hole is defined in the horizontal part for connection with the vacuum pump.

3. The casting equipment of claim 2, wherein the horizontal part covers only the upper portion of the vertical part.

4. The casting equipment of claim 3, wherein the horizontal part is seated on an upper portion of the tundish.

5. The casting equipment of claim 4, wherein a structure and an induction member are provided in the tundish, wherein the structure crosses an inside of the tundish while being spaced apart from a bottom surface of the tundish in order to form a flow of molten steel, and the induction member is disposed at each of both sides of the structure in parallel to the structure while being spaced apart from the bottom surface of the tundish.

6. The casting equipment of claim 5, wherein the induction member has a top surface higher in position than a top surface of the structure.

7. The casting equipment of claim 6, wherein a nozzle is provided to supply a gas to the tundish, and the nozzle is provided at one side of the structure between the induction members.

8. The casting equipment of claim 7, further comprising a detection unit configured to measure a level of the melting surface of the molten steel in the space.

9. The casting equipment of claim 8, wherein the detection unit comprises at least one of a distance sensor and a temperature sensor.

10. A casting method comprising:

preparing a tundish;
injecting molten steel to the tundish;
installing a vacuum forming member on an upper portion of the tundish to form vacuum in at least a partial area of an upper portion of a melting surface of molten steel accommodated in the tundish;
forming a rotational flow by blowing a gas into the molten steel; and
forming vacuum in at least a partial area of the upper portion of the melting surface of the molten steel.

11. The casting method of claim 10, wherein the preparing of the tundish comprises forming an induction member configured to define an area for forming vacuum, wherein the induction member is formed at each of both sides of a structure, which crosses an inside of the tundish while being spaced apart from a bottom surface of the tundish, in parallel to the structure.

12. The casting method of claim 11, wherein the installing of the vacuum forming member comprises:

installing a cover member between the induction members;
forming a space, which is spaced apart from the melting surface of the molten steel, in the cover member by submerging at least a portion of the cover member into the molten steel; and
connecting a vacuum pump to the cover member.

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13. The casting method of claim 12, wherein the forming of the rotational flow comprises blowing a gas to one side of the structure.

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14. The casting method of claim 13, wherein the forming of the vacuum comprises suctioning the space by operating the vacuum pump.

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15. The casting method of claim 14, wherein the forming of the vacuum is performed when at least a portion of the cover member is submerged into the molten steel.

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16. The casting method of claim 15, wherein the forming of the vacuum comprises measuring variation in level of the melting surface of the molten steel in the space,
wherein a degree of vacuum of the space is adjusted according to the variation in level of the melting surface of the molten steel.

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Fig.1

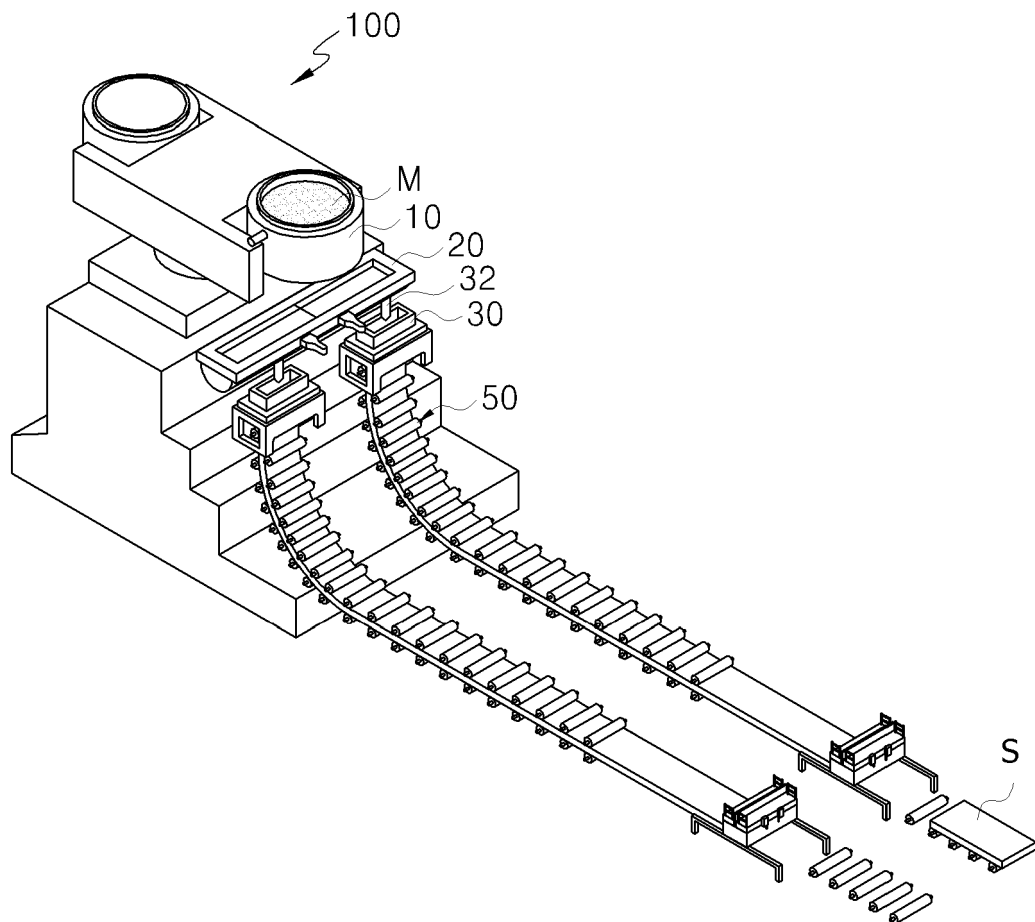


Fig.2

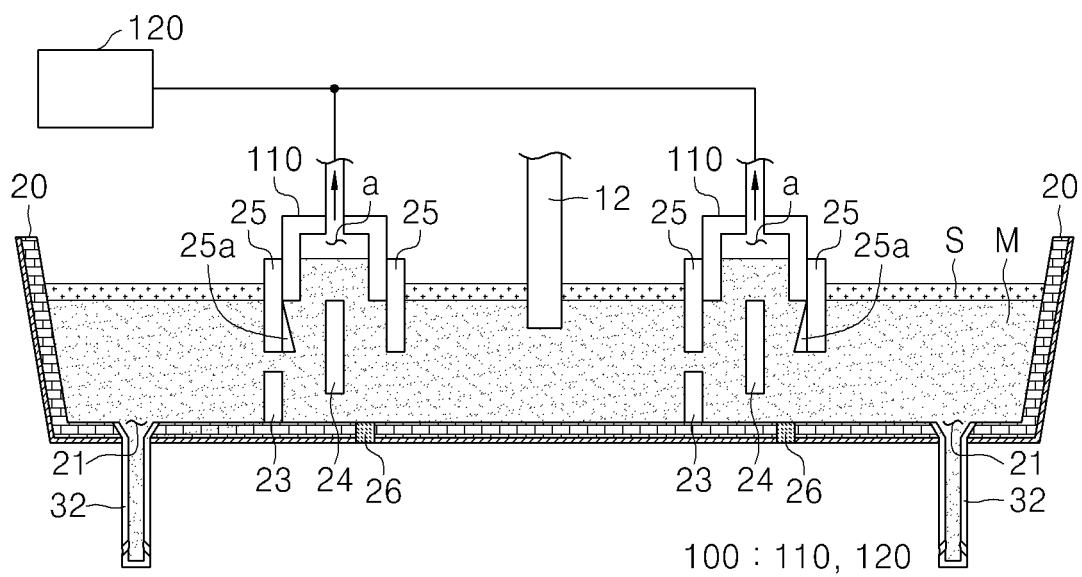


Fig.3

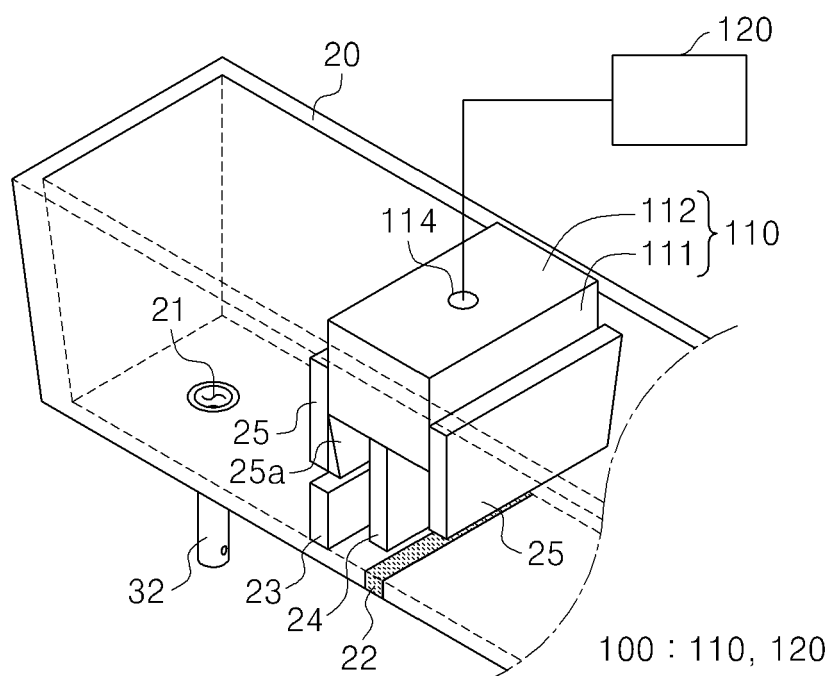


Fig.4

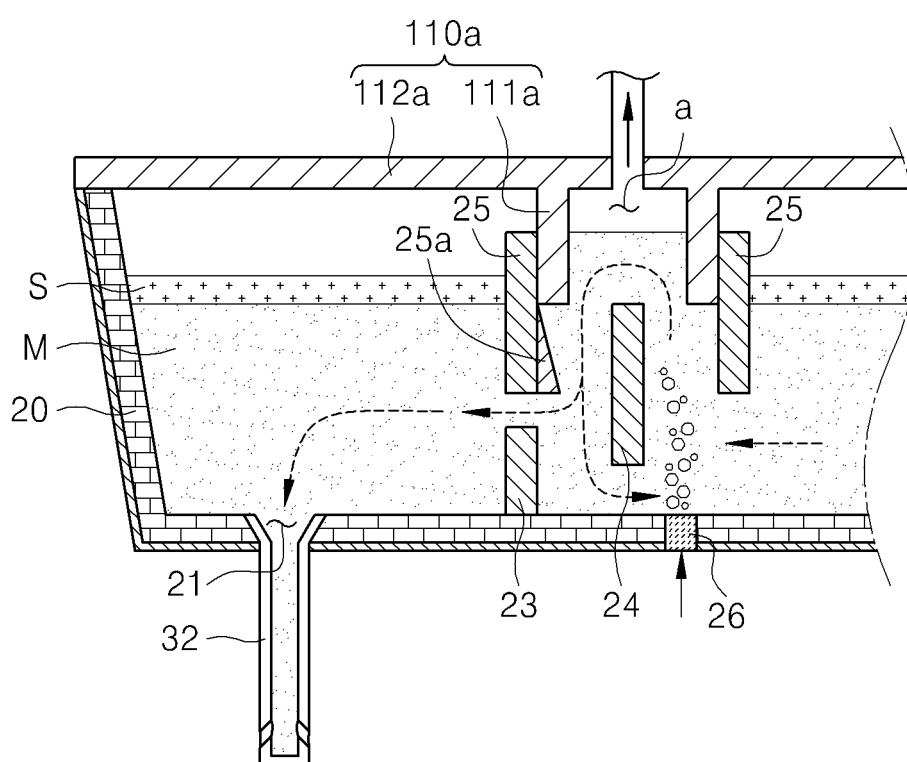


Fig.5

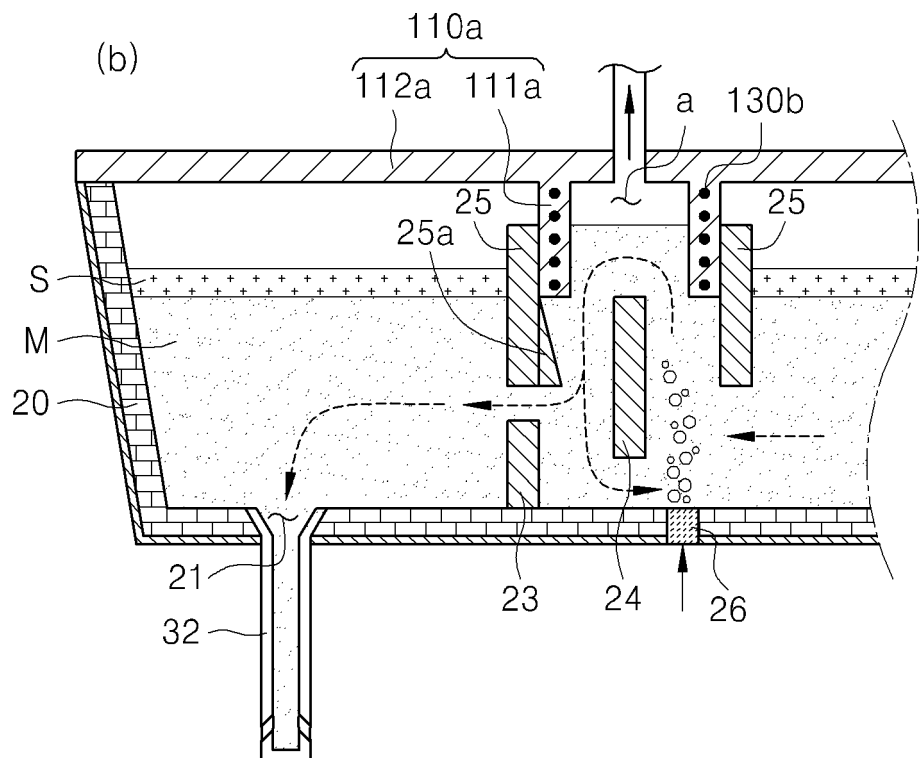
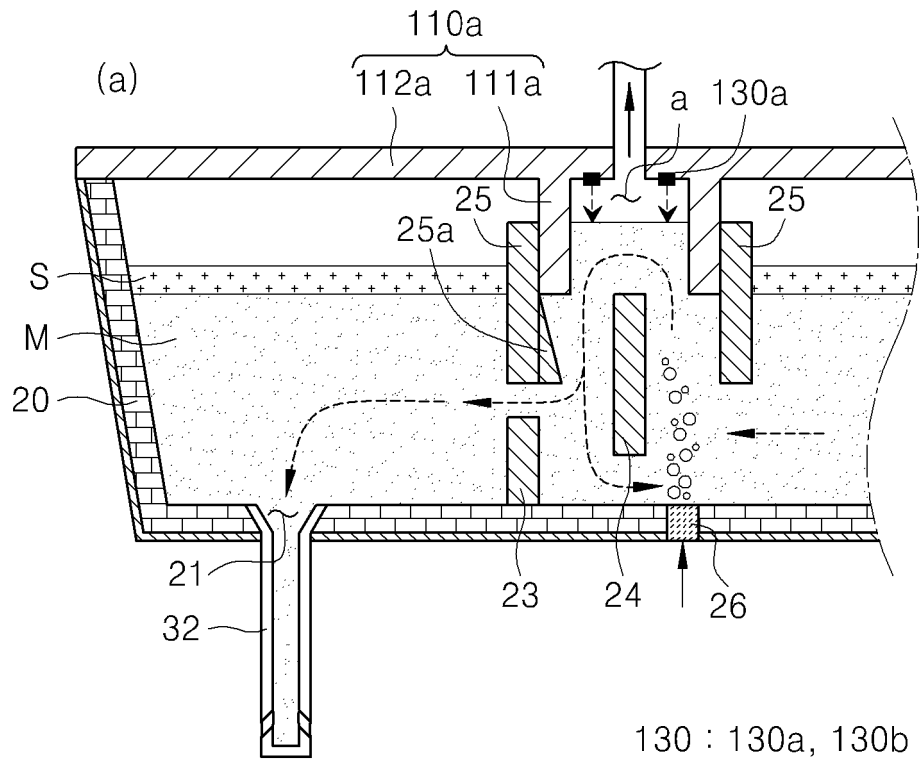
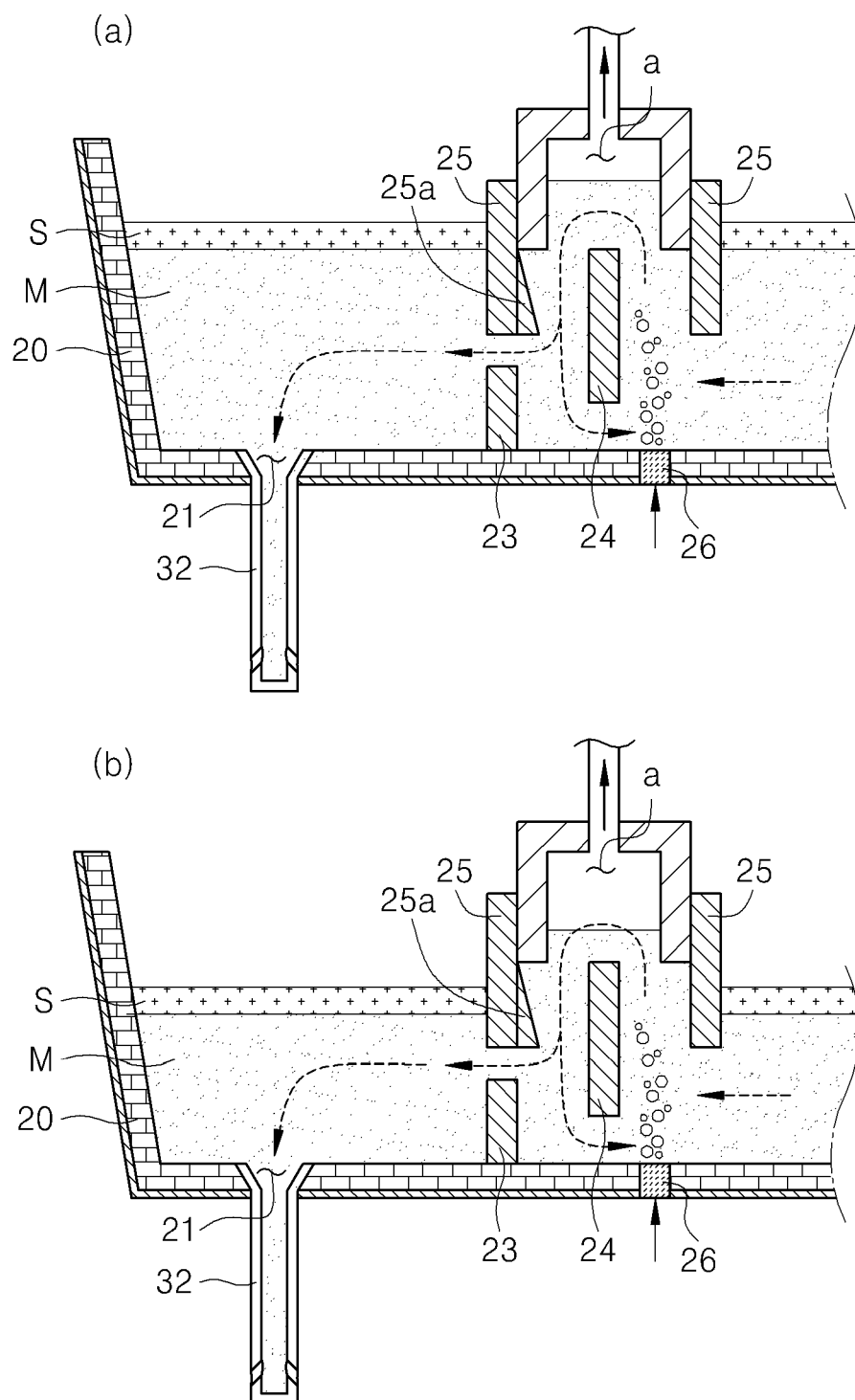


Fig.6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2017/012308

A. CLASSIFICATION OF SUBJECT MATTER

B22D 11/103(2006.01)i, B22D 11/113(2006.01)i, B22D 11/117(2006.01)i, B22D 11/18(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 11/00; B22D 11/10; B22D 1/00; B22D 11/16; C21C 7/072; B22D 11/113; B22D 11/117; B22D 11/18; B22D 41/00

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: tundish, cover member, vacuum pump, nozzle, inducing member, molten steel surface level, sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-119515 A (SUMITOMO METAL IND., LTD.) 23 April 2003 See paragraphs [0061]-[0064], [0071], [0075]-[0078] and figures 11, 13-14.	1-4
Y		5-16
Y	KR 10-2014-0129895 A (HYUNDAI STEEL COMPANY) 07 November 2014 See paragraphs [0026]-[0032] and figure 2.	5-9, 11-16
Y	JP 2006-035272 A (JFE STEEL K.K.) 09 February 2006 See paragraphs [0021], [0036] and figure 3.	7-16
A	KR 20-1998-0033067 U (POHANG IRON & STEEL CO., LTD.) 05 September 1998 See claim 1 and figure 2.	1-16
A	JP 2012-148336 A (JFE STEEL CORP.) 09 August 2012 See claim 6 and figure 1.	1-16

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

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"A" document defining the general state of the art which is not considered to be of particular relevance

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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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 MARCH 2018 (13.03.2018)

Date of mailing of the international search report

14 MARCH 2018 (14.03.2018)

Name and mailing address of the ISA/KR

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Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2017/012308

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		KR 10-2014-0077972 A	24/06/2014
		WO 2013-073212 A1	23/05/2013

REFERENCES CITED IN THE DESCRIPTION

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- JP 4096635 B [0007]
- JP 3654181 B [0007]